

**Using the indigenous technology of making *oshikundu* to mediate
learning of the topic diffusion in Namibia**

A thesis submitted in fulfilment of the requirement for the degree

Of

MASTER OF EDUCATION

(Science Education)

In the

Education Department

Rhodes University

By

Endjala Alma Panduleni

Supervisor: Prof KM Ngcoza

Co-supervisor: Dr Zukiswa Nhase

January 2023

Declaration of Originality

I, Endjala Alma Panduleni (17E8182); hereby declare that this thesis is my own original work and has not been previously submitted in any form for assessment or for a degree in any other higher education institution. All ideas, quotations and other materials used in this study derived from the work of other people have been acknowledged using complete references according to Rhodes University Education Department Guidelines.

A rectangular box containing a handwritten signature in black ink. The signature is stylized and appears to be 'AP' followed by a large, looped flourish.

Signature

January 2023

Date

Dedication

This thesis is dedicated, firstly, to my late Grandmother Justina Naambo ha Jasoni ha Ambole (NgwaJasoni) and my Mom Aili Niita ya Shingwedha Sha Simon. Being my grandmother's child has made me who I am today. Through her guidance and support, I came to understand what it meant to stand tall through various life's situations. She taught me that hard work accompanied by prayer will always yield optimum results. She would say "*Kalunga ka kala no ngunga yomuntu*" [Meaning when we genuinely ask God for our needs God will always provide].

To my mom, you are simply the best mom in the world. Thank you for your love and support, and most importantly learning from you that motherhood is a forever responsibility. Secondly, to my husband Junias Endjala and adorable, beautiful children Naomi Inekela-omuwa and Christoph Theo Iyaloo, thank you for your patience with me during this journey. The future that I desire for you has inspired me to soldier on in this MEd journey.

Acknowledgements

Primarily, I would like to thank the Almighty God who gave me the strength and wisdom to soldier on in this journey. It was never an easy journey but with God's grace, I managed to pull through. I am grateful my God for you strengthened me when I thought I could not do it. I have been fortified by His words that say, "I can do all things through him who strengthens me" (Philippians 4:13).

I would like to express my immense and profound gratitude to my supervisor and co-supervisor respectively. Professor Kenneth Mlungisi Ngcoza, you have been a tremendous mentor and a father. You offered guidance, feedback, motivation, and suggestions throughout my research journey and you were available whenever I wanted help. Prof, thank you for not giving up on me. May God bless you and give you the wisdom to do the same for other students to come. Dr Zukiswa Nhase you have been a true helping hand, a critical eye and an inspiration to me. I would therefore like to humbly thank both of you for encouraging me throughout this research journey and for allowing me to grow in this scholarly fashion.

To my fellow masters' scholars, I am thankful for your constructive comments, suggestions, and your constant motivation. "*Omukulu gonale atile, ondapo yoye hayo yamukweni*" [Meaning the pace at which I completed my study will not be the same with your pace. However, we did it in the end because of Ubuntu among us].

To my three critical readers, Ester Shinana, Martha Nyamakuti and Me Mika, I really do not have enough words to thank you, but the time you spent reading my work is really appreciated. Your Ubuntu is very much appreciated!

Finally, it would be very selfish of me not to thank the research participants in this study for fitting me into their busy schedules. We were an amazing team. To be with you on this journey has afforded me an opportunity to learn from you and I hope this experience was reciprocal as well. I would like to thank Ms Nikki Watkins for professionally formatting and editing my thesis so that it is of high quality.

Abstract

The Namibian Science curriculum acknowledges that indigenous knowledge (IK) is an important basis for learning science. Among the shared reasons is that it provides learners with access to abstract scientific concepts. As a result, teachers are encouraged to integrate IK into the teaching and learning of science. However, it seems that there are no explicit guidelines on how IK should be integrated into science classrooms. It is against this backdrop that this study sought to explore how the indigenous technology of making *oshikundu* (a non-alcoholic beverage) can be mobilised by Grade 8 Life Science teachers to mediate learning of diffusion in their classrooms.

The study was underpinned by interpretive and indigenous research paradigms. Within these paradigms, a qualitative case study approach was employed. Four Grade 8 Life Science teachers from four different schools in Okahandja town, Otjozondjupa Region, Namibia, participated in this study. Additionally, an expert community member who was knowledgeable about the indigenous technology of making *oshikundu* was requested to demonstrate how to make it. In this event, the Life Science teachers had to identify the science concepts embedded in the practice. To gather data, this study made use of semi-structured interviews, workshop discussions, observations and journal reflections. Vygotsky's sociocultural theory was used as a theoretical framework and Mavhunga and Rollnick's topic-specific pedagogical content knowledge (TSPCK) was used as an analytical framework.

The findings of this study revealed that the teachers' understanding was positively influenced by the integration of IK which certainly assisted them to relate better to the concept of diffusion. This was validated when teachers extracted emerging science concepts from the indigenous technology of making *oshikundu*. The implication of this study is that expert community member presentations can greatly enhance sense making of science concepts. The study thus recommends that school-based teachers' continuing professional development in collaboration with expert community members should be carried out to enhance both the teachers' subject content knowledge and pedagogical content knowledge on IK integration.

Keywords: Life Science; scientific knowledge; diffusion, indigenous knowledge; expert community member; *oshikundu*; sociocultural theory, TSPCK

Table of Contents

Declaration of Originality	ii
Dedication	iii
Acknowledgements	iv
Abstract.....	v
List of Tables	xi
List of Figures.....	xii
List of Abbreviations and/or Acronyms	xiii
CHAPTER ONE:	SITUATING THE STUDY
.....	1
1.1 Introduction.....	1
1.2 Background of the Study	2
1.2.1 Namibian education policies.....	2
1.2.2 My personal life history – Situating myself in the study.....	6
1.2.3 My Positionality and reflexivity in the study.....	10
1.3 Advocating for Integration of Indigenous Knowledge	11
1.4 Problem Statement	13
1.5 Purpose and Significance of the Study	14
1.6 Research Goal and Questions	15
1.6.1 Research goal.....	15
1.6.2 Research questions.....	15
1.7 Theoretical Framework.....	15
1.8 Definition of Key Concepts	15

1.9 Thesis Outline	17
1.10 Chapter Summary	18
CHAPTER TWO: LITERATURE REVIEW	19
2.1 Introduction.....	19
2.2 The Namibian Curriculum	19
2.3 The Concept of Diffusion	21
2.4 The Place of Indigenous Knowledge in the Life Science Syllabus in Namibia	24
2.5 Hands-on Practical Activities and Visualisation.....	25
2.6 Indigenous Knowledge in Science Lessons	32
2.7 Theoretical and Analytical Frameworks	36
2.7.1 Theoretical Framework: Vygotsky’s socio-cultural theory	36
2.7.2 Analytical framework: Topic-specific pedagogical content knowledge	41
2.8 Chapter Summary	43
CHAPTER THREE: RESEARCH METHODOLOGY	44
3.1 Introduction.....	44
3.2 Research Paradigm.....	44
3.3 Research Design.....	47
3.3.1 Qualitative case study	48
3.3.2 Research goal and questions	49
3.3.3 Research site, participants and sampling	49
3.3.3.1 Research site	49
3.3.3.2 Research participants and sampling.....	51
3.3.4 Teacher profiles	52
3.3.5 Research methods	53

3.3.5.1 Semi-structured interviews - Phase one.....	54
3.3.5.2 Workshop discussions - phase two	55
3.3.5.3 Participatory observation	60
3.3.5.4 Journal reflections.....	61
3.3.6 Data analysis	63
3.3.7 Validity and trustworthiness	64
3.3.8 Ethical considerations	65
3.3.8.1 Respect and dignity.....	65
3.3.8.2 Transparency and honesty.....	65
3.3.8.3 Accountability and responsibility	66
3.3.8.4 Integrity and academic professionalism.....	66
3.4 Chapter Summary	66
CHAPTER FOUR: SEMI-STRUCTURED INTERVIEWS AND DOCUMENT	
ANALYSIS	67
4.1 Introduction.....	67
4.2 Development of Sub-Themes and Themes	68
4.2.1 Teachers’ understanding of indigenous knowledge.....	70
4.2.2 Teachers’ experiences and pedagogical insights on the integration of IK in the teaching of Life Science	71
4.2.3 Link between Life Science and indigenous knowledge.....	76
4.3 Data Generated from Documents.....	77
4.4 Chapter Summary	86
CHAPTER FIVE: PARTICIPATORY OBSERVATIONS AND REFLECTIONS	87
5.1 Introduction.....	87

5.2 Workshops	87
5.2.1 Intervention workshop	88
5.2.2 Expert community member’s presentations	88
5.2.3 The science behind the making of <i>ongundo</i> (malted sorghum) – new knowledge.....	93
5.3 Teachers’ Conceptual Understanding of Diffusion Using <i>Oshikundu</i> as an Easily Accessible Resource.....	95
5.4 Teachers’ Understanding of the Link between IK and School Science Enhanced.....	98
5.5 Observed Shifts in Teachers’ Zone of Proximal Development and Pedagogy after the Expert Community Member’s Presentation	101
5.6 Chapter Summary	102
CHAPTER SIX: CO-DEVELOPMENT OF EXEMPLAR LESSONS.....	103
6.1 Introduction.....	103
6.2 The Co-development of an Exemplar Lesson.....	103
6.3 The Participants’ Views on the Research Process and How It Influenced Their Teaching of the Concept of Diffusion Integrating IK.....	111
6.3.1 Teacher 1.....	111
6.3.2 Teacher 2.....	111
6.3.3 Teacher 3.....	112
6.4 Chapter Summary	113
CHAPTER SEVEN: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION	114
7.1 Introduction.....	114
7.2 Overview of the Study	114
7.3 Summary of Findings.....	115
7.3.1 Research question one.....	115

7.3.2 Research question 2	116
7.3.3 Research question three	118
7.4 Recommendations.....	119
7.5 Areas for Future Research	120
7.6 Limitations of the Study.....	121
7.7 My Personal Reflections	122
7.8 Conclusion	124
References.....	125
Appendices.....	151
Appendix A: Ethical Clearance	151
Appendix B: Directorate Letter of Consent	152
Appendix C: Principal letter of Consent.....	153
Appendix D: Teachers’ Consent Letter	154
Appendix E: Letter to the Expert Community Member [English]	155
Appendix F: Semi-structured Interview Schedule.....	156
Appendix G(a): Collated Teachers Responses for Semi-Structured Interviews.....	157
Appendix G(b): Themes from Teachers Semi-Structured Interviews	162
Appendix H: Journal Reflection by Teachers.....	164
Appendix I: Predict-explain-explore-observe-explain (PEEOE) worksheets.....	165
Appendix K: Table for TSPCK components	176
Appendix I: Exemplar Lesson	178

List of Tables

Table 3.1: Shows the biographical information of teachers	52
Table 3.2: Shows a summary of the data gathering techniques used in this study	62
Table 4.1: Generated sub-themes from descriptions of the semi-structured interview	68
Table 4.2: Themes and sub-themes that emerged from the SSI	69
Table 5.1: Themes that emerged from the data and supporting theory or literature.....	95
Table 5.2: Some episodes linking IK with school science.....	98

List of Figures

Figure 2.1: Shows the role of integrating IK in the science classroom (adapted from Chikamori et al., 2019, p. 9)	34
Figure 2.2: Showing influential factors on the teachers' ZPD (drawn from Ebadi et al., 2010, p. 242 and adapted from Shinana, 2019, p. 42)	40
Figure 2.3: Showing the five components of TSPCK (adapted from Mavhunga & Rollnick, 2013, p. 115)	42
Figure 3.1: Shows the Namibian map with different regions (www.mapsofworld.com, 2015)...	50
Figure 3.2: The different phases of document analysis (Shinana, 2019, p. 61).....	58
Figure 3.3: Shows the model used in data analysis, to code, categorise and reduce the categories to sub-themes and the sub-themes to themes (Hashondili, 2020, p. 45).....	63
Figure 5.1: Shows <i>ongundo</i> (malted sorghum).....	93
Figure 5.2: Shows unfermented <i>ontaku</i>	96
Figure 5.3: Shows fermented <i>ontaku</i>	97
Figure 5.4: The scientific concepts in the form of mind maps	100
Figure 5.5: Shows the diffusion concept map by the participants	100
Figure 6.1a & b: The knowledge dialogue between IK and insert from a Life Science textbook on diffusion	108

List of Abbreviations and/or Acronyms

CPD:	Continuing Professional Development
CS:	Curriculum saliency
CTS:	Conceptual teaching strategies
ESD:	Education for Sustainable Development
IK:	Indigenous Knowledge
IKS	Indigenous knowledge systems
IT:	Indigenous Technology
LCA:	Learner-centred approach
LCE:	Learner-Centred Education
LOLT:	Language of learning and teaching
MoE:	Ministry of Education
MEAC:	Ministry of Education Arts and Culture
MEC:	Ministry of Education and Culture
MKO:	More Knowledgeable Other
NCBE:	National Curriculum for Basic Education
NSHE:	Natural Science and Health Education
PCK:	Pedagogical Content Knowledge
PEEOE:	Predict-explain-explore-observe-explain
PLC:	Professional Learning Community
SCORE:	Science Community Representing Education
SETD:	Secondary Education Teacher Diploma
SMK:	Subject Matter Knowledge
TMESD:	Transformation Model of Education for Sustainable Development

TSPCK: Topic-Specific Pedagogical Content Knowledge

WS: Westernised Science

ZPD: Zone of Proximal Development

CHAPTER ONE: SITUATING THE STUDY

1.1 Introduction

The main goal of this study was to mobilise the indigenous technology of making *oshikundu* to mediate learning of the topic of diffusion. I worked *with* Grade 8 Life Science teachers on how to integrate the IK of making *oshikundu* when teaching the concept of diffusion in their classrooms. The Namibian secondary school curriculum is implicit with guidelines on using the learners' community in teaching and learning processes. The absence of guidelines on how to use learners' sociocultural background to mediate learning makes it difficult for science teachers to consider the learners' prior knowledge in their teaching, thus, teaching scientific content in a decontextualised way. Moreover, this seems to contradict the affinity with learner-centred education (LEC) being promoted by our education system as espoused by Nyambe (2008).

However, it has been observed that these pedagogical approaches are not well implemented in Namibian classrooms. For instance, Shizha (2013) bemoans the fact that African learners are taught science with no reference to their IK. In other words, they are taught in a decontextualised way and this talks to my childhood experience. My *oshikundu* bottle would shatter due to pressure exerted by the carbon dioxide released as it ferments. This used to reduce me to tears as I thought somebody was deliberately breaking my *oshikundu* bottle, not knowing that there was a scientific explanation. Hence, this influenced my choice of the topic of diffusion. Moreover, Nangolo (2019) looked at osmosis only. This prompted me to look at diffusion, as my life science learners are always challenged in differentiating between diffusion and osmosis. Furthermore, Shinana (2019) accentuates that practical investigations are ignored; hence, teachers would rather teach in the traditional method (teacher talk) to illustrate scientific concepts. Resultantly, she further states that learners find it difficult to comprehend content which eventually leads to poor comprehension of science concepts. Considering this, Mukwambo (2016) suggests that educators should adopt contextualised teaching and learning pedagogical practices believing that it brings authentic context that helps aid learners to see the relevance of science concepts. This context triggered this

study which sought to support Grade 8 Life Science teachers in gaining knowledge on the concept of diffusion and on how to mediate the learning of diffusion using the integration of IK.

In this chapter, I thus describe the background of the study based on the National Curriculum for Basic Education in Namibia (Ministry of Education, Arts and Culture [MEAC], 2016), the subject policy for Life Science (MEAC, 2009) as well as literature from several Namibian scholars who have explored a similar context in recent years. This is followed by my personal experiences, the problem statement and the significance of this study. The research goal, questions and summary of the theoretical and analytical frameworks of the study are highlighted. Lastly, the key concepts used in the study are defined and the thesis outline is provided. I end with a chapter summary in which I pull the threads together.

1.2 Background of the Study

This section provides in-depth information related to the background of the study. It sets the stage for the purpose of the study and shows why it was worth carrying out.

1.2.1 Namibian education policies

Central to the Vision 2030 is the attainment of a knowledge-based society through human resource development. Thus, within this framework, the goal of basic education is to ensure that learners have access to quality education. Vision 2030 further states that “the country will operate a totally integrated, unified, flexible and high-quality education and training system prepares Namibian learners to take advantage of a rapidly changing global environment, including developments in science and technology” (National Planning Commission, 2004, p. 10). Consequently, this highlights the commitment the Namibian government has toward the learning of science education. It also offers an opportunity for Namibian educators to join hands with the government to explore how science can be taught in a way that makes sense to the Namibian child, thereby enabling them to apply their learnt knowledge in their respective societies. Consequently, this is echoed in the vision statement of the Ministry of Education that states that it envisages, “a prosperous and industrialised Namibia, developed by her human resources, enjoying peace, harmony and political stability contribute to the economic and social development of the citizens” (MoE, 2010, p. 2).

The education curriculum in turn has been developed to give direction to basic education towards the realisation of Namibia Vision 2030 (MoE, 2010). It ensures the continuation of the foundation principles of the Namibian education system described in *Toward Education for All* (Ministry of Education and Culture [MEC], 1993). Namibia aims at “developing from a literate society to a knowledge-based society where knowledge is constantly being acquired and renewed and used for innovation to improve quality of life” (MEAC, 2015, p. 2). At the centre of innovation are the science subjects.

In this regard, the Namibian school curriculum highlights that development in the field of natural science is one of the main driving forces behind the transformation of society and the world. Thus, the curriculum has defined scientific literacy as understanding scientific processes and being able to apply scientific thinking and skills which are deemed crucial today. Accordingly, the natural sciences area of learning contributes to the foundation of a knowledge-based society by empowering learners with the scientific knowledge, skills and attitudes to formulate hypotheses and to investigate, observe, make deductions and understand the physical world in a rational, scientific way. Contrary to the policy documents is the fact that Shizha (2013) bemoans the fact that African learners are taught science with no reference to their IK. Additionally, most teachers do not seem to be trying to integrate IK into their classrooms.

Asheela’s (2017) study conducted in Namibia revealed that some participating teachers who did not try to integrate learners’ IK indicated that they had no experience in how to use it to carry out hands-on practical activities in their science classrooms. This is caused in part by the lack of IK features in the curriculum and the structure of the education system that makes it hard for teachers to integrate IK into their teaching practices (Seehawer, 2018b). Teachers thus only teach what is in the textbooks, herein referred to as westernised science in this thesis. In consequence, this affects learners’ performance in science since they cannot link the westernised science taught at school to their everyday experiences (Le Grange, 2007; Gwekwerere, 2016; Shizha, 2007).

Worth noting is that in the context of this study, prior everyday knowledge entails a combination of prior knowledge that learners acquire from previous grades and IK acquired from their everyday experiences at home or in the community (Kuhlman, 2011). The NCBE stipulates that the fundamental structure of the learning process at all levels is to use the learners’ existing knowledge

and ideas to bring in new knowledge and to facilitate and direct them in transforming their prior knowledge into new knowledge (MoE, 2010). This is based on the notion that learning begins with the interests of learners and their experiences (MEAC, 2015). The above arguments are based on the premise that learners do not come to school as empty vessels, but instead they possess knowledge which is accumulated from their everyday life experiences (Gwekwerere, 2016). Moreover, their everyday life experiences can be taken advantage of and capitalised on during the learning process. The interest of this study was to provide an intervention through workshops that may enable teachers involved in this study to integrate IK into their science teaching.

Similarly, the Life Science syllabus is developed in a clear and simple style in order to provide new innovations in conceptual learning based on the ethos of learner-centred education (LCE). Learner-centred education (LCE) is a Namibian conceptual policy framework that encourages learner participation and involvement during teaching and learning (Sedlacek & Sedova, 2017). Mubita (1998) posits that LCE focuses on the learner and not on the teacher – meaning that it points out that teachers are expected to have a holistic view of the learner, valuing the learners’ life experience as the focal point of learning and teaching (MEAC, 2016, p. 1). Teachers are therefore expected to select teaching methods that can mediate learning content with the learners’ immediate environment.

Moreover, the implication of LCE pedagogy for teachers is that it points out their roles, teaching approaches and instructional materials, which includes the way teaching is organised. In other words, a teacher in LCE guides the learners in acquiring new knowledge and skills by creating a stimulating learning environment. This does not imply that the teacher is the only source of knowledge, but rather that they facilitate the learning processes and that learners are active agents (Nyambe & Wilmot, 2012). It thus suggests that, as alluded to earlier, teachers should select culturally responsive teaching and learning methods (Mavuru & Ramnarain, 2017).

Consequently, this evidently means that Namibia, in its National Curriculum for Basic Education (NCBE) (MoE, 2010), also aims at embracing IK for the learners as they see the value in it. Nevertheless, the syllabus does not state how the integration should take place and teachers seem to be grappling on how to implement LCE approaches. Moreover, Nyambe and Wilmot (2012, p. 22) posit that there are “contradictions in educators’ interpretations and practice of what learner-

centred education pedagogy is". In the context of this study, it was therefore presumed that pedagogical strategies refer to the methods, techniques, procedures and processes that a teacher uses during instruction. This study was thus aimed at providing an opportunity in the form of an intervention to mobilise and demonstrate how IK could be used in teaching science concepts thereby providing access to the abstract science concepts such as diffusion in the context of this study. Furthermore, this study introduced the teachers to cost-effective resources from the learners' immediate environment that the teachers can use in their classrooms to enhance conceptual understanding through practical demonstrations. This was done for the purpose of mobilising the use of easily accessible and cost-effective resources, which in my view could mitigate the lack of resources highlighted by scholars such as Asheela (2017), Asheela et al. (2021) and Nangolo (2019).

The decontextualised learning of science in Namibian schools is echoed yearly in the examiners' reports that are released by the MoE. This study analysed examiners' reports for grades 10 and 12 then (old curriculum) and currently for Grade 11 (new curriculum). In my opinion, the examiners' reports are very important documents for every educator as they summarise the learners' answers in each subject. Past studies have portrayed examiners' reports as one-sided. They portrayed them as only vital for analysing learners' answers and then using them to state the existing problems. However, examiners' reports could also be used as guides for improving teachers' pedagogies with regard to topics that are highlighted as problematic for learners. In this study, I used the examiners' reports to support the claim that the learning of diffusion is rather decontextualised resulting in learners' answers being superficial and non-scientific.

For instance, the Life Science and Biology examiners' reports for 2014–2021 highlight that learners do not show comprehension of concepts and one of the concepts stated is diffusion which is the focus of this study. In addition, it is also observed that at times, the knowledge demonstrated is rather superficial. For example, during 2011, Life Science examination learners were asked to give the functions of the placenta. The examiner's report highlighted that many learners had a vague idea when answering. They used terms like transport, give, take and provide as opposed to the expected answer which is diffusion. In fact, the correct answer is that it enables diffusion of substances between mother and foetus.

Moreover, when learners were asked to describe what would happen to the dialysis tube containing a salt solution if placed in pure water, they could not interpret their answers based on the context given. This suggests that learners could not differentiate between *osmosis* and *diffusion*. Moreover, the examiners' reports also pointed out that with reference to questions related to diffusion, learners' answers were of poor quality and that sometimes they opted to leave the questions unanswered (MoE, 2016).

I have also used the examiners' reports for introspection into my own teaching – this meant proposing a pedagogical shift using the integration of IK (making of ¹*oshikundu*) as a mediation for the teaching of diffusion. Based on these findings, the examiners' reports suggested that the poor quality and unscientific answers observed in the learners' responses might be attributed to poor teaching in science classrooms (MoE, 2016) as well as a lack of understanding of certain science concepts by teachers (Kapenda et al., 2002). Other scholars, however, have hypothesised that a lack of understanding of certain science concepts could be caused by limited use of hands-on practical activities when teaching science especially in under-resourced schools (Asheela, 2017; Asheela et al., 2021; Nangolo, 2019). I would like to confess that I have been a culprit in this regard as well.

1.2.2 My personal life history – Situating myself in the study

Being born and raised in a rural area, I can recall many local indigenous technologies which formed part of our livelihoods such as making *oshikundu*, collecting firewood, starting a fire and fermenting fresh milk. During my childhood, fresh milk obtained from cows needed to be preserved due to its perishable nature. One would pour it in a special container called *ondjupa* (*calabash*) and add roots from a tree called *omunkundzi*. The roots from the *omunkundzi* (*Bascia albitrunca* – Shepherd's tree) causes the milk to ferment faster so that it could turn into sour milk (Liveve, 2022). This meant that these roots are used as a catalyst that speeds up chemical reactions.

¹Oshikundu is a traditional *Oshiwambo* beverage made from sorghum and omahangu (pearl millet) flour and it is non-alcoholic. It is a staple drink for many *Oshiwambo* speakers in Namibia and it is a rich source of carbohydrates, proteins, vitamins, minerals as well as water for the body that prevents dehydration. Learners in the northern regions' everyday carry Oshikundu to school instead of juice as part of their lunch boxes.

When the ondjupa is full, it is then shaken for the lumps caused by the chemical reaction in the milk to smoothen out. The milk forms fat, and the fat and milk would then be separated. The fat would be used for cooking and the sour milk was preserved for eating with mahangu pap. The fat obtained from the milk is referred to as *omagadhi geengombe* (fat from cow milk). It does not taste like butter but more of cheese.

As I narrate the IK from my past experiences, I recall something that happened to my *oshikundu* bottle that I used to carry to school. I carried *oshikundu* to school in a bottle as my lunch. We used to collect these bottles from Cuca shop damping sites as our house was near Cuca shops. Thus, bottles were the readily available containers for carrying my *oshikundu* beverage. The school that I attended was about four km from our house. Because the school was far, the older learners that I used to walk with had come up with an idea of hiding our *oshikundu* bottles in the bushy area between our houses and closer to the school. The way of hiding the *oshikundu* bottle was putting it (bottle) under the leaves of any bush. The idea was that the shade of the leaves would keep the *oshikundu* cooler. However, to my surprise, in hotter days you would come back to find the bottle had shattered. I always wondered with tears what could have happened to my bottle as I looked forward to drinking my *oshikundu* along the journey from school. This question remained unanswered throughout my primary education phase as my sociocultural background was not taken into consideration during teaching and learning (Mavuru & Ramnarain, 2020). This also continued in my own teaching as well, prior to IK integration exposure.

Accordingly, Simpson (2014) recounts his school experiences in the following passage:

My experience of education, from kindergarten to graduate school, was one of coping with someone else's agenda, curriculum, and pedagogy, someone who was neither interested in my well-being as a kwezens, nor interested in my connection to my homeland, my language or history, nor my Nishnaabeg intelligence. No one ever asked me what I was interested in nor did they ask for my consent to participate in their system. My experience of education was of continually being measured against a set of principles that required surrender to an assimilative colonial agenda in order to fulfil those principles. (Simpson, 2014, p. 6)

From Simpson's quote above, it can be deduced that education was not relevant to him as it did not solve the peculiar situation that he encountered in life similar to my peculiar question of what made my bottle shatter. If I knew the reason, I would have stopped the practice of hiding my bottle

as it meant fermentation would take place and the volume of carbon dioxide would cause the bottle to shatter as solids have an expansion limit.

Upon completion of the Secondary Education Teacher Diploma training in 2009, I had no idea how to identify such knowledge called IK. Moreover, I did not carefully consider the role of prior everyday knowledge and the use of hands-on practical activities in science as a method of promoting the hands-on, minds-on and words-on approach (Asheela et al., 2021, Liveve, 2022). Certainly, there is time for everything.

At Rhodes University, I was exposed to IK both in my BEd Honours and master's in education. This has equipped me with the knowledge to realise the role and value of IK in the science curriculum. During Namibian Colloquiums, I have seen how other researchers are mediating different science concepts with IK. This has played a role in my introspection of my PCK in teaching which did not include elicitation of prior knowledge before IK exposure.

For the past nine years that I have been teaching Life Science and Biology, I have noticed with concern that learners perform poorly in these two subjects. This is pointed out in the Life Science and Biology examiners' reports for 2014–2021 as the learners do not show understanding of science concepts. Worth noting is the fact that even though the Namibian NCBE (2010, p. 7) calls for knowledge which embraces indigenous knowledge, it fails to explicitly indicate how IK should be aligned with the content in the science curriculum. This means, it then becomes worrisome because this implicit instruction of IK integration could lead to science teachers having different perspectives and interpretations of how best this integration can be achieved or they may fail to include it at all (Ogunniyi, 2007a; Onwu, 2012).

While the design of the curriculum could also influence the use of IK in science classrooms, some scholars such as Cronje et al. (2015), Govender (2014) and Ogunniyi and Hewson (2008) highlight that the views that science teachers hold about IK could act as a barrier against its successful integration into science classrooms.

Having the privilege of being part of Rhodes University, I had an opportunity to be exposed to the concept of IK. Practically, in our second year of BEd Honours (2018), we were tasked to apply teaching methodology which included the application of IK in our classrooms. The health

education chapter in Grade 9 Life Science, for instance, has an objective that requires learners to look at traditional medicines in their communities. As a result, during class discussions I noticed that my learners enjoyed talking about their local knowledge. This triggered my interest to carry out a study that would allow other teachers to mediate their teaching using learners' IK to help them contextualise the scientific concepts that might be challenging to their learners. Klein (2011) points out that the starting point for teaching and learning should be from the wealth of knowledge and experience gained from family, community and through interactions with the environment. Considering this, Roschelle (1995) highlights that if learners' prior knowledge is not elicited, they might end up learning something that is opposed to the teacher's intentions, thus leading to poor quality and non-scientific answers.

Notably, prior to the introduction of easily accessible resources as a way of carrying out hands-on practical activities (Asheela et al., 2021), I was not carrying out hands-on practical activities with my Life Science and Biology learners except for the higher-level Biology learners. This was because materials were not always available and acquiring these practical activity materials by the school meant spending money that the school does not have. Furthermore, the time needed for planning the practical activities felt like wasted time that could be used to plan the actual teaching of the learning content of what would be asked in the examination – I did not understand the importance of hands-on practical activities. In this regard, Asheela et al. (2021) opine that practical activities encourage active participation. They further highlight that practical activities enable identification of key concepts, conceptual understanding, education quality and relevance and make learners experience science first-hand. Moreover, Woodley (2009) and Millar (2010) accentuate that effective hands-on practical activities enable learners to make links between theory and practice. This ensures that the learners can apply their scientific understanding to the real-world application of science.

It is against the background described above that this study sought to engage Grade 8 Life Science teachers in an intervention on how to integrate IK in their lessons. In this interventionist study, I used the indigenous technology of making *oshikundu* as a vehicle to achieve this integration. This indigenous technology of making *oshikundu* was chosen for this study because of its potential in enabling mediation of learning of the concept of *diffusion* in Grade 8 Life Science classrooms.

1.2.3 My Positionality and reflexivity in the study

Moser (2008, p. 89) describes positionality as factors that “impact on the way we do our research and how the people we work with perceive us”. On the other hand, Thomas (2013) describes positionality as an undeniable position in the research process that affects the nature of the observations and the interpretations that the researcher makes. The IK technology of making oshikundu is mostly done by girls and women in the Oshiwambo culture and I was very nervous as I had two male participants and one female participant. Moreover, the participants were from two ethnic groups of Namibia, namely two Oshiwambo speakers and one Caprivian speaker. However, the diversity turned out to be an advantage because our Balangwe brother related his observation to his own sociocultural background and this made this study inclusive showing that IK can be used in multicultural settings. Moreover, “the social world in which we are interested in as social scientists is not straightforwardly perceivable because it is constructed by each of us in a different way” (Thomas, 2013, p. 108). He thus cautions that researchers must be explicit in their interest, personal circumstances, uncertainties and allegiances in the study undertaken.

I conducted this research as an MEd student, and I believe that this might have affected the study in terms of positionality. I, therefore, discussed the issue of positionality by ensuring that all the participants in this study knew and understood that their participation in this study was voluntary and that they were free to withdraw from participating in the research at any time they felt like doing so. Moreover, since the culture of participants was guided by the spirit of Ubuntu, participants looked forward to the communal discourse where every person’s opinion would be equally valued (Seehawer, 2018a).

Similarly, I also communicated to the participants that I was a co-learner during the presentations by the expert community member who was knowledgeable about the traditional technology of making *oshikundu*. This shows that I conducted this research *with* them rather than *on* them as we were all involved in the construction of knowledge (Ngcoza & Southwood, 2015). Thus, the workshop discussions we had enriched me with other indigenous technologies that align with the Life Science content thereby giving all of us the potential to make science accessible to the Namibian child.

I was also mindful of the fact that the expert community member was a custodian of the cultural heritage of making oshikundu and was therefore regarded as a more knowledgeable other as proposed by Vygotsky (1978). Therefore, the MKO's inputs would broaden our understanding of an indigenous practice in relation to the concept of diffusion embedded in the indigenous technology.

Moreover, this research helped me to be a reflexive researcher who was able to adjust to the situation when the need arose. I reflected each day after the research process. This helped me to be better prepared for each research phase. According to Isaacs (2019), I needed to be mindful that the “researcher influenced the research process, and the reflexivity is required in managing the complex social relations that invariably arose on the research journey” (p. 124). Thus, reflexivity allowed teachers to be open with me and I gave them the power to decide when the next phase of the research process would be done. Therefore, reflexivity enabled me to humble myself throughout the research process and beyond (Liveve, 2022).

1.3 Advocating for Integration of Indigenous Knowledge

Numerous African scholars have explored ways on how to alleviate the decontextualised science curriculum. Among the suggestions is the elicitation and use of learners' prior knowledge by science teachers (Kuhlane, 2011; Roschelle, 1995) and the use of easily accessible resources (Asheela, 2017; Nangolo, 2019; Shinana, 2019). Learners' prior knowledge involves the knowledge that the learners have acquired from the previous grades and the knowledge that the learners have gained from everyday experiences, such as at home or in the community. The idea of teaching science content using IK, such as learners' prior knowledge coupled with home experiences, is observed in the Life Science curriculum. On the other hand, use of easily accessible resources entails using materials that are available in the teachers' and learners' environments (Asheela et al., 2021).

For instance, some African scholars have called for the integration of IK into the school curriculum (Naidoo & Vithal, 2014; Ogunniyi & Hewson, 2008). These scholars believe that this could lead to meaningful and relevant learning. It is opined that, teaching without drawing on the learners' experiences makes learning of science alienating as the concepts appear abstract and generally out of touch with the reality of their world (Eriniso, 2013). Klein (2011) suggests that this feeling of

alienation often causes a high drop-out of learners from school. Following from this literature, Namibia as well as South Africa have responded to this call as evident in the transformation of their education policies.

In South Africa, for example, the Department of Basic Education, in the Curriculum and Assessment Policy Statement (CAPS, 2011) outline its aim as to value indigenous knowledge systems (IKS). Similarly, Namibia, (MoE, 2010, p. 7) embraces the integration of IK suggesting that teachers should select learning content and methods within the learners' immediate environment and community (MEAC, 2016).

Worth noting is that there have already been several studies that have heeded the call for the integration of IK into science teaching in Namibia under the Rhodes University umbrella research programme. My study was also part of this research programme. The research carried out by these scholars so far has revealed, for example, that some science teachers do not include or make use of IK in their science classrooms (Amutenya, 2014), while others try to integrate IK when opportunities arise (Mukwambo, 2017; Nikodemus, 2017). However, some studies (e.g., Asheela 2017; Nangolo, 2018; Ndevahoma, 2019) have recommended the integration of IK because they discovered that it promotes learners' participation as it helps them ask questions to link what they know to classroom science. In addition, they also established that learners' interest in science is boosted. Like any other developing country, Namibian schools are under-resourced. As a result, the need for use of local materials such as those used in IK is on the rise. Consequently, those scholars who have explored the use of easily accessible local materials found that these have potential to afford learners an opportunity to make sense of science concepts (Asheela, 2017; Samuel, 2017). While these studies revealed evidence of the benefit of using IK in teaching, teachers' views towards the integration of IK are also of great concern.

For instance, scholars such as Cronje et al. (2015), Govender (2014) and Ogunniyi and Hewson (2008) highlight that the views that science teachers hold about IK could act as a barrier against its successful integration into science classrooms. It is against this backdrop that this study sought to engage Grade 8 Life Science teachers in an intervention on how to integrate IK during their lessons. The cultural practice of making *oshikundu* was chosen for this proposed study because of its potential in enabling the mediation of learning the concept of *diffusion* in Grade 8 Life Science

classrooms. Learning the concept of diffusion at this level provides the learners with the basic ideas to differentiate diffusion from osmosis and active transport. Diffusion seems to be one of the problematic topics that has been identified in the national external examinations. My assumption is that the concept of diffusion could be taught in some de-contextualised ways.

I acknowledge that *diffusion* and *osmosis* are closely related concepts and if not properly contextualised, they can be easily confused (MEAC, 2016). A study on osmosis has been conducted in Namibia by Nangolo (2019), who explored how Grade 11 Biology teachers mediated learning of osmosis when using easily accessible resources. Her findings revealed significant challenges when teaching osmosis as a scientific concept notably in under-resourced schools. My study was an extension of her study and focused on the topic of diffusion.

Similar to Asheela's (2017), Nangolo's (2019) and Ndevahoma's (2019) studies, my study also aimed at using easily accessible resources. In contrast to these studies, however, as an innovation I invited an expert community member² to come and demonstrate how the indigenous practice of making *oshikundu* can be used to mediate the learning of diffusion. Notable is that the expert community member presented her practical demonstration in English. This is because not all the informants who were involved in this study were Oshiwambo speakers. Previous studies conducted on the use of community members to help mediate learning of science concepts proved to have successful results (Hashondili, 2020; Nyamakuti, 2021; Shinana, 2019). Similar to these studies, the expert community member was regarded as a more knowledgeable other as espoused by Vygotsky (1978).

1.4 Problem Statement

The poor performance of Namibian secondary school learners has been linked in part to a lack of understanding of certain science concepts (Kapenda et al., 2002). Additionally, other scholars have highlighted that poor performance in certain concepts is caused by limited use of hands-on practical activities when teaching science especially in under-resourced schools (Asheela, 2017;

²The community member is referred to in this study as an expert since she is the custodian of the indigenous technology of making *oshikundu*.

Nangolo, 2019). Moreover, Mika's (2019) study indicates that teachers seem to be faced with some challenges in integrating IK into their teaching practices.

Shinana (2019) expands on the challenges by pointing out that teachers do not realise that when faced with a lack of resources in their teaching, they could explore their immediate environment to look for alternative resources. She believes that this might afford them an opportunity to integrate learners' IK into their teaching. As alluded to earlier, the examiners' reports stated that learners are unable to differentiate between *osmosis* and *diffusion* concepts (MoE, 2016). My assumption is that this problem could be with science teachers rather than learners *per se*. It is against this background, therefore, that in this interventionist study, I sought to explore working *with* Life Science teachers using the traditional practice of making *oshikundu* by a community member to develop exemplar lessons on diffusion that they might use when integrating IK into their Grade 8 classrooms.

1.5 Purpose and Significance of the Study

The purpose of this study was to explore working with Grade 8 Life Science teachers using the indigenous technology of making *oshikundu* by a community member to develop exemplar lessons on diffusion that they might use when integrating IK into their Grade 8 classrooms. The cultural practice of making *oshikundu* was used as a vehicle or catalyst in this regard. This study could be of value in addressing the aspects of science teaching in the Namibian context – namely, the implementation of contextulised teaching and learning pedagogical practice approaches that aim at integrating IK into science teaching. A further potential value of this study is that it might hopefully contribute to the field of science teaching in Namibia in such a way that other scholars will close the gap of what I may have left out. Moreover, the participants might get some insights on how to mediate the learning of science concepts – diffusion in the context of this study – and draw on locally found materials, such as the ones used in the process of making *oshikundu*. Together with the participants, we might also be afforded an opportunity to improve our pedagogical content knowledge (PCK) on the topic of diffusion in particular, which might positively contribute to our personal pedagogical content knowledge (Carlson & Daehler, 2019).

The process of making *oshikundu* was selected as it provided a representation opportunity to the participants with regards to diffusion.

1.6 Research Goal and Questions

In this section I present the research goal and the research questions of the study.

1.6.1 Research goal

The main goal of this study was to mobilise the indigenous technology of making *oshikundu* to support Grade 8 Life Science teachers to develop exemplar lessons that integrate learners' IK in the teaching of diffusion. To achieve this goal, the study was guided by the following research questions.

1.6.2 Research questions

1. What are Grade 8 Life Science teachers' perspectives and pedagogical insights on the integration of local indigenous knowledge in their teaching?
2. In what ways do Grade 8 Life Science teachers interact, participate and learn (or not) during the practical demonstration of making *oshikundu* by the expert community member?
3. How do the Grade 8 Life Science teachers co-develop and then teach the exemplar lesson on diffusion that integrates indigenous knowledge in their classrooms?

To address the aforementioned research questions, a qualitative research design was employed and data sets were collected using semi-structured interviews, document analysis, workshop discussions, participatory observation and journal reflections.

1.7 Theoretical Framework

Adom et al. (2018) defines a theoretical framework as a foundation upon which the research is constructed in terms of philosophy, epistemology and methodology. In this study, Vygotsky (1978) supposes that learning takes place through social interactions with materials from people's cultures in their society and this was suitable for this study.

1.8 Definition of Key Concepts

Diffusion is the movement of molecules from a high-concentration area to a low-concentration one due to their kinetic energies (Kurt et al., 2013).

Easily accessible resources are materials that are easily available within a particular context which materials which can be obtained from the local environment or bought from local supermarkets (Asheela, 2017).

Indigenous knowledge is the inherited information and practices of the indigenous people that they have used and that have survived over a long period (Mapara, 2009).

Pedagogical Content Knowledge (PCK) is a concept which describes the knowledge which teachers have in terms of pedagogy and subject knowledge (Shulman, 1986).

Practical activities/investigations is any science teaching and learning activity in which learners are working individually or in groups, handling and observing the objects or materials they are studying (Millar, 2010).

Socio-cultural theory is a theory which emphasises that knowledge is acquired through social interaction (Vygotsky, 1978).

Social interaction is the process by which we act and react to those around us and the environment (Vygotsky, 1978).

Learner-Centred Education is an approach where a learner is put at the centre of the education process and actively engages in their own learning, and the teacher facilitates or mediates learning (MBEC, 1999; Nyambe, 2008).

Mediation involves the use of cultural tools such as language and materials to achieve the learning goal (Vygotsky, 1978).

Prior knowledge refers to knowledge individuals already had before they are exposed to new information (Roschelle, 1995; Lee, 2007).

Professional Development refers to a wide variety of specialised training where professional learning is expected to take place to improve professional knowledge and skills (Runhaar, 2008; Shabani, 2016).

1.9 Thesis Outline

The study was conducted at Inekela Secondary School (pseudonym), an urban area school in Okahandja, Otjozondjupa Region, in Namibia. The thesis consists of seven chapters.

Chapter One: Situating the Study

This chapter provided the background of the study and highlighted the reason for carrying out the study. The context was informed by the challenges of teaching science at international and national levels. The statement of the problem was explained, such as the gap in Namibian curriculum implementation. In addition, the potential value and the significance of my study was explained in relation to the indigenous technology of making *oshikundu* with a view to making science accessible to learners. The theoretical framework informing my study was briefly discussed. Lastly, the research goal and research questions, key concepts and thesis outline were provided.

Chapter Two: Literature Review and Theoretical Framework

This chapter presents literature relevant to the study to shed light on the existing knowledge on diffusion, curriculum requirements and the integration of IK in teaching science. In addition, literature on the conceptual, theoretical and analytical frameworks that underpinned this study are also discussed.

Chapter Three: Research Methodology

This chapter presents an overview of the research methodology (research paradigms and research design) underpinning this study. Furthermore, I outline the research goal, questions and process of the study. Thereafter, the research site, participants, sampling, research methodology and data generating techniques are discussed. The chapter also explains how the data generated from the various techniques were analysed. Lastly, the chapter presents a discussion pertaining to issues of validity and trustworthiness as well as those pertaining to ethical considerations.

Chapter Four: Semi-structured Interviews and Document Analysis

In Chapter Four, I present, analyse, interpret and discuss the data from semi-structured interviews and document analysis to answer research question one. The data generated shows that the science teachers have some understanding of IK but find it challenging to elicit it and integrate it into their teaching. Moreover, the findings show that teachers believe that if professional development platforms are available their PCK will improve.

Chapter Five: Participatory Observations and Reflections

This chapter gives a narrative description of data generated from the study. I present, analyse, interpret and discuss the qualitative data generated from the intervention workshop, mind map and concept map development workshop. I also present the journal reflections from the participant teachers.

Chapter Six: Co-development of an Exemplar Lesson

In this chapter I present an analysis and discussion of the data generated from the discussion during the development of an exemplar lesson.

Chapter Seven: Summary of Findings, Recommendations and Conclusion

In this chapter, I present a summary of the findings of the study as per the research questions. Further, I present recommendations for further studies, the limitations of the study, personal reflections and conclusion of the study.

1.10 Chapter Summary

In this chapter, I discussed the context of this study focusing on the international context of IK integration into science learning. In the local context, I discussed the expectations of Namibia's NCBE and its stance on IK integration in school science teaching. This was then followed by the statement of the problem, purpose and significance of this study, research goal and questions and a summary of the theoretical and analytical frameworks. Lastly, the chapter presented the data generating techniques, key concepts used in the thesis and the thesis outline.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The main goal of my study was to explore how the indigenous technology of making *oshikundu* can be mobilised through workshops with Grade 8 Life Science teachers to mediate learning of diffusion in their classrooms. Thus, the purpose of this chapter is to discuss and explore the various studies and literature on the concept of diffusion and how IK can be mobilised to help teachers contextualise science.

I first discuss the Namibian curriculum, the concept of diffusion, prior knowledge, IK, the importance of integration of IK in the classroom and the challenges of integrating IK into classrooms. Moreover, as indicated earlier, the focus of this study is on teachers learning about the integration of IK to mediate the concept of diffusion in their classrooms. Thus, I also discuss literature on professional development in this chapter. Lastly, the theoretical and analytical frameworks, namely Vygotsky's (1978) sociocultural theory and Shulman's (1986) PCK are also discussed.

2.2 The Namibian Curriculum

Education is the most powerful tool that can be used to change our world and attain self-enlightenment. Thangeda et al. (2016) outline that the all-time purpose of education is to empower and impart skills and knowledge to learners. Namibia, like all other countries, has its own NCBE. This official policy document guides teaching and learning in Namibian schools. It provides guidelines in terms of how to plan, organise and implement teaching and learning in schools as well as information about the knowledge that needs to be taught (MEAC, 2016). Furthermore, the curriculum states that it has been developed towards the realisation of Namibia's economic benchmark Vision 2030 which accordingly pronounces the goal for basic education as to "empower learners to actively participate in making Namibia a knowledge based society" by the year 2030 (MoE, 2016, p. 5).

Vision 2030 is a visioning framework that defines the present development state of Namibia and the desired future by the year 2030 (MoE, 2004). It thus states that education is one of the key development issues that can bring about the attainment of knowledgeable human resources. Within this framework, the goal of basic education is stipulated as to ensure that learners “have access to quality education”. For instance, the United Nations Children’s Fund (2000, p. 4), defines quality education as an education that is characterised by “processes through which trained teachers use child-centred teaching approaches in well-managed classrooms and schools and skillful assessment to facilitate learning and reduce disparities”. This resonates with Sallis (2002), who states that quality education is a multi-dimensional concept with different components. To Seehawer and Breidlid (2021), quality education should be responsive and take advantage of the plurality of epistemological and ontological realities that inform students’ daily lives (Gwekwerere, 2016). In the context of this study, only one component of quality education was focused on. As stated in the Basic Education Act (Act 9 of 2020) section 3 of 2020, quality education entails learners learning with support from their communities and their parents (Klein, 2011; Lavalley, 2009; Mateus & Ngcoza, 2019). Thus, this study involved a community member who did a presentation on the indigenous technology of making *oshikundu* to support teachers (learners) in contextualising the concept of diffusion.

In this regard, Vision 2030 further states that the country will “operate a totally integrated, unified, flexible and high-quality education and training system, that prepares Namibian learners to take advantage of a rapidly changing global environment, including developments in science and technology” (MoE, 2004, p. 10). It could be argued that this shows the commitment the Namibian government has made towards the teaching and learning of science. Namibian educators and researchers are therefore offered a platform to join hands with the government in exploring pedagogies that will enable science to be taught in a way that makes sense to the Namibian child. In my opinion, one way that might realise the latter is to teach science in a contextualised manner and hence ensure a dialogue between epistemologies in education as proposed by Seehawer and Breidlid (2021). The latter resonates with the foundational principles (*access, equity, equality and democracy*) of the Namibian education system described in Namibia, MoE (1993).

In the context of this study, only one component of quality education was focused on. As stated in the Basic Education Act (Act 9 of 2020) section 3 of 2020, quality education entails learners learning with support from their communities and their parents (Klein, 2011; Lavalley, 2009; Mateus & Ngcoza, 2019). Thus, this study involved a community member that did a presentation on the indigenous technology of making *oshikundu* to support teachers (learners) in contextualising the concept of diffusion.

Accordingly, the MEAC (2016, p. 2) highlights that inclusive education should recognise the “right of every learner and promotes access to and participation in the full range of educational programmes and services offered by the education system in mainstream schools”. It further highlights that it aims at “supporting and celebrating the diversity found among all learners and removing all barriers to learning” (MEAC, 2016, p. 2). Concerning what is outlined in the syllabus, African researchers have called for a paradigm shift in the way African learners are taught. This study hoped to answer the call by providing workshops with the intention of providing the participant teachers an opportunity to enact the definition of quality education as reiterated by Seehawer and Breidlid (2021). That is, contextualisation of the concept of diffusion.

2.3 The Concept of Diffusion

According to Bahar et al. (1999) and Cimer (2012), conceptual knowledge is not only knowing the name or definition of a concept, but it is also seeing the relations between concepts. Life Science and Biology are subjects which require learners to be able to identify and make the links between micro and macro relations among concepts – otherwise, learning cannot be realised (Jones & Rua, 2006). For this reason, these two subjects are among the subjects that learners struggle to learn due to their failure to comprehend the unity at the level of biological organisation in understanding the micro and macro level relationships among concepts, and in making sense of abstract concepts. That is, they seem to struggle to learn those concepts that point to the micro and macro relations inherent in biological events (Kurt et al., 2013).

Diffusion is one of the essential concepts in Biology. Hasni et al. (2015) point out that diffusion is the primary method of short-distance transport in cells and cellular systems. Concurring, Kurt et al. (2013, p. 187) define diffusion as “molecules movement from a high-concentration area to a low-concentration one due to their kinetic energies”. Moreover, Oztas (2013) accentuates that the

concept of diffusion is very common in science instruction, thus understanding the concept is a vital precursor to instruction in Life Science, Physical Science and Biology.

Unfortunately, many learners find this topic difficult to understand (MEAC, 2015, 2016). Scholars, such as Odom and Barrow (1995), Oztas and Bozkurt (2010), Oztas and Oztas (2012) and Zuckerman (1998) have pointed out that it appears that misconceptions associated with the concept of diffusion may play a large role in the difficulties associated with learning this concept. For instance, Oztas (2013) argues that the concept of diffusion is closely related to other concepts present both in Chemistry and in Physics, such as solutions, particulate nature of matter and permeability. In other words, understanding of the concept of diffusion leads to the understanding and application of knowledge in Physics and Chemistry as well as Biology. Thus, it becomes prior knowledge for other related concepts such as osmosis (Nangolo, 2018) and active transport.

Roschelle (1995) describes prior knowledge as a building block for new knowledge and connects old with new experiences. Learners' prior knowledge involves the knowledge that the learners have acquired from the previous grades and from everyday experiences (Gwekwerere, 2016; Kuhlman, 2011). It is important to take into consideration learners' prior knowledge in our teaching as neglecting it leads to learners' "educational disengagement" (Fataar, 2012, p. 55). In the same light, Breidlid (2013, p. 55) avers that the inherited Westernised education system also causes a colonial inferiority complex in African learners, which creates an "epistemological shock" in the classroom, hence leading to learning problems. Building on the latter, Seehawer and Breidlid (2021) accentuate that the inferiority complex causes alienation of African learners in their education system. They further state that this also leads to a perception that school education is irrelevant, sustaining the internalised colonial inferiority complex that regards everything non-Western as worthless.

To change the status quo in the pedagogical knowledge techniques of teaching, the following scholars are some of those advocating the integration of learners' IK into the African education system (Fataar, 2012; Mawere, 2015; Seehawer, 2018a). They emphasise integration as a means to ease learners' learning difficulties by building a bridge to access Western classroom knowledge (Aikenhead & Jegede, 1999). They further aver that knowledge dialogue (Seehawer & Breidlid,

2021), will thus in itself contribute to contextualised, culturally responsive education (Mhakure & Otulaja, 2017) that is relevant for the students' daily lives (Gwekwerere, 2016).

In Grade 8, the concept of diffusion is embedded in the topic of passage of substances. The concept of diffusion in the Namibian Science curriculum starts in Grade 8 up to Grade 12. For instance, in the Grade 8 curriculum both the Life Science and Physical Science Syllabus have basic competencies for learning diffusion. The MEAC (2015) states that learners should:

- Define diffusion as the movement of molecules from a region of their higher concentration to a region of their lower concentration, down a concentration gradient; and
- Discuss the importance of diffusion for living organisms.

In addition, the same objective is observed in the Grade 9 curriculum for Life Science. That is, learners are required to discuss the significance of diffusion to living organisms. This suggests that Grade 10 learners should have some prior knowledge of diffusion. Yet, it has been observed that learners still do not understand the concept of diffusion enough to perform well in assessment tasks. My assumption is that this problem could be related to how diffusion is taught in schools whereby learners' IK is neglected (Mukwambo et al., 2014; Seehawer, 2018a). It is against this background that in this study I mobilised the process of making *oshikundu*, which is a familiar practice to the participants, as an example on how to teach diffusion. This was intended to create a smooth transition from home knowledge to Westernised knowledge taught in science classrooms (Aikenhead & Jegede, 1999; Oluruntegbe & Ikpe, 2011). Aikenhead and Jegede (1999) refer to such transitions as border crossing.

However, Roschelle (1995) maintains that prior knowledge is not always advantageous as sometimes the same element of prior knowledge can provide an incorrect alternative to a theory. He terms these as “preconceptions, alternative conceptions, naive conceptions, and misconceptions” (p. 9). Sharing the same sentiment, Taylor (1999) also cautions that not all prior knowledge is educational. I, therefore, base my argument on Ogunniyi and Ogawa (2008) and Msimanga (2013), who point out that it is teachers who are knowledgeable about learners' prior knowledge, and have the right disposition and conceptions, that will be able to integrate learners' prior knowledge into their lesson presentations which could be in the form of IK.

2.4 The Place of Indigenous Knowledge in the Life Science Syllabus in Namibia

Worth noting is that in the context of this study, prior everyday knowledge entails a combination of prior knowledge and IK. The NCBE stipulates that the fundamental structure of the learning process at all levels is to use the learners' existing knowledge and ideas as a starting point for any learning. Moreover, existing knowledge and ideas help learners to connect with new knowledge, thereby facilitating and directing them in transforming their prior knowledge into new knowledge (MoE, 2010). This is based on the notion that learning begins with the interests of learners and their experiences (MEC, 1993). The above arguments are based on the premise that learners do not come to school as empty vessels; instead, they possess knowledge which is accumulated from their everyday life experiences (Gwekwerere, 2016). Such knowledge can be taken advantage of and capitalised on during the learning process.

Accordingly, in the context of this study, the Life Science syllabus is “developed in a clear and simple style in order to provide new innovations in conceptual learning based on the ethos of learner-centred education (LCE)” (MoE, 2016, p. 1). Learner-centred education (LCE) is a Namibian conceptual policy framework which encourages learner participation and involvement in pedagogy (Sedlacek & Sedova, 2017; Vygotsky, 198). Mubita (1998) points out that LCE focuses on the learner and not on the teacher. This suggests that teachers are expected to have a holistic view of the learner, “valuing the learners' life experiences as the focal point of learning and teaching” (MEAC, 2016, p. 1). Teachers are therefore expected to select learning content and methods on the basis of the learners' needs within their immediate environment and community (Asheela, 2017; Ndevahoma, 2019). In this regard, and extending on Vygotsky's (1978) seminal work, Mavuru and Ramnarain (2020) emphasise the importance of learners' diverse sociocultural backgrounds or contexts.

Moreover, the implication of LCE pedagogy to teachers is that it points out their roles, teaching approaches and instructional materials, which includes the way teaching is organised. In other words, a teacher using LCE guides the learners in acquiring new knowledge and skills by creating a stimulating learning environment. However, this does not imply that teachers are the only source of knowledge, but rather that they facilitate the learning process and that learners are active agents (Nyambe & Wilmot, 2012).

Consequently, this evidently means that Namibia in its NCBE (MoE, 2010) policy and the MEAC (2016), also aim at embracing IK for the learners as they see the value in it. However, the syllabus does not state how the integration should take place and teachers seem to be grappling on how to implement LCE approaches. Moreover, Nyambe and Wilmot (2012, p. 22) posit that there are “contradictions in educators’ interpretations and practice of what learner-centred education pedagogy is”.

In the context of this study, pedagogical strategies refer to the methods, techniques, procedures and processes that a teacher uses during instruction. Thus, this study aimed at providing an opportunity in the form of an intervention to mobilise and demonstrate how IK could be used in teaching science concepts, thereby providing access to abstract science concepts. Furthermore, extending on Asheela’s (2017) study conducted in Namibia, this study introduced the teachers to cost-effective resources from the learners’ immediate environment which the teachers can use in their classrooms to enhance conceptual understanding.

Several scholars have defined the term conceptual understanding. For instance, to Viennot (2008), conceptual understanding involves the application of an explanation to certain novel situations that are previously known. Sawyer (2008) claims that conceptual understanding takes place when facts and procedures are applied in real-life situations (Gwekwerere, 2016). Similarly, Koniceck-Moran and Keeley (2015) assert that a deeper understanding of a concept is achieved when students apply it in a different situation, describe or define it in their own words, make a model of it or find an appropriate metaphor for it. Thus, Tan et al. (2020) proffer that one important aspect of conceptual understanding is the capacity to promote retention of lessons learnt. One could then deduce that conceptual understanding can be achieved by using hands-on practical activities (Asheela et al., 2021; Mavuru & Dudu, 2021; Shinana et al., 2021) as it afford learners (teachers in my context) an opportunity to visualise concepts to avoid rote learning or memorisation.

2.5 Hands-on Practical Activities and Visualisation

Practical work (activities in this context) refer to any teaching and learning activity which requires learners to observe or manipulate objects and materials they are studying (Millar, 2004). Practical activities are further defined as hands-on learning activities which prompt scientific thinking about the world (Science Community Representing Education [SCORE], 2008). The NCBE stipulates

that understanding scientific processes, the nature of scientific knowledge and the ability to apply scientific thinking and skills is a requirement in the natural sciences (MoE, 2010). Thus, carrying out practical activities, practical demonstrations and practical investigations are specified to be among the requirements of the natural sciences subjects.

In addition, the curriculum points out that there is a need to empower learners with the scientific knowledge, skills and attitudes to formulate hypotheses, to investigate, observe, make deductions and understand the physical world in a rational scientific way (Nhase et al., 2021). In this regard, the syllabuses for Natural Science and Health Education (NSHE) grades 5–7, Physical Science grades 8–12, Life Science grades 8–10, Biology grades 11–12 and Agriculture grades 8–12 prescribe practical activities and demonstrations which all learners should be exposed to as a minimum requirement at the end of each topic (MoE, 2010). The subject policy guides for Physical Science for grades 8–12, Life Science and Biology grades 8–12 and Agriculture grades 8–12 resonate with the NCBE) with regard to practical activities as they are important for promoting understanding (Millar, 2010).

Notably, Namibia, like most African countries, is rich in natural resources and the exploration of these resources requires scientific knowledge and relevant skills (MoE, 2008). It might be from this premise that the curriculum considers hands-on practical activities to be important in imparting scientific skills and relevant knowledge to our science learners (Akuma & Callaghan, 2016; Asheela et al., 2021). The Namibian curriculum further points out that the latter resonates with Namibia’s vision of producing its own human resources that will use the national natural resources to develop the nation (MoE, 2010). Moreover, it states that scientific skills are a prerequisite for a progressive national economy and a means of satisfying human needs (MoE, 2010).

This is also in line with the Namibian vision, Vision 2030, which stipulates that by the year 2030, Namibia should be “a prosperous and industrialised Namibia, developed by her human resources, enjoying peace, harmony and political stability” (MoE, 2010, p. 2). In agreement with the recommendations of the NCBE, a large body of literature stands in agreement with the recommendations of the NCBE, that practical activities are fundamental to science teaching and learning (e.g., Abrahams & Millar, 2008; Millar, 2010; Jokiranta, 2014). In the same light, Gott

and Duggan (1996) express that carefully selected practical activities have a key role in the teaching of evidence of science concepts in science education.

Concurring, Asheela et al. (2021) contend that hands-on practical activities encourage active participation (Sedlacek & Sedova, 2017), highlighting that they enable identification of key concepts, conceptual understanding, education quality and relevance and makes learners experience science first-hand. When planned properly, learners find that practical activities are enjoyable, engage their learning at different levels and challenge them mentally compared to other teaching and learning approaches in science (Abrahams & Millar, 2008; Woodley, 2009).

Moreover, Millar (2010) and Woodley (2009) accentuate that effective practical activities enable learners to make links between theory and practice, ensuring that learners are able to apply their scientific understanding to the real-world application of science. Besides that, Sedlacek and Sedova (2017) state that when easily accessible resources are used to mediate learning, it deepens the notion of inclusivity resulting in active participation. Asheela et al. (2021) reiterate that easily accessible resources have the potential to reinforce social interactions which are essential to enhance meaningful learning. In this regard, Woodley (2009) advises that educators should ask themselves one vital question before conducting practical activities, that is, “what do I expect the students to learn after doing this practical activity that they could not learn at all, or not so effectively when they were merely told what happens?” (p. 50). It is thus considered obligatory for science teachers to help the learners see these connections between the theoretical ideas taught and the phenomena seen in practical activities (Jokiranta, 2014).

However, even though practical activities have advantages in science education, Hodson (1990) argues that some practical work conducted in many schools are ill-conceived, confused and unproductive. As a result, practical activities in many schools provide little in terms of real educational value because teachers use these thoughtlessly. This could be attributed to the fact that some teachers might lack the pedagogical knowledge of using practical activities effectively. In this context, it was hoped that this indigenous technology of making *oshikundu* would afford the science teachers an opportunity to easily accessible resources to contextualise science in their own classrooms to be able to help their learners cross smoothly between cultural science and school science (Aikenhead & Jegede, 1999).

Moreover, the indigenous technology of making *oshikundu* by the expert community member provided a form of visual presentation in the learning of diffusion. According to Wiebe et al. (2001), the use of indigenous technology as a cultural tool for mediating classroom science allows for the visualisation of scientific concepts, presenting learners (teachers in the context of my study) an opportunity to make sense of new science concepts in new but familiar contexts. Cook (2006) describes visualisation as a teaching and learning approach in which science instruction is combined with visual and verbal information. Additionally, Rundgren and Yao (2014) accentuate that visualisation in science education is a cognitive domain that has the role of making invisible ideas visible and more importantly illustrating abstract concepts and making them explicit.

To Lloyd (2015), visualisation is “a language of image” (p. 5). Accordingly, Asheela et al. (2021) propose conducting hands-on practical activities using easily accessible resources from the learners’ environment. It is against this backdrop that scholars such as Asheela (2017), Nangolo (2019), and Ndevahoma (2019), to mention a few, conducted their studies in Namibia on the use of easily accessible resources. Lloyd further states that these images are shapes, colours, forms, lines, patterns, objects, people and numbers. In an investigation by Eilks et al. (2012), it was revealed that visual representations help learners to understand and thus support learning by evoking effective reactions. It is against this background that this study aimed to offer a professional development platform that aimed at helping teachers become familiar with the use of easily accessible resources to enable them to help their learners visualise the concept of diffusion.

Easily accessible resources are defined by African scholars as resources that fit our context as locally available and improvised resources from the immediate environment (Asheela, 2017; Kambeyo & Ngcoza, 2017; Samuels, 2017). Similarly, Ahmed (2008) points out that these resources can also be referred to as relevant and cheaply selected tools or equipment that can be alternatively used to boost the effectiveness of the teaching and learning process. One should bear in mind that most Namibians schools are operating on a very limited budget, as per the ministerial universal educational school grant allocated per annum. The school educational grant is used to purchase the resources for practical activities among other needs for the school. It is against this background that Toplis and Allen (2012) points out that practical activities that require complex laboratory experiments are an expensive pursuit for secondary schools. Jacob (2015) similarly

states that most schools, especially the ones situated in rural areas, cannot afford to procure resources required for practical activities.

Alternatively, Salami and Olutu (2014) suggest that it is of supreme importance that teachers use improvised materials in the case where scientific materials are not available or inadequate when teaching practical concepts in the topic of diffusion. The findings of the studies in Namibia by Asheela (2017) and Samuels (2017) revealed that some teachers were not using practical activities in their science classes due to a range of constraints such as insufficient and unavailable laboratory equipment. Other studies, Nangolo (2019), Ndevahoma (2019), Shinana (2019), and Hashondili (2020) have reported positive results using easily accessible resources.

The NCBE also stresses the use of everyday materials such as waste materials that might have a scientific meaning, so that they can be used to investigate scientific phenomena (MoE, 2010). Moreover, Namibia, MoE (2009) emphasises that Biology teachers need to be creative and innovative in producing their own teaching and learning materials that are linked to the practical work intended. That is, due to the absence of conventional materials, efforts need to be made by Biology teachers to improve their lessons by improvising teaching materials (Ahmed, 2008; Chukwuka, 2013; Mensah, 2015). In this regard, Ahmed (2008) emphasises that to teach natural sciences successfully, even in schools with no laboratories or insufficient equipment, it would be of most significance to use easily attainable or accessible materials at the expense of the complex ones for the hands-on activities.

Moreover, Yitbarek (2012) encourages that hands-on practical activities that use cheap and readily available equipment enables learners to be more ‘minds-on’ as well as ‘hands-on’ when they feel they understand how the equipment they are using works. Considering this, Yitbarek (2012) highlights the following very important advantages of using easily accessible resources:

- creates awareness of local available materials in own environment which stimulates creativity to use them;
- experiments and models can be constructed without extensive experience, or the self-construction develops a sense of proud ownership and promotes a more frequent use;

- the easily accessible resources need no special infrastructure neither special storage facilities;
- leads to new knowledge discovery and talents for learners and teacher; and
- minimises costs on breakage, repair, and loss, as they can easily be replaced due to their availability in their local environments (Mensah, 2015, p. 34).

In addition to the NCBE as earlier discussed in this section, most of the science curricula such as Physical Science, NSHE, Life Science and Biology support the use of resources found in the immediate environment when investigating, interpreting and applying knowledge to practical investigation (MEAC, 2016). There are various scholars that use easily accessible resources in their studies in relation to teaching and learning of different science concepts. For instance, Asheela (2017) prepared *oshikundu* and used it to collect the gas to test for carbon dioxide. Her study revealed that teachers had good experiences with the hands-on practical activities which they were engaged in. Accordingly, Asheela further stated that teachers shared positive views on practical activities and that practical activities captured their interest, stimulated questioning, thinking and enhanced active participation. This study aimed at building on Asheela's (2017), to show how one can use the IK practice of *oshikundu* to mediate the teaching and learning of diffusion with Grade 8 teachers.

Nangolo (2019) also carried out an interventionist study with Grade 11 Biology teachers focusing on hands-on practical activities using easily accessible resources when mediating the learning of osmosis. Her study revealed that teachers demonstrated positive attitudes towards teaching osmosis using easily accessible resources. She also stated that teachers used a variety of mediation tools such as prior and local knowledge, language and easily accessible resources to enhance learning. However, she also reported some challenges regarding inadequate materials that hindered or constrained the teaching and learning process. Thus, she recommended that if teachers are exposed to numerous professional development platforms that include the use of easily accessible resources, this might improve their pedagogical approaches. This is what this study intended to explore.

In another study by Shinana (2019), easily accessible resources were used to mobilise the indigenous practice of making *oshikundu* to mediate learning of enzymes and to promote inquiry-based methods. She established that some teachers did not include the concept of enzymes in their teaching. She reasoned that teachers might have left out the concept of enzymes because they lacked the understanding of the new content of the Life Science syllabus. Moreover, her study might be highlighting the challenges faced by Life Science teachers in their engagement with the new content of the Life Science syllabus. She stated that the practical demonstration of making *oshikundu* in her study equipped the teachers with the knowledge of enzymes and how to teach enzymes using an inquiry approach. She therefore suggested that there is a need for professional development programmes focusing specifically on supporting science teachers to engage deeply with the new content of the Life Science syllabus. It should be recognised also that easily accessible resources could be in the form of indigenous practices. Thus, in this study I mobilised the indigenous technology of making *oshikundu* to mediate the teaching and learning of diffusion.

Namibia, like many other multicultural African countries, has diverse cultures. This study, however, focused on the cultural practice of making *oshikundu* or *ontaku* that is practiced by the Aawambo people. The Aawambo people are geographically located in the northern part of the country. However, due to economic and educational reasons they are scattered all over Namibia. *Oshikundu* or *ontaku* is a non-alcoholic fermented drink prepared using water, pearl millet (*Pennisetum glaucum*) flour and sorghum (*Sorghum bicolor*) malt flour (Shinana, 2019). It is prepared in almost all Oshiwambo households depending on the availability of *omahangu* and sorghum flour. It is believed that *oshikundu* has the ability to curb hunger, thus learners from rural households are often provided with it as their lunch. It can, however, be coupled with other foods, yet *oshikundu* is the main content of their school lunch box; thus, the assumption is that learners have a background knowledge of this indigenous technology of making *oshikundu*.

There is a body of literature on *oshikundu* (Asheela, 2017; Embashu et al., 2013; Embashu, 2014; Hepute et al., 2016; Nikodemus, 2017; Shinana, 2019) and in each case, researchers have highlighted the scientific knowledge embedded in this IK practice. Kasanda and Kapenda (2015), however, complain that this knowledge is not documented and so there is a danger that it could be lost or distorted. Thus, bringing it into the classroom as a teaching aid might just be one of the

ways of ensuring that this knowledge remains in our society and is used to create dialogue between indigenous and Westernised knowledges as reiterated by Seehawer and Breidlid (2021).

Moreover, using this knowledge to mediate science concepts might also help to bring about the realisation of the importance of our cultural heritage as advocated by Cocks et al. (2012) and Chilisa (2012). Thus, in my view, and in line with culturally responsive pedagogies (Mhakure & Otulaja, 2017), the science embedded in the cultural practice of making *oshikundu* could be optimally used by teachers in their science classrooms to contextualise science lessons – this creates an opportunity to make learning experiences more authentic and relevant to the learners (Mavuru & Ramnarain, 2017).

2.6 Indigenous Knowledge in Science Lessons

Kibirige and van Rooyen (2006) define IK as a legacy of knowledge and skills unique to a particular indigenous culture, involving wisdom that has been developed and passed on over generations. They further state that IK is local knowledge, derived from interactions between people and their environment. Concurring, Snively and Williams (2008) propose that every culture has its own science. Accordingly, building on Snively and Williams's (2008) proposition, Mukwambo et al. (2014) emphasise that there is a dialectical relationship between IK and Westernised science. They further propose that IK is embedded in Westernised science and hence a dialogue between these knowledges is possible (Seehawer & Breidlid, 2021).

Considering these deliberations, Dei and Asgharzadeh (2006, p. 54) describe IK as “knowing developed by local/indigenous people over generations as a result of sustainable occupation of or attachment to a place. As a result, such occupancy allows people/communities to develop a perfect understanding of the relationship of their communities to their surrounding natural and social environments”. Furthermore, and expanding on Mukwambo et al.'s (2014) study, Seehawer (2018a) advocates for the transformation and re-Africanisation of the curriculum. She further points out that IK integration should be seen as a prerequisite to decolonise and Africanise the education system as Western knowledge “has failed to address the specific needs of the African masses” (Matemba & Lilemba, 2015, p. 171).

It could be argued, therefore, that Namibian learners regardless of their sociocultural background do carry IK as their cultural funds of knowledge when entering a science class (Mavuru & Ramnarain, 2017; Nyamakuti, 2021). Such cultural heritage needs to be used in science classrooms to provide the learners' epistemological access to scientific knowledge. Furthermore, Higgs (2016) states that IK integration is a step in the right direction in making it the foundation to reshaping African curricula (in particular Namibia) and the education system, thereby advancing the cultural and social educational transformation of Namibia and Africa at large. As alluded to earlier, Seehawer and Breidlid (2021) suggest that a dialogue between epistemologies (Western knowledge system and IK System) is a core aspect of quality education, because it is regarded as 'Two-Eyed-Seeing' thus, the application of different knowledge in different local and global contexts gives relevant skills in this complex 21st century reality.

Accordingly, the role of integrating IK in the science classroom can be well explained by adapting Chikamori et al.'s (2019) Transformation Model of Education for Sustainable Development (TMESD) framework. To Chikamori et al. (2019), the TMESD framework comprises three learning processes: "knowing the present", "past-present relationship" (focusing on dependence of the present on the past), and the "future-present". These scholars refer to the process of studying the past-present relationship as *retroduction* and future-present relationship as *retrodiction* (see Figure 2.1 below). In the context of my study, the TMESD diagram below illustrates how learning diffusion through the integration of IK can take place in three sub-processes.

The first sub-process of "knowing the present" illustrates that because it is known that in the past the concept of diffusion was a challenge to learners, at present it is known that Western Science (WS) poses a considerable challenge to learners. Hence, the curriculum can be transformed by sharing cultural knowledge in the science classroom to mediate the concept of diffusion in order to make sense of the aforementioned. The integration of IK plays a role in the "retroductive learning" process which is the second process of TMESD. During this process, the community member shared the cultural heritage on making *oshikundu* to make learning of diffusion accessible to learners. When the community member shares her cultural knowledge on making *oshikundu*, learners will link the concept to their prior knowledge (linking the past) to understand the concept of diffusion (thinking of the present). This is because Chikamori et al. (2019) assert that learners

deliberately consider the present, learnt from the first learning process, in connection with what they know from the past. When learners comprehend the concept of diffusion from “retroductive learning”, they will go through a retroductive learning process. Learners will likely understand most of what is related to diffusion and will be encouraged to make use of their IK to help them understand and make sense of the concept of diffusion in the future. Similar to Hashondili’s (2020) study, this process is thus summarised below in Figure 2.1.

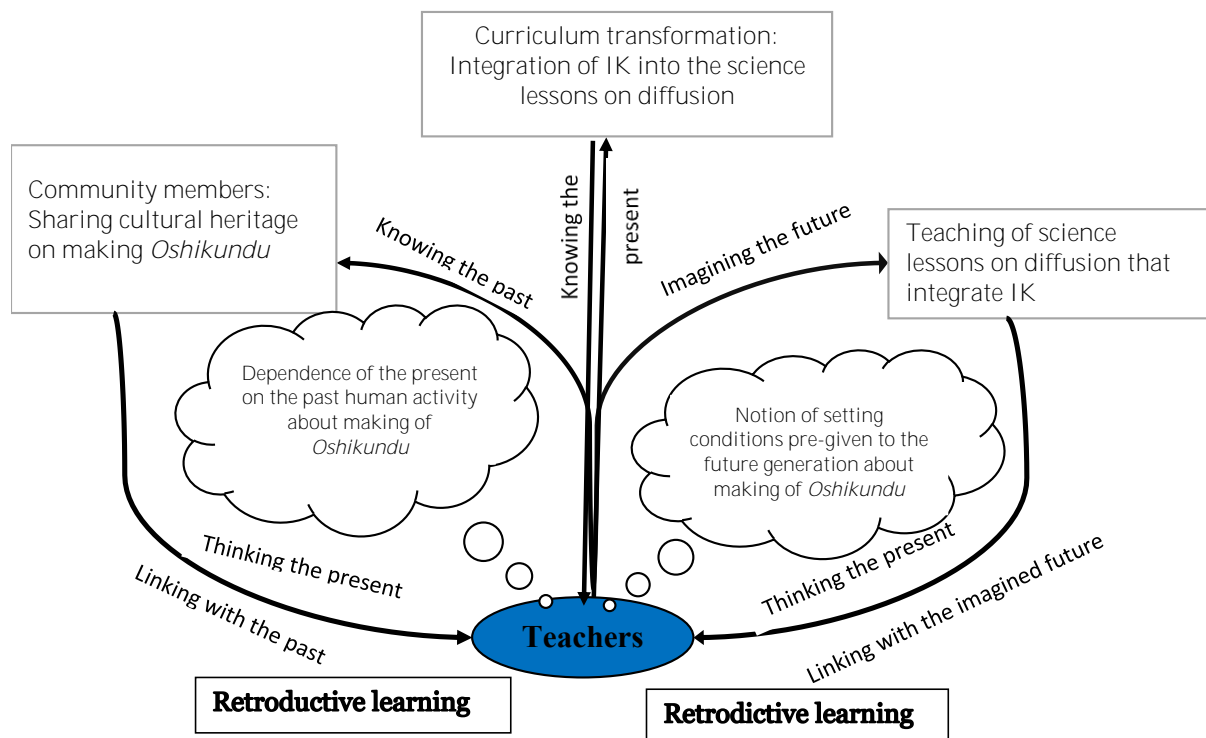


Figure 2.1: Shows the role of integrating IK in the science classroom (adapted from Chikamori et al., 2019, p. 9)

Furthermore, Aikenhead and Jegede’s (1999) theory of collateral learning posits that duality of thought is created in the memory of schemata of indigenous learners when they learn WS. This suggests that when learners are challenged by the two worldviews of science (Ogunniyi, 2007a), learning occurs in many forms.

Notwithstanding, as much as some scholars advocate the integration of IK into the science curriculum, some scholars such as Cobern and Loving (2001), Hodson (2009), and Horsthemke and Schäfer (2007) criticise the assumptions associated with the integration of IK into science

teaching. These scholars argue that IK and Westernised knowledge should be treated separately. For instance, Horsthemke and Schäfer (2007) highlight that some learners perceive local IK as outdated. Concurring, Hodson (2009) succinctly points out that there is a need to be cautious not to include “anything and everything in the curriculum under the banner of science” (p. 118).

Unlike Horsthemke and Schäfer (2007), however, Hodson (2009) is for the plurality of knowledges believing that choosing to exclude some forms of knowledge from the curriculum might create barriers and deny access to science. Some proponents of integration of IK also warn against romanticising this knowledge (Afonso-Nhalevilo, 2013; Keane et al., 2016; Mhakure & Otulaja, 2017; Mukwambo et al., 2014; Ogunniyi, 2007a) emphasising that any misconceptions brought about by IK should be identified and cleared – one way of doing this is through professional development platforms such as workshops.

2.7 Professional development

Professional development refers to a wide variety of specialised training where professional learning is expected to take place to improve professional knowledge and skills of teachers (Shabani, 2016). Buczynski and Hansen (2010) describe professional development as an occupational instruction which is aimed at equipping teachers with tools and resources necessary to produce quality instruction. They further point out that the goal of teachers’ professional development is to go and implement knowledge learnt in their classrooms and to provide the learners with enduring and applicable understanding of scientific concepts. Well established in literature is the poor performance of learners in the concept of diffusion (MEAC, 2015). It is also indicated that learners show poor understanding of the concept (MEAC, 2015). These findings necessitate improvement in pedagogical approaches which can be done through professional development (Tekkumru-Kisa & Stein, 2017). In this context, the workshop intervention might allow teachers to contextualise the concept of diffusion and its associated concepts from the practical demonstration of making *oshikundu*.

In addition, Rout and Behera (2014, p. 9) point out that professional development plays a major role in changing teachers’ teaching by moving beyond “comprehension of the surface features of a new idea and innovation, to a deeper understanding of a topic”. For this reason, Eun (2008)

suggests that professional development is one of the most effective ways to improve the teaching and learning process. Likewise, Guskey and Yoon (2009) allude to the idea of workshops as they emphasise that they are seen as contributing more positively to professional development. Adding to the debate, Eun (2008) as well as Shabani (2016) further explain that workshops are essential in professional development as they create opportunities for teachers to interact with others (Vygotsky, 1978).

Essentially, learning during workshop interactions is enhanced as teachers share their experiences, knowledge, skills, problems, difficulties and possible solutions (Eun, 2008; Ngcoza & Southwood, 2019; Nhase, 2019). It was thus hoped that the social interactions created during the workshops would afford the teachers an opportunity to learn new skills and knowledge of teaching diffusion in their classrooms. The process of making *oshikundu*, done by the expert community member (MKO), was seen as the mediatory cultural tool that promoted learning during the intervention workshops. It was thus hoped that the newly learnt pedagogical approach and the use of IK to mediate learning of diffusion would contribute to the teachers' shifts in the zone of proximal development (ZPD) as reiterated by Vygotsky (1978).

Accordingly, a professional development setting was chosen to help teachers influence each other's pedagogy as well as introduce them to the concept of integration of IK into Life Science lessons (Asheela et al., 2021; Shinana et al., 2021).

2.7 Theoretical and Analytical Frameworks

In this section, I discuss the theoretical and analytical frameworks used in this study. Both these theories assisted me with my data analysis process.

2.7.1 Theoretical Framework: Vygotsky's socio-cultural theory

This study was informed by Vygotsky's (1978) sociocultural theory. Central to this theory is the concept of social learning. Vygotsky believes that learning precedes human development. He further maintains that mental processes begin as actual social relationships among people on the inter-psychological level and later, the new information will be processed further on the intra psychological level. The idea was that participant teachers might learn best when working together with others during collaboration (Goos, 2004). Moreover, Vygotsky (1978) believes that

meaningful learning is enhanced when learners are learning through *social interactions* with materials from their culture.

While Vygotsky's theory focuses on how children learn, Eun (2008) suggests that *learning and development* should not be restricted to children only. He argues that learning and development are essential for both children and adults. In essence, the models which are used in teacher professional development are aligned to Vygotsky's theory (Eun, 2008, 2011; Shabani, 2016). For example, the concept of "mentoring" found in teachers' professional development models is aligned to Vygotsky's view of the MKO. In addition, most professional development initiatives are conducted through training which engages teachers in interactions with each other. This creates an opportunity to learn and build on their knowledge. The enhancement of learning results into the extension of the teachers' ZPD. All these discussions made Vygotsky's theory compatible with this study. Within this theory, I used three concepts, namely *mediation of learning, culture and language, social interactions* and *ZPD*. I now discuss each of these below.

Vygotsky (1978) defines mediation as the link between teachers and learners that directly affects learner understanding of knowledge and skills in science. He further explains that mediation is used as a tool in cognitive change. Kozulin (2003) classifies these mediatory tools into three categories i) human mediator (the more knowledgeable other), ii) psychological or symbolic mediator: the system and skills modelled by the more knowledgeable other in the process of social interaction with the less competent, and iii) the external mediator: the technical tools that are involved in the process of social interaction.

In this study, the hands-on practical activity of making *oshikundu* placed the demonstrator (local woman) as the MKO as she demonstrated and explained how *oshikundu* is made to the less knowledgeable (the teachers and me). This provided us with an opportunity to relate the knowledge from the practical demonstration to the scientific concept (diffusion). Furthermore, the use of psychological tools such as Oshiwambo (an indigenous language) increased the level of participation (Naidoo, 2010; Sedlacek & Sedova, 2017). Moreover, the use of journal reflections also served as mediatory tools which we used to record our reflections on the intervention process. The journal reflection entries also reflected our learning progression during the intervention. Extending from Vygotsky's (1978) seminal work, John-Steiner and Mahn (1996) indicate that

SCT assumes that human activities take place in cultural contexts and are mediated by language and other symbolic systems.

Furthermore, mediation is important in understanding how human mental functioning works and how it is dependent on cultural contexts, institutional backgrounds and historical settings since these settings shape and prove the cultural tools that are mastered by the individual to form this functioning (John-Steiner & Mahn, 1996). Language plays a pivotal role in knowledge construction in SCT. This was observed during the practical demonstration by the ECM when some teachers gave their comments in their mother tongue. Learners (teachers in the context of this study) construct knowledge in the language that is known to them, and this language is embedded in the society where the learner comes from. Hence, teachers were shown that it was possible to scaffold learners so that learners can make sense of scientific concepts. That is, teachers can use language as a cultural tool to connect the IK of learners and scientific knowledge and this is mediation. Expanding on Vygotsky's seminal work, Eun (2008) further explains mediation as the specific mechanism involved in the transition between social interactions and individual mental functions.

According to Vygotsky (1978), learning takes place through social interactions with peers or knowledgeable others (parents, teachers or learners). He further explains that social interactions can be a study between social groups, by interacting with other people and communicating the shared expectation to those new to it. Social interaction is the mechanism of distribution of functions and a method of mastering those functions (Rubtsov, 2016). During social interactions, sharing of ideas might take place and the participants may thus have an opportunity to collaboratively construct knowledge. A study by Singh and Richards (2006) revealed that English teachers who were involved in their study learnt collaboratively from the activities and discourses which were mediated using cultural artefacts. Similarly, Barak and Dori (2009) also established that engaging teachers in education discourses enhances their development of critical thinking and argumentation skills.

This study was intended to promote teacher learning through interactions with each other and the MKO (the community expert woman). This follows the suggestion that a more skilled person (MKO) should purposively frame social interaction activities to yield learning (Eun, 2008). I

realised that when the community member (MKO) explained and demonstrated how *oshikundu* is made, she contributed to the learning experiences of the teachers. Expanding on Vygotsky's seminal work, Ellis (2000) ascertains that this theory of learning starts not through interactions but during interactions and it is through successful interactions that a more knowledgeable other (MKO) can move another through the ZPD. Other scholars (Ebadi et al., 2010) also contend that the use of mediatory tools such as mentors, artefacts and diary writing positively influences teachers' ZPD.

The ZPD is defined by Vygotsky (1978, p. 86) as “the distance between the actual development level as determined through independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers”. Eun (2008) points out that there is ZPD in the professional development of teachers. He then describes it as a learning space between the present level of teaching knowledge and pedagogical knowledge of teaching at the next level with the support from others. Thus, this study intended to show teachers that there is an alternative pedagogy of integrating IK into the teaching of science which offers their learners access to scientific knowledge. Moreover, the context of this study has the potential to offer the teachers larger ZPDs as they will work in a group compared to individuals (Vygotsky, 1978).

Vygotsky indicates that learning within the ZPD can lead to cognitive development and acquisition of higher-level psychological functions (Miller, 2011). Higher order thinking skills are skills such as the ability to analyse, to evaluate and synthesise information or situations (Zohar & Dori 2003). In addition, Barak and Dori (2009) view higher order thinking skills as those skills that enable the people to pose complex questions, present solid opinions, introduce consistent arguments and demonstrate critical thinking. The practical demonstration of making *oshikundu* was thus a good example to explore the higher order thinking skills which the participants and I acquired. Moreover, I also hoped that the acquisition of these skills might strengthen our PCK on the topic of diffusion and its associated concepts.

I used the three highlighted concepts of sociocultural theory as proposed by Ebadi et al. (2010, p. 242). Drawing on the seminal work of Shinana (2019, p. 42), I analysed how the mediatory tools impacted the teachers' ZPD (see Figure 2.2 below). I feel this model helped me analyse my data because the IK practice is an intervention, which I hoped would influence (or not) our professional development. Therefore, with the following diagram, I show how I hoped the concept of sociocultural theory would play a role in the teachers' ZPD with regard to IK.

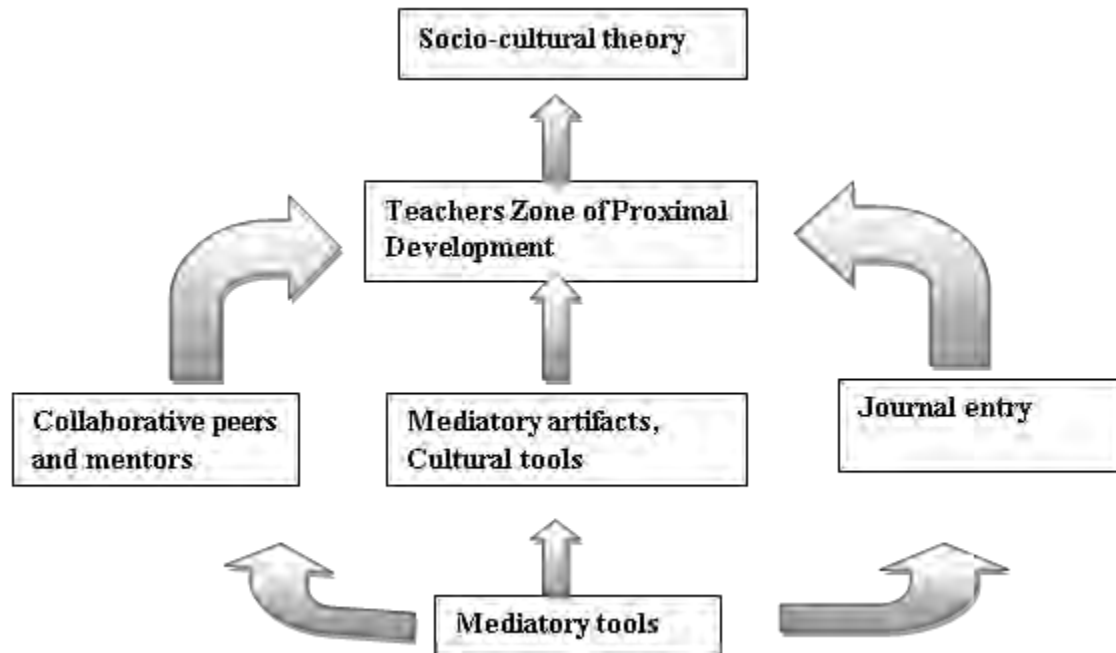


Figure 2.2: Showing influential factors on the teachers' ZPD (drawn from Ebadi et al., 2010, p. 242 and adapted from Shinana, 2019, p. 42)

Moreover, from this model, the concept of mediation and ZPD were also used to analyse how the mediatory tools which this study used can enhance mediation of the concept of diffusion and how the tools promote the acquisition of higher order thinking during the planned workshops. The concepts were further used to analyse how teachers integrated the IK of making *oshikundu* in planning for their model lessons. The model lesson analysis thus provided an idea how the workshop intervention had influenced the teachers' knowledge and skills on how to integrate IK into their teaching.

2.7.2 Analytical framework: Topic-specific pedagogical content knowledge

Pedagogical Content Knowledge is an academic construct that was introduced by Shulman (1986). It represents an idea rooted in the belief that teaching is more than just delivering subject content knowledge to learners with the expectation that learners will just absorb information for later reproduction. Instead, PCK is believed to be the knowledge that teachers develop over time and through experience and how to teach content in particular ways to enhance learners' understanding (Shulman, 1987). Furthermore, Shulman states that PCK consists of distinctive bodies of knowledge for teaching. He indicates that PCK represents "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented and adapted to the diverse interests and abilities of the learners and presented for instruction" (Shulman, 1987, p. 8).

Shulman (1986) introduced the PCK, explaining it as ways of representing and transforming subject matter knowledge to make it understandable to learners. To Shulman, however, subject matter knowledge precedes PCK. Concurring, Kind (2009) refers to PCK as a concept that represents the knowledge that teachers use in the process of teaching. He acknowledges, however, that teachers' PCK is difficult to understand. Additionally, Kind's (2009) criticism of PCK is that it is not grounded in learning theories.

As an attempt to address the criticism directed at PCK and extending on the seminal work of Geddis and Wood (1997), Mavhunga and Rollnick (2013) highlight that each science topic has its own specific PCK. That is, teachers tend to use different methods even when teaching the same topic. In light of this realisation, these scholars adapted the five-content specific components of the topic-specific pedagogical content knowledge (TSPCK) from Geddis and Wood (1997, p. 613), namely, "learners' prior knowledge, curricular salience, what is difficult to understand, representations including analogies and conceptual teaching strategies" (Mavhunga & Rollnick, 2013, p. 115) (see Figure 2.3 below).

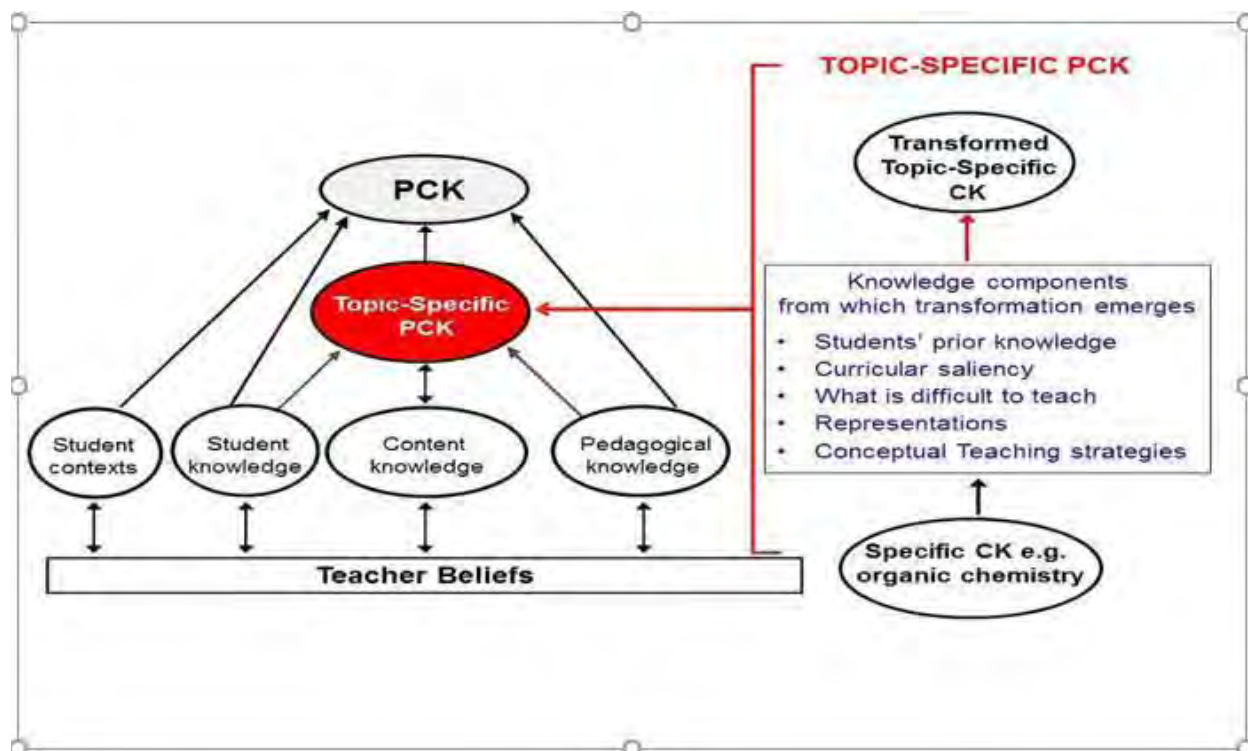


Figure 2.3: Showing the five components of TSPCK (adapted from Mavhunga & Rollnick, 2013, p. 115)

Learners’ prior knowledge (including everyday knowledge and misconceptions) enables teachers to know the learners’ level of understanding. Most importantly, learners’ misconceptions or errors are not dismissed but instead are used to advance learning. Curriculum salience relates to sequencing of science concepts within a certain topic; the component ‘what is difficult to understand’ places emphasis on concepts which are difficult for learners; representations have to do with various forms of presenting the subject matter to make it comprehensible to learners and the last component has to do with the strategies used in teaching. I have used these components as lenses for co-analysing the curriculum documents and during the co-development of a model lesson on the topic of diffusion.

According to the Refined Consensus Model, teachers’ professional knowledge is in three domains, i.e. collective, personal and enactment (Carlson & Daehler, 2019). Shinana et al. (2021, p.4.) define collective PCK as a “specialist knowledge held and shared by a broader community” – in this

context, the Grade 8 Life Science teachers. Personal PCK (pPCK) is the cumulative and dynamic PCK and skills of an individual teacher that reflect the teacher's own teaching and learning experiences along with the contribution of others. Lastly, enactment PCK is the unique subset of knowledge that a teacher draws on during the planning and teaching of and reflecting on a lesson (Shinana et al., 2021). Adding another dimension to PCK, Mazibe et al. (2020) introduced the idea of reported PCK (rPCK), which is the knowledge that teachers portray in a written and spoken format. Similarly, the PCK that teachers communicate when they reflect on their teaching experiences and project what they may do in the future is reported as rPCK in this study. It is believed that a teacher's pPCK in teaching science is developed, shaped and refined over time through formal education, teaching experiences and professional sharing (Carlson & Daehler, 2019).

2.8 Chapter Summary

In this chapter, I discussed literature relevant to this study. I discussed the requirements for the curriculum in terms of IK and the concept of diffusion, where I highlighted how imperative it is to have a conceptual understanding of diffusion and to make the links between micro and macro relations among concepts such as osmosis and active transport. Discussions around IK integration also revealed that the approach has both benefits and challenges in science classrooms. In addition to the challenges that could hinder or constrain effective integration of IK, discussion on the impacts of viewing WS plurality has been highlighted. Further, consideration of teachers' conceptions and dispositions are regarded as factors that could influence the teachers' PCK. The chapter also discussed professional development as a platform which is believed to have the potential to allow teachers to learn examples of how to integrate IK into their Life Science classrooms. Lastly, I discussed the theoretical as well as the analytical frameworks which guided this study. In the next chapter, I will discuss the research methodology employed in this study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

Teddle and Tashakkori (2009, p. 21) define methodology as “the broad approach to scientific inquiry specifying how research question should be asked and answered”. In this chapter, I thus discuss the research methodology that guided this study. Within the research methodology, I discuss the research paradigms/orientations that informed my study as well as the research design employed. Within the research design, I discuss a case study research design, the research site and participants, data gathering methods used in this study, the validity and trustworthiness and the ethical issues which were considered in this study.

3.2 Research Paradigm

A research paradigm can be used as a lens through which reality is interpreted (Nieuwenhuis, 2007). That is, a research paradigm represents a key element in the research project that influences how the research should be conducted and how the meaning of reality may be constructed and interpreted (Poni, 2014). This means it can be defined as a sort of camp to which a researcher belongs in terms of assumption thinking and the approach to the research (Okeke & van Wyk, 2015). This study is underpinned by the interpretivist and indigenous research paradigms. Within the indigenous research paradigm, I used the Ubuntu perspective.

3.2.1 Interpretivist paradigm

The interpretivist paradigm strongly points out that both the researcher and participants influence the collection of data and analysis (Wahyuni, 2012). Similarly, Thomas (2013) accentuates that the interpretivist paradigm is of the view that there is a world out there that is constructed by each

of us in a different way and it carries different meanings for everyone. Thomas (2013) further indicates that interpretivists are interested in people and the way they interrelate, what they think and how they form ideas about the world. In this regard, Cohen et al. (2018) posit that the aim of the interpretivist paradigm is to understand the subjective world of human experience and views the social world as an emergent social process. In the context of my study, it was deemed significant for me as a researcher to understand the participants' world by immersing myself in their situation. Essentially, this paradigm helped me to understand the teachers' experiences, understandings and pedagogical insights on the use of IK in their teaching.

Furthermore, this paradigm was used in this study to understand Life Science teachers' attitudes towards the indigenous technology of making *oshikundu* by the ³expert community member. It explored in-depth everyone's experiences of the phenomena (Okeke & van Wyk, 2014). In this study, an interpretivist paradigm helped me as the researcher to better understand teachers' experiences and understandings of local knowledge on diffusion. Cohen, Manion and Morrison (2018) maintain that, an interpretive paradigm aims to understand the subjective world of human experiences and views the social world as an emergent social process. This scholar assume that people construct their own meaning when they interact with the world around them. Hashondili (2020, p. 32), however, cautions that researchers, "should not predict what people might do, but rather understand how people make sense of their world and how they make meaning of their actions". Indeed, this view resonates with the interpretivist paradigm whose focus is on understanding people's experiences from their individual behaviours and actions (Cohen et al., 2018). Thomas (2013) elaborates that the key in interpretivism is to make sense of the understanding people we are talking to have about the world and how we can in turn comprehend this. However, one of the criticisms of the interpretivist paradigm as pointed out by Nuntsu (2020, p. 28) is that it tends to focus on descriptions at the expense of explanations. Also, it focuses on individuals. To ameliorate this in this study, I complemented the interpretivist paradigm with the indigenous research paradigm (Chilsa, 2012).

³Expert community members are referred to as experts in this study since they are the custodians of traditional knowledge and are recognised for their funds of knowledge and wisdom.

3.2.2 Indigenous research paradigm

The indigenous research paradigm is viewed by many scholars as an emerging approach to research which foregrounds the indigenous people's ontologies, epistemologies and axiologies (Chilisa, 2012; Le Grange, 2007; Mbembe, 2021; Seehawer, 2021; Wilson, 2008). However, it is important to understand that indigenous people are not a homogenous group of people with a universal culture and worldviews. For this reason, I drew on Ubuntu, which is a principle or perspective embedded in the indigenous paradigm, as the relational lens that informed our conduct as we collaboratively engaged in the co-construction of knowledge in this study (Chilisa, 2012; Wilson, 2008). Ubuntu is an African philosophy that is commonly found among the people of Southern Africa, including the Aawambo and Balangwe who were the participants in my study. Within the indigenous research paradigm, I used the Ubuntu perspective.

The use of the Ubuntu paradigm in this study was also in accordance with a call from scholars such as Chilisa and Ntseane (2010) who suggest that indigenous researchers should start viewing indigenous research through the lens of a postcolonial indigenous paradigm rather than in an interpretive way. Wilson (2008) defines a postcolonial indigenous research paradigm as a means of hearing non-Western voices and emancipating the voice of the formerly oppressed generations. In agreement, Makabela (2015) accentuates that the foundation of Ubuntu should be used to underpin African research activities because it focuses on seeking for explanations and solutions to mitigate problems faced by Africans. It thus points out that for African research to be relevant, it should be embedded in the Ubuntu perspective. In other words, the inaccessibility of scientific knowledge by Namibian learners needs to be viewed with an African lens for relevance.

Ubuntu is a "philosophy that is a collective effort characterised by the spirit of togetherness which sees human needs, interests, and dignity as of fundamental importance and concern" (Higgs, 2008, p. 453). In other words, Ubuntu is concerned with the welfare of the whole community as opposed to individual needs and interests as it holds the view that through collaboration, a lot can be accomplished. Simply put, it is the spirit of togetherness (Seehawer, 2018a). Seehawer further

posits that in an Ubuntu perspective, the knowledge is generated and validated through discussions with the concerned community.

In this regard, Makabela (2015) avers that the Ubuntu perspective befits the African research activities as it focuses on African IK and their behaviours. In this regard, Khupe and Keane (2017) recommend that African research needs to be aligned with lived experiences and value the culture of participants in shaping the identities of communities. Building on the latter, scholars like Ali and Shishigu (2020) and Mabingo (2020) accentuate that the philosophical idea of incorporating culturally based knowledge should not only be about the content that learners learn but should be relevant to learners' everyday life and fitting to the values of the community in which they live. My intention in this study was not only to describe the teachers' social interactions and experiences during their engagements in the intervention workshops, but also to observe a shift in their ZPDs (Vygotsky, 1978).

During the data collection phase of this study, I came to comprehend the true meaning of the expression "I am, because we are" (Oviawe, 2016). The Ubuntu perspective was the underlying force behind bringing in the Grade 8 Life Science teachers to form a community of practice with the expert community member. The professional development platform (workshops) were opportunities created for active collaboration between the Life Science teachers to improve their content knowledge as well as pedagogical skills. Moreover, the expert community member's willingness, as a MKO (Vygotsky, 1978), to share her knowledge by facilitating the practical demonstration on making *oshikundu* was central to her Ubuntu. In the section that follows, I now discuss the research design for this study.

3.3 Research Design

According to Merriam and Tisdell (2016), research is a systematic inquiry. They further alluded that engaging in a systematic inquiry involves choosing a study design that corresponds with your research questions, your worldview, personality and skills. Concurring, Cohen et al. (2018) explain that a research design is a plan or strategy that is drawn up for organising the research and making it practicable, so that the research questions can be answered based on evidence. Thus, the research determines the design of the research, which in turn informs the methodology (Cohen et al., 2018). Moreover, Maxwell (2012) asserts that the research design is not only influenced by goals, the

conceptual framework, methods of collecting data, research questions, the research setting and conclusions of the study, but it should indicate how the researcher will analyse the data (Bertram & Christiansen, 2020). The research design employed in this study is a case study research design and I discuss this below.

3.3.1 Qualitative case study

Creswell (2008) defines a case study as a comprehensive investigation of a confined system. It also provides a researcher with a deeper understanding of the dynamics of a situation (Bertram & Christiansen, 2020; Cohen et al., 2018; Maree, 2014). In addition, Yin (2009) suggests that case studies have a particular ability to answer the ‘why’ and ‘how’ research questions, rather than simply the ‘what’ questions. That is, case studies have the potential to evaluate or explain why a particular phenomenon did or did not work. Cohen et al. (2018) highlight the strengths of a case study as establishing cause and effect, and that they observe effects in real contexts, recognising that context is a powerful determinant of both cause and effect. Moreover, qualitative research also has the advantage of providing detailed data, encouraging discussion and being more flexible. Nevertheless, Mander (2017) avers that a case study is criticised on the basis of using only a small number of participants, which makes it difficult to generalise data.

This study adopted a qualitative case study research design in the form of an intervention. The intervention was intended to support Life Science teachers to develop exemplar lessons that enabled them to mediate learning of diffusion by integrating the local IK of making *oshikundu*. My case consisted of three Life Science teachers. The three teachers took part in answering the interview questions and also participated in the workshops – during the workshops I was a facilitator, co-learner and observer. This approach resonates with Merriam and Tisdell (2016) who state that qualitative study offers the researcher an opportunity to expand their understanding through non-verbal and verbal communication. In this regard, I accessed information from the observations that I made and the reflections that the teachers provided (Eisner, 2017). Moreover, Eisner (2017, p. 35) posits that qualitative researchers do not end with what is observed but penetrate the surface beneath manifested behaviours.

My unit of analysis, in the case described above was the social interactions, participation and learning experiences during the presentation of the indigenous technology of making *oshikundu*

by the expert community member. The reason for this research approach was to do research on how Life Science teachers could integrate IK from knowledge received from the community member for the effective teaching of diffusion.

3.3.2 Research goal and questions

The main goal of this study was to mobilise the indigenous technology of making *oshikundu* to mediate learning of the topic of diffusion.

To achieve this goal, the study was guided by the following research questions:

1. What are Grade 8 Life Science teachers' experiences, understanding and pedagogical insights on integrating indigenous knowledge in their teaching?
2. In what ways do Grade 8 Life Science teachers interact, participate and learn (or not) during the practical demonstration of making *oshikundu* by the expert community member?
3. How do the Grade 8 Life Science teachers co-develop an exemplar lesson on diffusion that integrates indigenous knowledge?

3.3.3 Research site, participants and sampling

In the next sections, I discuss the research site, participants and sampling. I begin this section with the research site.

3.3.3.1 Research site

This study was conducted at three different sites and had two phases. Phase 1 was carried out at three government schools where the participants were teaching. Phase 2 of this study was carried out in a government school in the Otjozondjupa region as shown by the arrow (see Figure 3.2). The school was located in an urban area. This school offers Grade 8–12 and at the time of this study, the school had 554 learners of which 295 were male and 260 females. It had a staff complement of 26 teachers. That is, the teacher ratio was 1:45. The school had one principal who was male. In addition, the school had three heads of departments, viz., mathematics and science

3.3.3.2 Research participants and sampling

This research study was conducted at Inekela Secondary School (pseudonym) in the Otjozondjupa region in the central part of Namibia. The study involved three Grade 8 Life Science teachers from three different schools in the Otjozondjupa region. These teachers were purposively selected as suitable to best help me to understand the central phenomenon that I was exploring (Aurini et al., 2016; Creswell, 2015). To be able to gain an in-depth exploration of the Grade 8 concept, I purposively selected teachers that were teaching Grade 8 Life Science in 2020. Due to the changes to the Life Science syllabus in 2017, it was vital to select teachers who were familiar with the new syllabus in terms of content and pedagogy for the study to offer them professional development.

For the benefit of this study, all three teachers were qualified to teach Biology and two of these teachers had experience in teaching Biology at Grade 12 level. Though experience in teaching Grade 12 was not a criterion in sampling, their participation was of benefit to the study as the concept of diffusion is also reported to be a challenge in Grade 12 as per the examiner report. Moreover, I felt it would be appropriate to have grade 8 participants as this is the beginning of the Life Science content and it might therefore be vital to help teachers teaching grade 8 to develop a pedagogy that would enable their learners differentiate diffusion from osmosis at this level.

The participants were all experienced Life Science teachers as they had been teaching it for a number of years, however, their teaching experience was not a sampling criterion. Thus, they seemed to be aware of challenges associated with Life Science content, including hands-on practical activities. This suggests that the introduction of the indigenous technology by the community member might help them realise that easily accessible materials from the environment can help them conduct hands-on practical activities that might enable their learners to contextualise difficult concepts in science (Asheela, 2017; Nangolo, 2019; Shinana, 2019). The practical demonstration also aided in drawing the participants (teachers) into a discussion identifying the emergence of the concept diffusion or any other science concepts that they picked up. With regard to the IK, the participants were from two ethnic groups of Namibia, namely, two Oshiwambo speakers and one Caprivian speaker. The diversity was really an advantage because our Balangwe brother (T3) related his observations in the context of his own sociocultural background and this made this study inclusive – IK can thus be used in multicultural settings.

Sampling refers to the process of defining the population on which the researcher will focus (Cohen et al., 2018). These scholars affirm that sampling is the process used to select a given number of people (sample) from a population. Sampling involves making decisions about which people, settings, events or behaviours to include in the study (Bertram & Christiansen, 2020). Similarly, Maree (2016) asserts that sampling involves making the decision of who to include in the study. In my case, I used purposive sampling to identify participants based on the fact that the participants were all teaching Grade 8 Life Science this academic year, thus it benefited the study in terms of observing their integration of IK into their teaching. In purposive sampling, the sample is chosen for a particular purpose, feature, event or activity (Aurini et al., 2016; Cohen et al., 2018). The community member was chosen because she is a custodian of the cultural heritage of making *oshikundu* and she was therefore considered to be a more knowledgeable other (MKO) as proposed by Vygotsky (1978).

Worth mentioning is the fact that the sample size in this study was relatively small because the aim of this study was not to generalise the findings to a larger population, but to understand the Life Science teachers' experiences, perspectives and pedagogical insight on the use of IK in the Life Science classroom (Merriam & Tisdell, 2016).

3.3.4 Teacher profiles

All three of the Grade 8 Life Science teachers participated in the semi-structured interviews. Instead of using pseudonyms, the teachers preferred to be identified by means of codes. The codes used were T1 to T3 which represent teacher 1 to teacher 3. Table 3.1 shows the teachers' profiles.

Table 3.1: Shows the biographical information of teachers

Biographical information	Category	Number of teachers	Teachers' codes
Ethnicity	Aawambo	2	T1, T2
	Balangwe	1	T3
Gender	Females	1	T2

	Males	2	T1, T3
Age group	30-35	2	T1, T2
	36-40	1	T3
Teaching experience	1-10 years	1	T1
	11-20	2	T2, T3
Qualification	Degree	1	T3
	BEd Honours	2	T1, T2

The participant teachers who participated in this study were two males and one female. All the participants had five years or more experience. Moreover, two teachers had a BEd Honours qualification and one teacher had a degree in education. The participants were aged between 30 and 40 years. Ethnically, the group was diverse, representing two different ethnic groups from the northern part of Namibia, that is, the Aawambo from the Oshikoto region and the Balangwe from the Zambezi region. Thus, the presentation by the expert community member was done in English so that no translation was required except when the need arose due to questions asked in Oshiwambo by participating teachers. The expert community member was a science teacher by profession, who holds a master’s degree in science education. She currently is a Chief Education Officer at NIED.

3.3.5 Research methods

The following data gathering methods were used to gather data in this study, namely, semi-structured interviews, observation (participatory and classroom observation), workshop discussions, stimulated interviews and journal reflections. Mills (2011) points out that using different data gathering methods ensures triangulation of data. That is, this strategy “reduces the risk that your conclusions will reflect only the systematic biases or limitations of a specific source or method and allow you to gain a broader and more secure understanding of the issues you are investigating” (Maxwell, 2012, p. 106). I now discuss each of these data gathering techniques below.

3.3.5.1 Semi-structured interviews - Phase one

According to Cohen et al. (2018), a semi-structured interview is an interchange of views between two or more people on a topic of mutual interest aimed at knowledge production. Bertram and Christiansen (2020) state that semi-structured interviews have a schedule of questions (mostly open ended) which can be explored in any order and the researcher is free to follow up on responses in any way deemed appropriate (see Appendix F). It therefore afforded me an opportunity to prompt and probe the participants on any misunderstood questions with regard to experiences, understandings and pedagogical insights on the use of IK to mediate learning of the concept of diffusion. I conducted individual interviews with three teachers. With the permission of the participants, I tape-recorded the interviews for transcription so that no information was lost or misconstrued.

I interviewed the participant teachers individually from three different schools. The interviews took place at their schools' premises after school hours. The sites were chosen carefully to provide a non-threatening environment where the participants would respond freely (Mutanho, 2021). In my study, the semi-structured interview was tape-recorded, and the duration differed from participant to participant but ranged between 15 to 20 minutes. The interviews with all three participating teachers took three days, because I could only afford to visit one school a day.

I found semi-structured interviews very useful and beneficial because it enabled me to find answers to research question 1 (see appendix G for the data obtained). Generally, interviews went very well and teachers were free with their answers. The only challenge that I found was that my questions were not answering the research questions as I had hoped. On reflection, I realised that I had to add an additional question. Participant 3 was then asked the additional question and it yielded the answer to the research question. I then realised that I had to go back to my other two participants and find out if they would allow me to ask the additional question after I explained the situation and they agreed. This challenge showed me that it is important to ensure data validity by piloting questions to afford a researcher rectification of errors (Brooks et al., 2016; Dikko, 2016; van Teijlingen, 2014).

3.3.5.2 Workshop discussions - phase two

Workshops were key to this study. The term workshop is defined by Orngreen and Levinsen (2017, p. 71), as “an arrangement whereby a group of people learn, acquire new knowledge, perform creative problem solving or innovate in relation to a domain-specific issue”. The aim was to create an experience for both the participants (the three teachers) and I where we could discuss and develop model lessons that integrated IK. Thus, Eun (2008) states that the best way to improve teaching and learning strategies is to engage teachers in training such as workshops, that will help them to improve their teaching strategies. In support, Shabani (2016) suggests that teachers should be involved in activities that help them improve their professional development. Thus, the workshops helped us strengthen our higher order thinking skills and further improve our topic-specific knowledge in diffusion. The workshop discussions seemed most appropriate as they helped set an environment for social interactions which is considered a vital place for learning from a constructivist view (Vygotsky, 1978). Sedlacek and Sedova (2017) also view participation in social interactions to enhance learning. Four workshops were conducted and in order to capture the rich data from these workshops, I asked a critical friend to videotape them. The intention of the workshops was to:

- build trust and good rapport with the participants;
- negotiate and ask for permission to video record the discussions of the study during the workshops;
- explain to the participants the reflection guideline;
- do document analysis with the purpose of establishing the cause for concern in the topic of diffusion and to strengthen the context of the study;
- analyse documents to triangulate the data obtained with semi-structured interviews with regard to the teachers’ pedagogical insight;
- have a presentation by a community member who is an MKO about the indigenous technology of making *oshikundu*;
- write down the science concepts emerging from the presentation and reflect on the community members’ presentations; and

- use the local knowledge presented by the community member to co-develop exemplar lessons that integrate IK to mediate the learning of diffusion.

What follows are descriptions of the activities of the workshops.

Workshop one: Orientation workshop

We met for the first time as group with the three participants during this workshop. The workshop commenced with the introduction of the participants. As this was a professional development practice, I was guided by Eun (2008) who states that involving teachers in the planning stage of professional development would be an effective means to achieve the purpose, as their needs and goals will then be reflected in their activities. I therefore asked the participants to discuss their workshop expectations and every aspect they felt needed to be addressed during the workshops. In addition, Merriam (2009) states that adult learners are self-directed and therefore prefer to participate in planning, implementing and evaluating their own learning. The workshop also afforded me an opportunity to discuss the evaluation template with the participants. I also made it clear that they should not be limited by the template thus giving them a mandate to add whatever they would want to reflect on.

The participants shared their workshop expectations and decided on the following workshop below with a meeting time at their convenience. The workshop went well as all the participants managed to attend. The teachers were happy to meet each other, and they shared a few jokes here and there. During this workshop, I noticed that time was a challenge because one participant showed up 30 minutes late. This delayed the activity of the workshop. In addition, the other participants also felt delayed but nevertheless, the workshop activity was completed. This activity led us to the third phase of workshop one, where document analysis was done. This is discussed in the following section.

Workshop two: Document analysis

Bowen (2009) points out that document analysis is a systematic procedure used for reviewing or evaluating documents, both printed and electronic material. In the context of qualitative research, document analysis requires that data be examined and interpreted to elicit meaning, gain understanding and develop empirical knowledge (Cobin & Strauss, 2008). Shinana (2019) points out that she saw it as a lost opportunity to not have used the TSPCK components during the analysis of the curriculum documents and this study would therefore like to close that gap. The documents that we co-analysed were also used as a triangulation tool for the findings obtained in the semi-structured interviews with regard to the participant teachers' pedagogical insights.

The following documents were analysed: the broader curriculum of education (MEAC, 2016), Grade 8 Life Science syllabus (2015), textbooks and examiners' reports. Shinana (2019, p. 60) describes the examiner report as "a document which provides comments based on common mistakes and errors detected from the learners' answer scripts countrywide". In addition, Nsingo (2015) explains that these reports are documents that give accounts of the learners' performance by commenting on every examination question paper for each school subject that the learners sat for. He further points out the importance of examiner reports as documents that play a vital role in educating teachers on how learners performed in past examinations, what mistakes they made and examples of how specific questions should be answered.

Worth noting, is that NCBE (2016), is the official policy document that guides teaching and learning in Namibian schools. Consequently, the subject syllabus for Life Science is developed to achieve the aims and goals of education stipulated in the NCBE. Equally, the textbooks are designed in relation to the content which is provided by the subject syllabus. To offer a comprehensive view of reviewing these documents, the purpose for analysing each document is displayed in Figure 3.2 which I adopted from Shinana (2019).

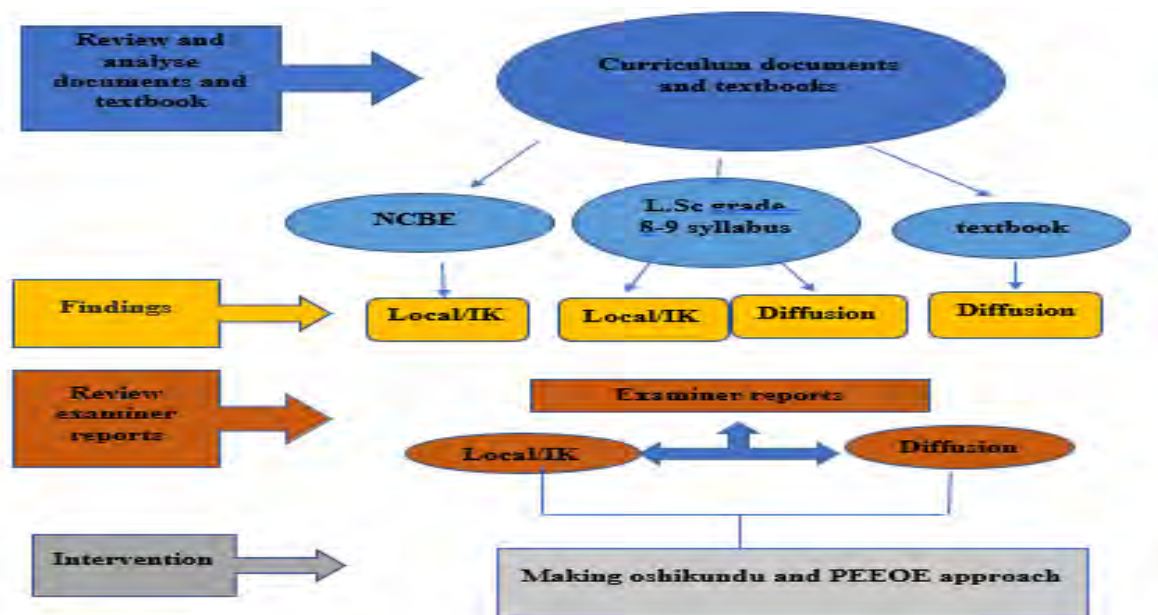


Figure 3.2: The different phases of document analysis (Shinana, 2019, p. 61)

Workshop three: Practical demonstration on the process of making *Oshikundu*

I carried out an intervention in the form of workshops which took place over a period of two days. Three Grade 8 Life Science teachers (T1, T2 and T3) participated in the workshops. In addition to the three teachers, a local woman who was an expert in making *oshikundu* was invited to demonstrate the process involved in making *oshikundu*. This suggests that bringing a community expert to do a practical demonstration does not only involve parents in the education of their children but contributes a sense of value to indigenous science so that learners may respect their culture (Cocks et al., 2012). Moreover, it reinforces the notion of learning from the sociocultural setup as espoused by Vygotsky (1978).

During the practical demonstration, the expert community member communicated in English as the group of teachers spoke different languages. However, there was no limitation to vernacular participation as prompt translation was offered by participants to enable the non-Oshiwambo speaker access to what was being communicated by others. According to the socio-cultural theory, the use of cultural tools such as language, is essential to the learning process. In line with this perspective, the language was used to encourage the teachers to verbalise their ideas and to

comment on the ideas of the others, which subsequently contributed to their learning (Simsek & Kabapinar, 2010). During this process, I was a participatory observer. While the expert community member demonstrated how to make *oshikundu*, we identified the scientific concepts that emerged from the process of making *oshikundu* which were used to develop a mind map. Additionally, a worksheet was provided for the practical demonstration (see Appendix H).

The aim of the worksheet was to show how teachers could use the predict-explain-explore-observe-explain (PEEOE) method (Asheela et al., 2021). Abrahams and Millar (2008) and Woodley (2009) accentuate that it is important to properly plan practical activities to enable learners to find practical activities enjoyable and engaging. They further state that engaging learners throughout the practical activities challenges them mentally compared to other teaching and learning approaches in science.

When the expert community member finished preparing the *oshikundu*, she stated that we needed to give it time to cool down before we could dilute it with water. She then passed the bucket with the *oshikundu* paste to T2 to continue stirring as this would help to cool it down faster. When the *oshikundu* paste cooled down, the community member then asked T2 to add water. She kept instructing her until she was satisfied with the dilution. The diluted *oshikundu* was then poured into four bottles. Two of the bottles had *oshikundu* with *oshipithitho* while the other two contained *oshikundu* without *oshipithitho*. The bottles were placed in two different environments. Two bottles in the classroom (room temperature) and two bottles in a cool environment (a fridge). The teachers made predictions of the set experiment, illustrated their predictions and provided explanations for their predictions on the worksheet provided (see Appendix H). Again, observations of the set experiments were then done in workshop three.

Overall, the workshop went well. This was evident in the level of teacher participation. The teachers were interested in being part of the practical demonstration. What came out as motivation for their interest and level of participation, was their identification of scientific concepts embedded in the indigenous practice demonstrated by the community member. The non-Oshiwambo participant was also very delighted as he could contextualise the practice of *oshikundu* making to his own indigenous practices. However, due to time constraints, instead of constructing concept mind maps, the teachers were asked to list the concepts that emerged from the practical

demonstration with the intention of developing the mind maps and the concept maps in the next workshop of observation.

Workshop four: Making of concept maps and observation

Observation is a systematic looking and noting of events, behaviour of a setting, artefacts and routines that gather primary data (Cohen et al., 2018). In this study, participant teachers were enabled through observation to identify the scientific concepts that emerged from the indigenous practice. They used these concepts to develop mind maps and concept maps as it was postponed to workshop three. The participant teachers and I used the concepts they listed in workshop two.

Moreover, the teachers then made observations to see what occurred as a result of the set experiment. Participant teachers had to complete worksheets individually and then as a group in order to make predictions about the prepared activities as well as explanations for their predictions. In addition, they also had to make observations and give explanations for their observations of the practical activities. They completed their observations on a worksheet (see Appendix H). Concepts that emerged from the discussions were identified and added to the mind map which was constructed earlier. The observations provided opportunities to discuss concepts of the topic of diffusion and related topic such as gaseous exchange. The one teacher who had experience in teaching diffusion used tea bags and discussed his experience about how learners still struggle to describe what they observe during the practical demonstration. He further stated that learners would rather define the concept. This then showed how professional development took place as teachers further pointed out that they could use the worksheet approach used in the practical demonstration workshop to allow learners to PEEOE (Asheela et al., 2021).

3.3.5.3 Participatory observation

Observation can be classified either as non-participant or participant, depending on the role played by the observer. Gay et al. (2012) define participatory observation as a setting where the observer becomes a part of and a participant in the situation being observed. That is, the researcher takes part in the activity they set out to observe and in doing so, they also gather data on the activities, people and physical aspects of the setting. Thus, Thomas (2013) and Maxwell (2012) suggest that to have better insight and understanding, the interpretivist researcher should be a participant in

their research situation and understand it as an insider. Participatory observation provides the researcher with the advantage of collecting data directly from the real-life lived experiences (Cohen et al., 2018).

Furthermore, Cohen et al. (2018) state that observation is the technique researchers use to generate data in a social situation. The observation technique resonates both with Vygotsky's (1978) sociocultural theory and Shulman's (1986) PCK. It was therefore necessary for me to be a participant observer in order to see, hear, feel and observe what actually took place (Bertram & Christiansen, 2015). This also helped me to find out about social interactions as explained by Vygotsky (1978). Moreover, as a participant observer, I observed how the Life Science teachers interacted, participated and learnt (or not) during the presentations made by the community member. Participatory observation further afforded me an opportunity to inquire about the steps that the presenter was taking in her demonstration, thus digging deeper to find out things which may be hidden through enquiry (Creswell, 2016). Furthermore, the demonstration on the making of *oshikundu* by the expert community member also helped me to gain insight into teachers' participation and understanding of the value of IK when teaching science. However, being a participant observer was a bit challenging for me. I needed to divide my time well, so that I could both concentrate on observing and gathering rich data from the discussions and allow other participants to ask their questions and make contributions without interfering.

3.3.5.4 Journal reflections

Lamb (2013) defines reflection as a process whereby one creates meaning by making explicit references to their experience (prior and post) of a phenomenon. In this study, reflection was encouraged at different stages; thus, it yielded data that showed the intended professional growth as per the intervention study. Two types of reflection occurred in this study. One, the journals written by the informant teachers; two, an oral reflection by the expert community member. The objective of reflective practice in learning, as stated by Creswell (2012), is to ensure a more precise and meaningful understanding of a situation and to provide effective applicable actions for strengthening performance, thus, the expert community member reflected after the demonstration. During these reflections, I asked her to clearly explain the steps involved in the making of the *ongundo* (malted sorghum flour) that is added to the *mahangu* paste in the making of *oshikundu*.

In the context of this study, journal entries were made right from phase one of the study to afford teachers more opportunities to internalise the learning process which could then help them to externalise their learning during the development of exemplar lessons (Vygotsky, 1978). Eun (2008) points out that writing reflections in professional development leads to self-analysis and personal reflection. He further stresses that this process is essential for internalisation of learnt knowledge to occur.

Therefore, the participants' reflections helped me ascertain whether the mediation tool (IK) brought about better understanding of IK and whether its integration assisted teachers to view learners' IK as a wealthy resource that can be used as a foundation for learning (Rochelle, 1995). Similarly to Nhase's (2019) study conducted in South Africa, the reflective space also helped us to collaboratively reflect on what we had learnt during the presentation by the expert community member and most importantly, how to take the knowledge gained to our science classrooms in order to improve our practices. All teachers wrote journal reflections (see Appendix H) and they answered all the guiding question in the reflection template.

Table 3.2: Shows a summary of the data gathering techniques used in this study

Technique	Purpose	Research question
Semi-structured interview	To discover teachers' experiences', understanding and pedagogical insight on the use of local knowledge on food preservation.	1
Document analysis	To ascertain the teachers' pedagogical insights with regards to IK and to strengthen the context of the study.	1
Participatory observation	To see how teachers interacted, participated and learnt during the presentation made by the community members and the scientific concepts that emerged from community members' presentations.	2
Journal reflections	To allow teachers to express themselves about what they thought about the presentations and to use the local knowledge presented by the community member to develop a lesson plan that integrated IK.	3

3.3.6 Data analysis

The data sets in this study were generated from semi-structured interviews, document analysis, workshop discussions, participatory observations and journal reflections. Data analysis involves organising, explaining and reducing data for it to make sense (Cohen et al., 2018). Similarly, Merriam and Tisdell (2016) describe data analysis as the process of making sense out of data. This involves interpreting what people have said and what the researcher has seen and read. To find out the meaning in data, Cohen et al. (2011) explain that this is a process that involves organising, accounting and explaining data. In this thesis, data are presented and analysed in both Chapters Four and Five. These chapters are organised according to the research questions.

I adopted a thematic approach to data analysis. That is, qualitative data were colour-coded and analysed inductively-deductively by coming up with sub-themes. Thereafter, common sub-themes were grouped together to form themes (see Appendix I). I first transcribed the semi-structured interviews and then began the process of data analysis by means of narratives which were written out as stories. From the narratives, I identified episodes. I then started to colour-code the data. The aim in coding data was to identify episodes. Within these episodes, I identified themes and categories. These themes will be discussed later in relation to literature, as well as the two theories, namely, sociocultural theory and TSPCK. I adopted Hashondili's (2020) model of data analysis which is based on Saldana's (2009) seminal work. I looked for similarities in order to come up with themes and sub-themes (see Figure 3.3 below).

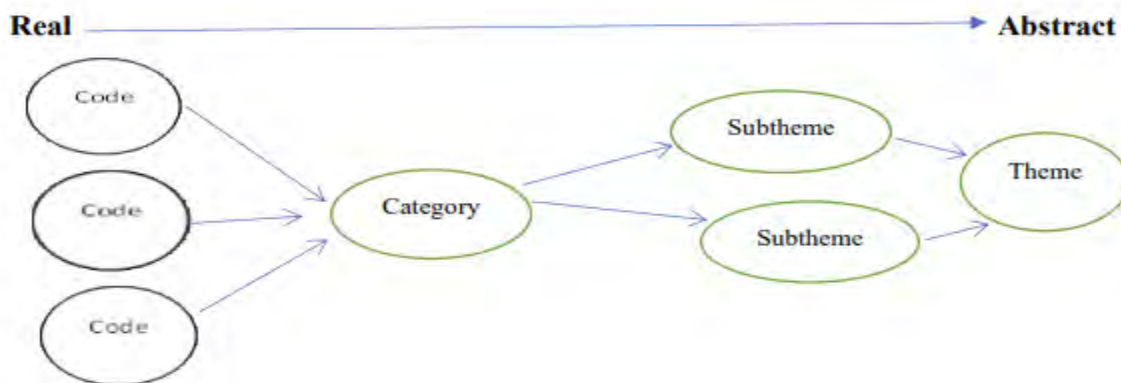


Figure 3.3: Shows the model used in data analysis, to code, categorise and reduce the categories to sub-themes and the sub-themes to themes (Hashondili, 2020, p. 45)

I analysed the data generated from the narrations about the teachers' experiences and their understanding using the five components of TSPCK adapted from Mavhunga and Rollnick (2013). I used TSPCK to examine how to make use of learners' understanding, their knowledge of common misconceptions and gate-keeping concepts on curriculum that make the topic difficult to understand. Sociocultural theory was used to analyse data that was generated through workshops. The sociocultural perspective was used to analyse teachers' experiences of learning through social interactions and how the participants engaged in social interactions during the presentations made by the community members. I analysed how the community members mediated learning and teaching using language cultural tools. The ZPD was used to see if there was a shift in the participants' understanding through observation and reflection and during the development of the exemplar lesson plan. Moreover, all data were labelled with codes and themes. To validate data, the following process was used.

3.3.7 Validity and trustworthiness

Validity is one vital aspect of research that looks at how accurate and credible the research findings are (Creswell, 2016). In light of this, Merriam and Tisdell (2016) suggest that validity can be ensured through careful attention to a study's conceptualisation and the way in which the data are collected, analysed and interpreted and the way in which findings are presented. Validity in this study was ensured through various ways. The data were gathered from four different sources. First, I gave the semi-structured interview transcripts back to the three teachers to ensure that they reflected exactly what they had said (member checking).

Second, data were gathered through document analysis. What makes data from document analysis valid is that all participants, including myself, were involved in co-analysing the curriculum documents. That is, this data were generated through discussions which involved more than one person.

Data were also gathered through various interactions and discussions that took place during the workshops and the observations which I made during the workshops. This was first-hand data. Third, combining data from the semi-structured interviews, document analysis, workshop discussions, participatory observation and journal reflections was also another way of validation, termed as triangulation (Aurini et al., 2016; Cohen et al., 2018).

Moreover, during the intervention workshop, three different worksheets were given to participants which were completed during the discussions. This created an opportunity for the teachers to write down their thoughts and ideas. This suggests that I did not just rely on observed data which I might have misinterpreted, but instead also relied on the written information from the teachers' worksheets. This strategy was useful in strengthening validity and trustworthiness in this study.

3.3.8 Ethical considerations

In this section, I discuss various aspects pertaining to ethical considerations in this study.

3.3.8.1 Respect and dignity

The rights of the participants were addressed and respected in this study. Furthermore, their welfare, anonymity and privacy were protected. During the signing of the informed consent letters, I retold the participants and the expert community members that their participation in the study was voluntary and thus they had the right to withdraw from it at any time. I was also mindful and respectful of the schedule of the participants and ensured that the research activities were done at convenient places and times. I discussed that I would ensure anonymity in this study. The participants were informed that workshop presentations would be recorded, and they were asked to give their consent for them to be recorded. I also highlighted that I would not share the information from this study with third parties without their permission. As this thesis would be in the public domain, I was also considerate of the data that I presented, to ensure that anything that I wrote in the thesis did not compromise the dignity of the participants.

3.3.8.2 Transparency and honesty

I explained the aim and process of the study to the participants in detail before they gave their consent to participate in this study. Letters of consent were written both in English and for the community member in Oshiwambo, to make sure that all the participants understood the content. Furthermore, permission to conduct this study was obtained from the directorate of education in the Otjozondupa region, the school principals, the participant teachers and community member, and all their responses were positive.

3.3.8.3 Accountability and responsibility

This study was conducted in accordance with the principles of the ethical policy and guidelines for educational research. I made sure not to misuse my position as a researcher but rather conducted my study in agreement with research principles, as well as the education department regulations of Namibia on conducting research in schools. That is, I ensured that the participants' work was not compromised by the study and the workshops were conducted after school hours. Moreover, I was also in constant communication with my supervisors as they provided me with guidelines and contributions during the time I conducted the study. This ensured that ethical issues which were raised during my data collection phase or write up of the thesis was communicated to my supervisors and they provided suggestions thereof.

3.3.8.4 Integrity and academic professionalism

This study is my own product, as I have used my own ideas and where I used others' ideas, I correctly acknowledged and referenced them according to the referencing guidelines. Data were presented without fabrication.

3.4 Chapter Summary

In this chapter I described the research design and methodological orientations used in conducting this study. I also outlined the research goal and questions of this study. The research site, participants, sampling and positionality were also discussed. I explained how the data were gathered and analysed. The issues of validity and trustworthiness were explained, and ethical issues were considered and then discussed. In the next chapter, I will present, analyse and discuss the data generated from the semi-structured interviews and document analysis.

CHAPTER FOUR: SEMI-STRUCTURED INTERVIEWS AND DOCUMENT ANALYSIS

4.1 Introduction

In the previous chapter, I discussed the research methodology employed in this study. I explained how data were generated to answer my research questions of this study. In this chapter I present, analyse and discuss the data generated from semi-structured interviews and document analysis. The aim of the semi-structured interviews was to establish the Grade 8 Life Science teachers' experiences, understanding and pedagogical insights on the integration of IK, specifically in the topic of diffusion. On the other hand, document analysis was done with the purpose of establishing the pedagogical insights of the participant teachers with regard to the integration of IK into their teaching. Moreover, it also served as a triangulation method with the data collected in the semi-structured interviews with regard to the participants' pedagogical insights.

First, I present, analyse and discuss data generated from the semi-structured interviews followed by the data generated from the document analysis. I commence this chapter with the presentation of the pseudonym codes that I used for the participant teachers involved in this study. I interviewed three teachers individually and these were recorded with a voice recorder with their permission. The participants were also given codes that are used throughout the thesis. The codes used are shown in Table 3.1 (see Section 3.3.4). T1 to T3 represent teacher 1 to 3 and M and F shows male or female. SSI is for semi-structured interviews; therefore, for example teacher 1 male semi-structured interviews would be T1MSSI. This made it easy when presenting, interpreting and discussing the data obtained from the SSIs. Themes were developed from sub-themes and are presented in the table below (see Section 4.2). This chapter is therefore outlined according to the themes developed from the data from T1SSI to T3SSI.

4.2 Development of Sub-Themes and Themes

Data generated from the SSIs were inductively analysed (McMillan & Schumacher, 2010). The data were collated according to the questions they answered, and the teachers' responses were colour-coded using different colours. Thereafter, the same colours were combined into sub-themes which were later developed into themes (see Appendix G). Notable is that the participants' perspectives and pedagogical insights were different and as a result, different themes were developed. Subsequently, the data generated from the SSIs are presented under these themes: teachers' understanding of IK; teachers' experiences and pedagogical insights on integration of IK; and links between science and IK as shown in Table 4.1 below.

Table 4.1: Generated sub-themes from descriptions of the semi-structured interview

Description of SCI	Sub-themes from the semi-structured interviews	Data source
Local /IK definition	<ul style="list-style-type: none"> ▪ Easily accessible resources ▪ Learners' prior knowledge 	SSI
Importance of IK in our teaching	<ul style="list-style-type: none"> ▪ Contextualisation ▪ Sense making ▪ Facilitate interaction with learners ▪ Easily accessible materials used in practical activity 	SSI
Advantages of integration of IK	<ul style="list-style-type: none"> ▪ Knowledge construction ▪ Hands-on practical experience ▪ Visualisation ▪ Scaffolding ▪ Discovery learning ▪ Sense making ▪ Conceptual understanding ▪ Retention ▪ Mediation 	SSI
Disadvantages of integration of IK	<ul style="list-style-type: none"> ▪ Language barrier ▪ Translanguaging leads to loss of information ▪ Misconceptions ▪ Time consuming ▪ Cultural diversity 	SSI

The themes that emerged from the data were then linked to the relevant literature/theory as shown in Table 4.2 below.

Table 4.2: Themes and sub-themes that emerged from the SSI

Research question 1: What are Grade 8 Life Science teachers' perspectives and pedagogical insights on integrating local knowledge into their teaching?		
Themes	Sub-themes	Literature/Theory
Teachers' understanding of the term indigenous knowledge	<ul style="list-style-type: none"> ▪ Understanding of the term IK ▪ Learners' prior knowledge ▪ Easily accessible resources 	Mosimege and Onwu (2004); Kibirige and van Rooyen (2006); Roschelle (1995); Taylor (1999); Kuhlana (2011); Dziva et al. (2011); Higgs (2010); Mukwambo et al. (2014); Matemba and Lilemba (2015); Tylor and Cameron (2016); Mavuru and Ramnarain (2017)
Teachers' experiences and pedagogical insights in the integration of IK in the teaching of Life Science	Benefit of integration of IK knowledge construction Hands-on practical experience Visualisation Discovery learning Sensemaking Conceptual understanding Retention Mediation Disadvantages of integration of IK Language barrier Translanguaging Misconceptions Time consuming	Kuhlana (2011); Shulman (1986); Ogunniyi,(2007a); Roschelle, (1995); Fataar (2012); Kibirige and Van Rooyen (2006); Hashondili (2020); Mukwambo et al. (2014) Mavhunga and Rollnick (2013) Shinana (2019)

	Cultural diversity	
Link between Life Science and indigenous knowledge	<ul style="list-style-type: none"> ▪ Contextualisation ▪ Sense making ▪ Facilitate interaction with learners ▪ Easily accessible materials used in practical activity 	Asheela et al. (2021); Shinana (2019)

4.2.1 Teachers’ understanding of indigenous knowledge

An understanding of how the Grade 8 Life Science teachers perceived or viewed IK was a vital point of departure in my pursuit to understand their perspectives and pedagogical insights on integrating IK in their teaching. For instance, the teachers involved in this study were requested to state their understanding of IK. They explained that IK is: *“For me it is basically what learners are coming with/bring with to class or the knowledge that learners are exposed to at home or in their society”* (T2). To T3, *“It is the knowledge one learns in your environment”*.

From the above excerpts, it can be surmised that these teachers have some understanding of what IK is. For example, to T2 and T3, IK is the knowledge from the learners’ environment (Chikamori et al., 2019; Kibirige & van Rooyen, 2006). In this regard, these scholars state that this legacy of knowledge and skills are unique to a particular indigenous culture, involving wisdom that has been developed and passed on over generations. Thus, Snively and Williams (2008) accentuate that every culture has its own science. This means that in the community there are more knowledgeable others (teachers or community elders) who are responsible for this unique transmission of knowledge. Concurringly, Chikamori et al. (2019) state that IK is local knowledge, derived from interactions between people and their environment.

Moreover, T2’s definition of IK further indicated that IK can also be in the form of prior knowledge. This finding coheres with scholars such as Gwekwerere (2016), Kuhlana (2011), and Roschelle (1995) who state that new knowledge starts with the selection of ideas from everyday experiences. For instance, Roschelle (1995) describes prior knowledge as a building block for new knowledge and connects old with new experiences. Learners’ prior knowledge involves the

knowledge that the learners have acquired not only from the previous grades but from their everyday experiences as reiterated by scholars such as Kuhlane (2011) and Gwekwerere (2016) to mention a few.

T1 elaborated that: “*The moment we use our local materials to teach our learners using things that they are exposed to then we are talking about local knowledge*”. This excerpt is congruent to Vygotsky’s (1978) concept of mediational cultural tools such as language and materials that are used to achieve a learning goal. Scholars have termed these cultural tools and practices as easily accessible resources (Asheela, 2017; Nangolo, 2019; Ndevahoma, 2019). In this regard, Asheela et al. (2021) propose conducting hands-on practical activities in science teaching using easily accessible resources from the learners’ environment. These scholars suggest use of easily accessible resources leads to a greater conceptual learning which results in development of sense making in key scientific concepts.

A number of studies have looked at this pedagogy and have highlighted several benefits for the learners (Asheela et al., 2021, Kambeyo & Ngcoza, 2017; Samuels, 2017; Ogunniyi & Hewson 2008). Similarly, Shinana (2019) avers that easily accessible resources bridge a gap between home, community and school science.

4.2.2 Teachers’ experiences and pedagogical insights on the integration of IK in the teaching of Life Science

Findings from the semi-structured interviews showed that teachers seemed to be aware of the importance of integrating IK into the teaching of science. For instance, T2 narrated that “*off course local/IK is very important*”. Moreover, T1 pointed out that it helps learners relate to scientific content. He however, shared his disappointment with the exclusion of IK from examination papers, stating that the question paper has typical examples of people in Europe: “*It is not based on us*” (T1). T1 seems to be pointing out that the science content we teach our learners seems to be promoting a Western way of doing things (Western context), whereas it is supposed to be contextualised to our own Namibian way of doing things. This links to “educational disengagement” as espoused by Fataar (2012, p. 55) and the alienation of the Namibian indigenous child, who will then in turn develop a perception that school education is irrelevant. The learners will thus internalise this colonial inferiority complex that regards everything non-Western as

worthless as stated by Breidlid (2013), which will then create learning problems for them. On the other hand, T2 gave the advantage of IK by pointing out that it is “*used as the base on which teachers build on with the new content*”. This finding resonates with Roschelle (1995) and Kuhlana (2011) who emphasise the importance of elicitation of learners’ prior knowledge.

From the above statements, it could be deduced that both T1 and T2 seem to view IK as vital in the teaching and learning processes. For example, T1’s answer links to contextualisation of assessment activities. He stated that this will enable the learners to relate to scenarios given and recall the knowledge around such scenarios. This pointed me to literature on WS alienating African learners (Seehawer & Breidlid, 2021). It is from this background that one can hypothesise that with the integration of IK into science teaching, it will make scientific knowledge less strange thus enabling learners to relate to their everyday experiences (Gwekwerere, 2016).

In addition, T2 highlighted that IK is a form of prior knowledge and serves as a foundation on which new content is added. T3 explained that IK has the ability to remove abstractness (contextualisation) from new content. This means that learners are able to relate to what they know already. He further encouraged the use of local easily accessible materials as they are familiar to learners and learners have the know-how to manipulate them, hence enhancing their understanding. The latter resonates with the advantages of hands-on practical activities as stated by Sedlacek and Sedova (2017) who highlight that it enables identification of key concepts and conceptual understanding, enhances education quality and relevance of education and makes learners experience science first-hand.

Although T3 described IK as very important, the excerpt from T2 which states that “*I incorporate IK. Not to say on daily basis but in some case like you mentioned diffusion, you can mention making a cup of tea, could be one simple example that can be used for diffusion*” shows that she was honest in sharing that she does not integrate it every day. This could be due to a lack of guidance from the curriculum as stated by scholars such as Asheela (2017), Shinana (2019), and Kakambi (2020). Nevertheless, it could also be because of the challenges that come with the integration as stated by the participants and this resonates with literature from Bantwini (2010), Jacobs (2015) and Mothwa (2011) who state that many science teachers seem to struggle to integrate IK into their lessons.

It is against the above background that scholars such as Asheela et al. (2021) suggest that collaborative learning settings, such as the one offered by this study, serve as a motivation and reinforcement of positive self-efficacy. Bandura (1994, p. 1) defines self-efficacy as “people’s belief about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives”. Concurring, Yuksel and Alci (2012) posit that teachers’ actions and behaviour are related to their levels of self-efficacy. Both these stated qualities are needed by science teachers to implement hands-on practical activities that integrate IK. Likewise, Mutanho (2021) concurs stating that professional development platforms like this study may provide solutions and address stated challenges as those pointed out by the participant teachers. He further alludes that the policy of integrating IK into science lessons cannot be realised unless teachers are equipped with the necessary conceptual tools to enable them to implement the rule.

Another challenge pointed out by the participants was indigenous language. For instance, they stated that integration of IK is limited due to the cultural diversity in the classroom. In this regard, T1 reflected:

One of the problems that I have noticed in the integration of IK, is our indigenous languages. The usage of indigenous language can be a disadvantage because our official language is English so for example if we want to understand something deeper, there is a language barrier.

In support of the disadvantage stated, T3 agreed:

In local language we do not have the terms that we have in the syllabus so sometimes it become difficult for us as teachers to explain the terms that are used in most cases, they are more abstract to them for us to translate that into our local languages from English it takes a very cumbersome process.

From the excerpts above, it could be hypothesised that the participants seemed to be aware that IK includes the element of language. They also indicated that language is specific to a certain community and could be difficult to share with other communities (Hashondili, 2020). This finding corroborates with Kibirige and van Rooyen (2006), who accentuate that IK is a legacy of knowledge and skills unique to a particular indigenous culture. T3 seems to be pointing out that, due to the uniqueness of indigenous languages, it is a complex process to find appropriate words for some scientific terms. This echoes with Simasiku and Ngcoza (2019), who argue that there are more terminologies in indigenous language that make it very complex to teach science using indigenous language. Thus, Fang (2004) suggests that teachers should be careful whenever they code switch, so as not to change the meaning of concepts.

Besides the fact that T3 seemed to understand the importance or benefits of indigenous language to the teaching and learning process, he admitted that the enactment (ePCK) of IK is quite difficult. This confirms the tensions that exist between the intended and the enacted curriculum (see Section 1.2.2). Thus, T3's lamentation is a glimpse into his limited ePCK. Therefore, the workshops carried out in this study to integrate IK became an eye opener for the participant teachers. Hashondili (2020) thus offers an explanation that IK is embedded in local language and the two cannot be separated – this links to Gibbons (2003), as he highlights that language plays a very important role in communication and development of scientific ideas in science. Likewise, Nyamakuti (2021) affirms that culture influences a particular kind of science. Thus, the absence of translanguaging in science teaching and learning might be a reason why it is difficult for learners to understand and make sense of science.

Mavuru and Ramnarain (2019) allude that it is through language that learners can construct knowledge and make sense of science. Building on Mavura and Ramnarain, Hashondili (2020) points out that using local language could thus help teachers to be free and not confined to WS during science lessons. This suggests that it is appropriate to do translanguaging. García et al. (2006) define translanguaging as the use of more than one language in a classroom. García (2009) further describes translanguaging as the “language practices of bilinguals from the perspective of the users themselves” (p. 45). Hence, translanguaging serves as a foundation that lends theoretical

strength to a multilingual pedagogical stance that accepts all resourceful linguistic inventions of teachers and students (Wang, 2019).

The excerpt above also points out why professional development platforms (workshops) are important. Ngcoza and Southwood (2015) stress that these professional development workshops should have the prerequisite of identifying the teachers' needs. Based on what these scholars argue, one can then claim that the professional development training given to teachers when curriculum innovations are made is often inadequate and not aligned to the teachers' needs. In addition, the challenges stated by the participants also align with Mutanho (2019) who points out that teachers are not given the opportunity to identify their needs. He further states that collaborative engagement in problem solving activities is key. He explains that collaborative engagement enables those involved to co-construct knowledge and solutions to the challenges they face in their teaching – in this context, the integration of IK in a multicultural classroom.

On the other hand, T2 also showed mistrust with regard to IK as she expressed that if learners come to class with misconceptions, it might take a teacher time to make them understand. This finding coheres with Keane et al. (2016), Mhakure and Otulaja (2017) and Mukwambo et al. (2014) who accentuate that any misconceptions brought about by IK should be identified and cleared.

The above finding also showed that T2 seemed to lack conceptual tools to handle the misconceptions that may arise from the integration of IK. Thus, when confronted with the need to integrate IK, these teachers will likely face conflict within themselves because they mistrust IK as a learning tool (Mutanho, 2021). Mutanho (2021) further explains that, for some teachers, instead of seeing IK as a tool that can be used to make science easier to understand as anticipated by the policy, they feel that it might increase misconceptions and tribal tension. Thus, to a certain degree, T2 and T3's views of IK show that it might increase misconceptions and tribal tensions. These teachers' responses can be viewed as historically accumulated structural tensions within science education that are traceable to the time of apartheid. As Jensen (1998) points out, Bantu education which these teachers received promoted ethnicity and tribal tensions while at the same time denigrating African IK. It might be this narrow conception of IK that made some scholars such as Cobern and Loving (2001), Hodson (2009), and Horsthemke and Schäfer (2007) criticise the

assumptions associated with the integration of IK into science lessons. These scholars argue that IK and Westernised knowledge should be treated separately.

These teachers' experiences and pedagogical insights also highlighted that IK has an element of easily accessible resources. The easily accessible resources have the ability to become mediation tools that can be visualised by learners to enhance conceptual understanding of Life Science content.

4.2.3 Link between Life Science and indigenous knowledge

The excerpt below shows how T1 uses easily accessible resources to mediate learning of the concept diffusion.

If learners have this knowledge of how the tea particles are moving from the tea bag into the water, from the beginning the learners can see the changes that are happening. And if you have to use this example in the classroom the learners will understand better and will be able to apply these theories when given practical examples in the exam or in their activities.

From the excerpt above, it could be hypothesised that easily accessible resources can be used to enhance the understanding of the scientific concept of diffusion. The participant further stated that practicals enable learners to visualise what they are learning; thus, by seeing, they can understand what is theorised as diffusion and this offers them (learners) a better understanding (Nangolo, 2018). She further explains that the sense making obtained from the practical activity will enable them to answer the assessment activity with understanding. This links to a proposal by Asheela et al. (2021) who believe that to master the science concepts, learners should learn through hands-on, minds-on and words-on practical activities as tools to foster understanding in the learning of science. To Harlen and Qualter (2018), learning during practical activities is enhanced as learners are afforded an opportunity to raise questions to suggest ways of answering them, to make predictions, to propose explanations, to collect evidence and to interpret it in relation to the question being investigated.

Furthermore, T1's suggestion also has affinity with Kibirige and Tsamago's (2013) findings that postulate that practical activities increase understanding of content because they reinforce critical thinking and logical reasoning. Above all, knowledge which is gained through activities in which learners are involved, such as practical investigations, promote meaningful learning with understanding (Asheela, 2017; Lamm, 2017) and contribute to retention of knowledge (Blanchard et al., 2010; Easterly & Myers, 2011; Nikodemus, 2017; Schmid & Bogner, 2015; Jacob 2015).

Retention of knowledge literature resounds in the data obtained from T1 as he narrated that "*the learners can use local materials to carry out either an experiment or a project and this remains permanent other than the foreign stuff that they are not quite converse with*". This excerpt also echoes with Bosman (2016), who explains that direct interaction with the materials during the collection of data leads to discovery of knowledge. After learners gain information that they discover during practical investigations, they further get the opportunity to test their findings against those of the scientists (Dixon, 2015; NRC, 2000). Discovery learning as espoused by Bosman (2016) is stated by T1, as he explained that using easily accessible resources to conduct practical activities enables the learners to discover and come up with new knowledge because science is contextualised. This agrees with Gwekwerere's (2016) study which also established that integrating IK into science lessons makes it accessible to learners.

4.3 Data Generated from Documents

The data collated from the documents were analysed using deductive analysis. To Mavhunga and Rollnick (2013), transformation of topic content involves the following knowledge components: learners' prior knowledge; curriculum saliency (CS); what makes the topic difficult to teach (WDT); representations (RP) that include the use of examples, illustrations, analogies, simulations and models that may be employed to support an explanation; and lastly, conceptual teaching strategies (CTS). These knowledge components were used as guidelines for this workshop.

These five components are mostly given in a similar order by other scholars. I, however, preferred to start with CS. Curriculum saliency (CS) refers to the identification of the most important meaning of major concepts of a topic, without which understanding of the topic would not be possible. This includes the knowledge to logically sequence the learning and the knowledge of

pre-concepts needed prior to teaching a topic that make it challenging for learners to understand (Mavhunga et al., 2016).

In the context of this study, to ascertain the level of understanding of teachers of the curriculum, I asked them to describe what a curriculum is, and they responded that:

The backbone/blueprint of teaching and learning (T3)

The document that gives guidance as well as and contain policies that educators should follow to achieve what is stated in the curriculum (T1)

The document that gives direction for planning, organising and implementing teaching and learning as well as gives guidelines on how assessment should be done. Also, the responsibility for the school for teaching and learning (T2)

According to the Refined Consensus Model, teachers' professional knowledge is in three domains, that is, collective, personal and enactment (Carlson & Daehler, 2019). These participants seemed to exhibit a collective PCK because they all stated that the curriculum guides and directs teaching and learning. However, it is evident that T1's pPCK is limited because his definition seems to be a bit vague. In contrast, however, T2 seemed to have an advanced understanding because she highlighted all three components as stated in the curriculum. The document analysis workshop discussions shed light on the enactment of the broad curriculum as limited to personal PCK. Although the teachers collectively agreed that they use the curriculum, T3 highlighted that he, however, "*will not use it on everyday basis, for that I use the syllabus, but it guides my teaching as well as my assessment*". This also showed that his understanding is advanced as he elaborated on his initial description of the curriculum.

Further analysis led to a discussion of the aim of the broad curriculum and the syllabus, which is (MEAC, 2016, p. 2):

The curriculum has been developed to give direction to Basic Education towards the realisation of Namibia Vision 2030. A knowledge-based society is one where knowledge is created, transformed, and used for innovation to improve the quality of life.

T3 volunteered and reflected that “*the subject that allows learners to become innovative is science. Science gives learners room to think out of the books*”. In this regard, T2’s response was:

Yes, the curriculum stipulates that it aims at empowering learners with scientific knowledge. Whose scientific knowledge, is it? Are our learners familiar with it? If it is unfamiliar, then is not the content that is making our learners to run away from the science field? I think we should bring in the learner’s prior knowledge so that learners build on what they experience every day.

The excerpt from T2 echoes Shiza (2013, p. 4) as he asked, “Whose knowledge do schools impart? Education is not limited to accumulating knowledge and skills; it involves acquiring ways of interpreting and giving meaning to concepts, forming links, and understanding ideas”. T2 further expressed that when learners do not understand the science content, they tend to move from the science field of study. This finding might link to Le Grange (2007) who talks about cognitive dissonance. Extending on Le Grange’s (2007) seminal work, Simasiku (2022) explains that cognitive dissonance is a result of science teachers ignoring learners’ life experiences when teaching. Thus, Le Grange (2007) explicitly instructs teachers to build a bridge to allow learners to traverse between the two worldviews and in so doing, prevent learners developing cognitive dissonance. Likewise, Roschelle (1995) ascertained that prior knowledge needs to be used as a building block for new knowledge as it connects old with new experiences. Learners’ prior knowledge involves the knowledge that the learners have acquired from the previous grades and from everyday experiences (Gwekwerere, 2016; Kuhlana, 2011).

However, T2’s question discussed above does not only show her pPCK but also talks to another domain of modern consensus by Mazibe et al. (2020) which is reported PCK (rPCK). This is the knowledge that teachers portray in a written and spoken format. In this case spoken. Building on this aspect, Shinana et al. (2021) explain that the PCK that teachers communicate when they reflect on their teaching experiences and project what they may do in the future is reported PCK. Moreover, the questions that T2 asked caused the other participants to respond with facial gestures of approval. This shows that her pPCK was influencing the other participants as she was communicating with them. This links to Carlson and Daehler (2019), who ascertained that a teacher’s pPCK in teaching science is developed, shaped and refined over time through formal

education, teaching experiences and professional sharing. In addition, T2 also seemed to show a positive conception towards IK and thus advocated for the integration of IK into science teaching and this resonates with Rutledge and Mitchel (2002) and Atallah et al. (2010) who argue that learners (teachers in this context) with positive dispositions tend to act and think positively and will therefore, integrate IK into their teaching.

Moreover, CS informs how the enactment of the selected topic will take place. The curriculum analysis and the syllabus discussion also touched on the teaching and learning approach to be used by all Namibian schools which is the learner-centred approach. This is the pedagogy centred on the learner and is “guided by principles of social constructivism: critical and transformative pedagogy, democratic education, conceptual learning, integration of knowledge, and meaning making and reflective practice” (Dahlström, 1999, p. 7). The participants displayed an advanced collective PCK (cPCK) as they were analysing the role of the teacher in the learner-centred pedagogy from their broad curriculum and syllabus. The excerpt from T2 below shows that the participant was cognisant of the approach to be used in teaching and learning in Namibia. However, she was left helpless because during the Coronavirus pandemic faced from 2020–2021 she could not enact this approach due to measures taken to change the delivery of education from face-to-face to online. For instance, T2 reflected: *“During this Corona pandemic, it is not possible to use the LC approach”*.

T2’s reported PCK cements Nyambe and Wilmot’s (2012) assertion that teachers tend to interpret learner-centred pedagogy enactment as dependent on strong external controls that influence the pace of discourses such as the scheme of work, syllabus coverage, the school timetable, authorities and the NIED moderation. Indeed, this was the case, as during the time this study was conducted the syllabus was rationalised. In other words, the teaching time was revised and made shorter and some content was removed from what needed to be taught. This was done with the intention to prevent learners from spending more time together in confined classroom spaces during the COVID-19 pandemic. T2’s answer can be analysed as a limited interpretation of what LCE is. On the other hand, T3 showed an advanced CS in his understanding of LCE as he offered an alternative to T2’s and T1’s comments:

We can give learners activities that they can carry out independently out of the classroom setup. This is because the curriculum places the learners at the centre of learning, and this is where we go back to the point of professional discretion as mentioned in the syllabus.

T3's comment on LCE echoes the curriculum as it stipulates that, "teachers must decide if it is best to let learners discover or explore information for themselves or learners need directed learning" (MEAC, 2015, p. 4). Moreover, T2's response showed that professional development has taken place as she was redirected to rethink her pedagogy and stated:

It then boils down to teachers' preparation. We need to think about the learners we have in order to come up with an appropriate teaching method because the mainstream system have diversity of learners.

Learner-centred education (LCE) puts learners at the centre of learning. The Life Science syllabus (2015, p. 4) states:

The starting point for teaching and learning is the fact that the learner brings to the school a wealth of knowledge and experience gained continually from the family, the community, and through interaction with the environment. Learning in school must involve, build on, extend, and challenge the learner's prior knowledge and experience.

The second component of TSPCK is the learners' prior knowledge, which includes common learner misconceptions known about a topic (Mavhunga et al., 2016). In this component, the teachers were probed to share their personal PCK on how they integrate their learners' IK into the teaching and learning of scientific knowledge. T1 responded by stating: "*It is imperative to relate learning content to real-life situation. This will motivate learners to try and carry it out at home and this in turn enhances their practical skills*". This finding coheres with Gwekwerere (2016) who argues that relating scientific content to a familiar situation helps learners to visualise what they have seen, and they can then easily make a connection between their own life situations and the science concepts. The collective PCK that emerged from T1 and T2 is that there is a relationship between the curriculum and the community because the school as an institution serves the community from which the learners come. T3 further stated: "*The knowledge taught in class*

will be shared in the community. This means learners are taking the knowledge to the community and they also bring the community into the classroom”.

Moreover, T2 showed an advanced pPCK in the prior knowledge component as she elaborated that the knowledge that the learners bring from the community to school is their IK. She further claimed that such knowledge is of benefit to teachers because it makes their work as teachers much easier. This finding talks to using the ‘Two-Eyed-Seeing’ approach recommended by Hatcher et al. (2009) which looks at education within integrative science. They state that it incorporates a more holistic mindset and is transcultural as well as multidisciplinary, multidirectional and multisensory, with the total environment as the laboratory. Likewise, Mushayikwa and Lubben (2009) narrate that when they engaged teachers in identifying familiar everyday examples that could be used to describe the main science concepts in the topic, they noticed that successful contextualisation resulted in more confidence, greater authority and leadership and professional efficacy, greater adaptation of content and more creative use of resources in terms of classroom efficacy.

This led to a discussion on whether the teachers are eliciting learners’ prior knowledge. T3 gave a general answer stating: *“In a school set up, three teachers might not be doing it but the other 10 might be doing it”*. He justified this by pointing out that teachers are not given professional development platforms to present their needs and be assisted to improve their PCK (Mutanho, 2021). In support, T2 stated:

This is the reason why community of practice is important. Circuit teachers need to come together to interpret and share ideas that we can all learn from. This will then influence us to adopt best practices into our teaching.

This excerpt shows that T2 is also in agreement with T3’s answer, as she echoes that the workshops offer teachers a platform to develop their PCK which in turn will enable them to improve their pedagogy. The third component of the TSPCK is what is difficult to understand which refers to gate-keeping concepts which are difficult to understand often because they cause conflict with previously established understanding (Mavhunga et al., 2016). In the context of this study, I chose to discuss this in two ways. The difficulties of teachers in understanding how diffusion should be

taught as per the syllabus and the difficulties of learners' understanding of the concept of diffusion. The teachers' analysis of the syllabus revealed that they are grappling with the interpretation of the syllabus. The topic of diffusion has two basic competencies in the syllabus, defining diffusion and stating the importance of diffusion. The collective PCK from the teachers was whether one must teach the concept of diffusion's definition only or go further to make it accessible to the learners. It seemed that the syllabus is not explicit enough. Moreover, the suggested practical activities are listed separately from the actual basic competence. Thus, the teachers' interpretation might be that they are optional, especially inexperienced teachers. In this regard, T2 asked: "*But do you think a novice teacher will be able to think of a practical activity if the syllabus is not stating it?*" On this question, T3 showed an advanced personal PCK as he answered T2's question by stating that they need to advise their HODs to attach new teachers to experienced teachers who can mentor them on carrying out practical activities in science teaching. T3 further stated:

Understanding is the crucial part. And it comes with the practical as I have suggested. One cannot teach diffusion/osmosis without doing practical activities. It is a must. Let the learners come with resources from home so that we unpack diffusion vividly. Then you can even ask them to identify the importance of diffusion.

The above response links to literature on creating a smooth transition from home knowledge to Westernised knowledge taught in science classrooms (Aikenhead & Jegede, 1999; Oluruntegbe & Ikpe, 2011). Aikenhead and Jegede (1999) refer to such transitions as border crossing. Cultural border closing is further termed by Seehawer and Breidlid (2021) as dialogue between knowledges. This showed how advanced T3's pedagogical insight was in making the concept of diffusion accessible to learners as compared to the other participants. T1's and T2's responses showed that their collective PCK might indicate weak enactment of PCK as they seemed to struggle at times to enact the concept of diffusion with a pedagogy that would enable learners to apply it to assessment questions – hence the confusion between the concepts of osmosis and diffusion. Subsequently, Hatcher et al. (2009) suggest a 'Two-Eyed-Seeing' approach for teachers struggling to enact Westernised scientific knowledge. These scholars define 'two-eyed-seeing' as learning to see from one eye with the strengths of indigenous ways of knowing and from the other eye with the strengths of Western ways of knowing and then using both eyes together.

Moreover, the other point that emerged on the WDT component, is the type of materials suggested for carrying out practicals with the learners. T2 pointed out that exposure to materials stipulated in the syllabus plays a major role in whether the teacher will carry out the practical or not. For instance, T2 reflected: “*Do I know how to use ammonia and a Visking tube for a cell surface membrane? Tea bag is better. If I don’t know how to use ammonia, I will just leave out the practical*”. This links to studies on the use of easily accessible resources that have shown how IK can be used to positively influence teaching and learning (Asheela et al., 2021; Hashondili, 2020; Nangolo, 2018; Ndevahoma, 2019). The use of easily accessible resources as proposed by Asheela et al. (2021) leads to the fourth component of PCK, the representations.

Representation refers to a combination of representations at macro, symbol and sub-microscopic levels that may be employed to support an explanation. Shinana et al. (2021) explain that representations (RP) include the use of examples, illustrations, analogies, simulations and models that may be employed to support an explanation. T3 clearly explained how he demonstrates for his learners the concept of diffusion using the easily accessible resource of tea bags and spray. This type of enactment of PCK is echoed by Kandjeo-Marenga (2008) who observed and reported that in under-resourced science classrooms the enactment mostly consists of practical activities that take the form of demonstrations.

T1 and T2 showed that their personal PCK is very weak as they showed that they are struggling with the fourth component of TSPCK in their teaching. Evidently, T2 objected to T3’s reported PCK by stating that “*the syllabus only asked the learners to define the term diffusion*”. She, however, stated that “*in the examination, the learners are asked application questions?*” On this, T3 explained to the other participants that it is important to unpack the basic competence to enable learners to understand. He further suggested to his co participants that they should “*let the learners to come with resources from home so that we can unpack diffusion vividly*”. T1 and T2 showed that professional development had taken place as they collectively pointed out that interpretation of the syllabus is key when teaching and learning with reference to practical activities.

Additionally, T2 also stated that “*exposure to materials plays a major role*”. It might be the exposure that T2 spoke of which leads to confusion between diffusion and osmosis by learners as reported in the examiners’ reports (2015–2020). One can then argue that the confusion between

the concepts of diffusion and osmosis might lead to the inability to identify the importance of diffusion in plants and animals, which is the second basic competence of the concept of diffusion. Thus, T2 also showed a weak enactment of PCK as she gave her reported PCK on the representation component of TSPCK.

According to Mavhunga et al. (2016), CTS, refers to teaching strategies consequential to the considerations made from the other four components and dismisses general teaching methodologies. Rollnick et al. (2017) imply that this component looks at teaching strategies most likely to be fruitful when used in the teaching and learning process. In the context of this study, it emerged that curriculum salience is needed by each teacher because the interpretation of the curriculum results in an adoption of the correct TSPCK. The teachers' collective PCK was that the enactment of the topic of diffusion will have to be learner-centred. The participant teacher, however, pointed out that that it is difficult to effectively interpret the curriculum as individual understandings may differ. T2 and T3 both suggested that one way of solving this would be to introduce community of practice platforms where circuit teachers need to come together to interpret and share ideas that they could all learn from. T3 opined that "*the community of practice will then influence us to adopt best practices into our teaching*". This links to Tam (2015), who points out that the role of a professional learning community (PLC) is very crucial (in the context of this study I have chosen to use professional development community) in changing teachers' beliefs and practices. She further highlighted that a collaborative culture and effective learning activities are some of the key elements in helping teachers to overcome initial difficulties (in this case the enactment of PCK) and induce their motivation for transformation.

The participants also suggested ways to include learners' prior knowledge in the enactment of content by introducing the topic of diffusion through story telling. T4 (walked in at the workshop and contributed to the discussion even though he is not a participant) shared that: "*Hunters use to smell the air and warn each other not to move because elephants are close by*". He explained that this was helpful in making sure that the hunters would not encounter danger when they ventured into the forest. The participants also discussed that storytelling might be one way of removing the confusion that learners have between osmosis and diffusion. One can then explain that the smell

from the elephant can be linked to particles in the air and osmosis linked to the water particles only. This flows to the next component of what is difficult to teach.

The participants shared their personal PCK on how to make learners understand concentration gradient theoretically but could not really come up with any other suggestions other than that of using practical activities. T3 stated that “*understanding is the crucial part. And it comes with the practical activities*”. They thus suggested the use of materials that learners can bring from their localities – this links to Asheela (2017) and Ndevahoma (2019) who alluded that teachers are therefore expected to select learning content based on the learners’ needs within their immediate environment and community. This will help in clearly unpacking diffusion which links to representations. The corrective preference of materials to use in diffusion practicals as suggested, seemed to be things that learners could see, that is, tea bags and traditional dye. T3 explained the advantages of using their choice of materials: “*They make a lasting impact because learners can see real particles moving. This will help remove the abstractness from the scientific concept*”. This is congruent with Shizha’s (2013) sentiments that Africans should be educated within African indigenous cultural contexts, for in doing so, they will be reclaiming their voices in the process of educating the African child.

In conclusion, building on Mavhunga et al. (2016), a conceptual teaching strategy according to Shinana et al. (2021) is a component that acts as a directive for the baseline data needed for effective planning of an intervention. It also used to identify any shifts in teachers’ competencies after an intervention.

4.4 Chapter Summary

In this chapter, I presented, analysed and discussed the qualitative data from the semi-structured interviews and document analysis. This aimed at answering the first research question of my study. The findings revealed that teachers have some understanding of IK. Firstly, it is unique to a certain community and secondly, it is passed on from one generation to the next. The data also revealed that even though the teachers appreciated the use of IK, there seems to be tension between their conceptions and the implementation. Therefore, a professional development community will help them develop their PCK with reference to integration of IK. In the next chapter, I present, analyse and discuss data generated from the workshops and teachers’ journal reflections.

CHAPTER FIVE: PARTICIPATORY OBSERVATIONS AND REFLECTIONS

5.1 Introduction

The main goal of this study was to mobilise the indigenous technology of making *oshikundu* to mediate learning of the concept of diffusion. In the previous chapter, I presented, analysed and discussed data generated from semi-structured interviews, workshop one – which was the orientation workshop and document analysis carried out in workshop two, which was aimed at co-analysing curriculum documents, textbooks and the examiners' reports.

In this chapter, I thus present data from workshops three and four. These workshops were presented together. The reflections which were made by the teachers are also used in the discussions. Data from these workshops were aimed at answering my research question 2 which is:

In what ways do Grade 8 Life Science teachers interact, participate and learn (or not) during the practical demonstration of making oshikundu by the expert community member?

5.2 Workshops

The workshops were aimed at providing support to the teachers to help them understand the concept of diffusion. Support was given using two approaches. First, the practical demonstration of making *oshikundu* was used as a form of representation in this study as reiterated by Mavhunga and Rollnick (2013). Second, during the process of making *oshikundu*, the participants and I were afforded an opportunity to learn how IK could be used to mediate learning of the concept of diffusion and other related concepts. I thus present, analyse and discuss data from the practical demonstration of making *oshikundu*. In these discussions, I show whether the practical demonstration enabled and/or constrained Grade 8 Life Science teachers' interactions and participation and understanding of the concept of diffusion.

5.2.1 Intervention workshop

Data from Chapter Four (see Section 5.1) revealed four problems associated with mediation of learning the topic of diffusion in relation to the integration of IK. First, the data showed that even though the teachers knew that IK is important in the teaching and learning of science, the enactment seemed to be a challenge for some participants. This confirms the tension that exists between the intended and the enacted curriculum as stated in Section 1.2.2. Second, the basic competency of the concept of diffusion in the syllabus is implicit, thus, teachers interpret the basic competencies differently. Third, materials suggested by the syllabus are at times not familiar to teachers, hence they omit some of the hands-on practical activities concerning the concept of diffusion suggested in the syllabus. Fourth, the way the syllabus outlines the basic competencies and the suggested practical competencies seem to cause the teachers to omit practical activities. This layout seems to imply that the suggested practicals are optional. What follows is a discussion on how teachers were supported to acquire knowledge of the concept of diffusion and I further selected episodes that talks to the sociocultural perspective advocated by Vygotsky (1978).

5.2.2 Expert community member's presentations

Central to this study was the presentation by the expert community member who was invited to share her IK and wisdom on making *oshikundu* with the teachers. This resonates with Mandikonza (2007), who conveys that community members have knowledge of cultural practices and that such practices can be used in teaching science. Moreover, it addresses the call by the NCBE that “in the community there are persons with expertise in ... cultural traditions, crafts, sports ... who can be approached to support teaching” (MEAC, 2016. p. 53). As a result, I regarded the presentations as the main platform to enhance the teachers' understanding of the place of IK in science lessons. Importantly, the data sets from the presentations by the expert community member were subsequently used to co-develop exemplar lessons on diffusion integrating IK. The expert community member is referred to as ECM throughout the thesis. However, where the participants asked questions directly, they referred to her as Me Ndagwedha (Me, respectful word we attach to any elder woman's name in Oshiwambo) as per her permission.

The three teachers and I were all participant observers in the presentation made by the ECM. The concept of interaction emerged as the ECM was doing the practical demonstration of making *oshikundu*. Two types of interactions unfolded during the demonstration by the ECM. Firstly, it occurred when participants asked questions of the expert community member. These questions emerged from our observation of the practical demonstration of making *oshikundu*. Secondly, there was interaction which took place among us – the researcher and the informants. This came about because we were trying to identify scientific knowledge from the activities which took place during the practical demonstration (Nyamakuti, 2021; Shinana, 2019).

The ECM started her presentation by stating that we were going to make ⁴*ontaku*. The name *ontaku* is used interchangeably with *oshikundu*. This is because the Aawambo has about seven dialects and some words may sound and read differently yet they have the same meaning. The ECM thus referred to *oshikundu* as *ontaku* in her own dialect. Thereafter, she introduced the items she was going to use in making *ontaku* by pointing them out as cold water at room temperature, boiled water, mahangu flour (millet flour), *ongundo* (malted sorghum flour – flour made from germinated sorghum grains) and *oluko* (wooden spoon) for stirring. She then said; “*Now step one, we take a generous amount of mahangu flour and add it to the bucket. Step two, add water*”. She explained that the water should not be boiled but just hot. However, the hot water she used in this instance had boiled and thus she also added cold water to the mahangu in the bucket.

Step three, she started stirring the mixture and remarked that we were too quiet and should feel free to ask her questions. She encouraged us to ask questions (possibly because of the nature of her work which is a subject advisor). This links to Cocks et al. (2012) who accentuate that participants’ questions are a way of providing knowledge about their cultural heritage. I, however, realised that the participants were listening attentively as the community member was presenting so that they could obtain the correct first-hand information (Nyamakuti, 2021). I then asked a question to the community member: “*Me Ndagwedha, why are you adding cold water first?*” The

⁴ oshikundu/ontaku which has already fermented, which acts as a catalyst when added to oshikundu which did not ferment

community member explained: *“If I don’t add cold water, the paste will become overcooked like porridge, the water should just be hot”*.

She continued with step four, adding boiled water and continuing stirring. As she was stirring, she stated that it was now turning into a paste. The ECM then extended her previous explanation of why it is not wise to use boiling water by stating that if the water is boiled, the *oshikundu* will not be tasty. However, the Aawambo people have different ways of making *ontaku*. For instance, T2 indicated: *“I don’t use cold water. I just use hot water”*. The ECM then asked T2: *“Do you let it cool down?”* T2 replied: *“No I don’t”*. T3 then asked if the use of cold or hot water is a technique or preference. T2 answered him and said: *“I think cold water and then boiled water will have a lot of residues, well else the hot water, the mahangu flour particles in the paste will be smooth not coarse”*. The ECM then answered T3 by saying that *“it depends on preference”*. She then linked the coarse residue (dregs) to health by stating that culturally, the residue is believed to help with stomach cramps in young children. As a result, it is believed that children that drink *oshikundu* hardly suffer from stomach aches.

She then exclaimed: *“Now for step five! Add sorghum flour to the paste after thoroughly stirring mahangu paste”* – this links to Shinana’s (2019) study that stated that stirring helps to break down the flour particles. By then, the paste would have cooled down as well. The ECM then showed us a smaller amount of sorghum flour when compared to her generous mahangu flour. This affirmed what Shinana stated in her study that in *oshikundu*, only a small amount of malted sorghum is added – if you put in too much, the *oshikundu* will ferment too fast and over fermenting would result in the formation of alcohol. I then asked: *“Why do we add sorghum flour to the paste?”* T1 volunteered an answer: *“Scientifically, is it not for fermentation?”* The ECM then said: *“Yes, it is. However, we also believe it is a sweetener”*. T2 exclaimed: *“So, it is a sweetener and a catalyst?”* I then redirected her question to T1 who initially spoke about fermentation and asked: *“Does it mean, without sorghum, there is no fermentation?”* T1 then responded and said: *“Yes, you know, in science, we have things that we add to reactions that speed up the reaction”*.

T3 then asked a follow-up question concerning the malted sorghum flour: *“Does it mean then it is only sorghum that can be used as a catalyst? Or can mahangu as well be used as one?”* To this, the ECM answered T3 by stating that the ability of the flour to become a catalyst depends on how

it was prepared. In this case, for instance, *“Sorghum seeds were first soaked in water for several hours, then taken out and allowed to germinate. Thus, the flour is called a natural sweetener”*. T2 then asked the ECM: *“What is it in the sorghum flour that makes it taste sweet?”* The ECM said that we would come back to that question later. *“For step six, we continued to stir and waited for the paste to cool down before we diluted it into ontaku. Remember I said, ‘The more you stir the sweeter the ontaku will have a nice taste’”* exclaimed the ECM.

As the ECM was stirring the *ontaku* paste, I asked the participants if they could smell something. The other participants all answered and said, *“Yes we can”*. I then pointed out to the informants that the concept of diffusion is being shown in the demonstration. With excitement, T3 then said:

Wow this reminds me of my childhood. I grew up very close to my mom and I remember how she used to prepare her traditional beer. Cultures are similar. Wow. The smell really reminds me of my mother acidic traditional beer.

I elaborated and stated that there are similar IK that are common among the Bantu speakers. Thereafter, T1 inquired: *“Why do we have to wait for the paste to cool down before we dilute the paste?”* The ECM answered by saying that *“in our culture we believe the paste will become slimy if we add water while the paste is hot”*. I then volunteered in the vernacular that they refer to the slimy *ontaku* as *okuombotoka* in Oshiwambo. She further stated that it is believed to signify bad news in the family. The ECM agreed by stating that it is true that there are some beliefs associated with slimy *ontaku*, however, it can also be an issue of hygiene. If the container used or the stirring stick was not washed properly, it can also make *ontaku* slimy. Moreover, the slimy *ontaku* does not taste good or sweet. On this, T2 stated that *“for me, personally, to avoid the slimy ontaku, I mostly prepare my ontaku in the evening and allow it to cool down overnight”*. The ECM asked T2 if she always diluted her *oshikundu* in the morning every season. T2 and I in unison answered *“no”*. In this regard, T2 explained further by stating that during winter she added water to the cooled paste before she went to bed. In the morning, she would just add the diluted paste to the fermented *oshikundu*.

T1 added in vernacular, “*otashi kala inashipy*” [otherwise, it remains (unfermented)]. T1 was code switching between Oshiwambo and English at times when he needed to express what transpired in the practice of making *ontaku*. This coheres with Mavuru and Ramnarain (2020) as well as Masimanga and Lelliot (2014) who posit that home language can be instrumental in integration of scientific concepts as it has the potential to afford learners with an opportunity to think and express their opinions explicitly. In this regard, researchers such as Mavuru and Ramnarain (2020) advocate for the use of home language to allow learners to access science. This is shown when T4 shifted to her mother tongue when she could not fully express her idea in English.

Additionally, the ECM’s explanation on diluting *ontaku* that has cooled down resonates with Shinana’s (2019) assertion that if the *oshikundu* paste is diluted while warm, then the enzyme activities are activated faster due to the temperature. This means that fermentation would start earlier and by the time one would want to drink *oshikundu* it would have become sour (Nikodemus, 2017).

T3 indicated that he would like to add to the answer that was given to T1 on why the paste must cool down. The reason why this stage is important is because there is a reaction taking place. He explained: “*Catalyst as we said speeds up the rate of reaction, right? Thus, I believe if the paste is left overnight, this gives the reaction enough time for the rate of reaction to continue until all substrates are used up or a limiting factor comes in to affect*”. Thus, he felt that there are certain factors that play a role in the reaction taking place in the *oshikundu*, for instance, water temperature and its preparation. The MCE agreed with T3 in stating that by drinking *ontaku*, the elders will tell if the stages involved in *oshikundu* making were followed properly or not. T4 then said, “*In short, the art of making ontaku needs patience and love*”.

It was at this time that T3 reflected on his childhood years. He stated that he grew up seeing his mother preparing the traditional beer in the evening, and the next day, it had fermented and had gas bubbles. He further reflected: “*I never could link this to science. To say it is diffusion taking place. I also never asked her why she did things the way she did. Now I want to go and ask her as to why things happen as they happen*”. The MEC then said, “*In the same light of providing clarity, who wants to answer the question posed by T2 as to why the malted sorghum is sweet?*” I offered

the explanation stating that in Biology, there is a concept of germination. The water that we used for soaking the seed would activate the enzyme amylase to digest the starch (a polysaccharide sugar characterised by being tasteless) into maltose. The second enzyme will then be maltase converting maltose into glucose which is a monosaccharide sugar characterised by a sweet taste. Hence, the sweet taste is malted sorghum. T4's explanation is congruent with Adhikari and Acharya (2015) who explained that the enzyme amylase, which is produced during malting, leads to the hydrolysis of starch into glucose. Thus, it is the presence of this glucose in the malted sorghum that ferments to release carbon dioxide (Nandjedi, 2022). Thus, *ongundo* plays the role of a catalyst and enhances fermentation in the process of making *oshikundu* by lowering the activation energy needed for the particles to collide.

The cooling down of the *ontaku* paste was then hastened by the continuous stirring by T2. After it was noted that it was cooler, Meme told T2 to add water, cautioning her to be careful when adding it. She explained: “*Ontaku should not be too diluted. It should be left a bit thick (yikwate pepunda) in such a way that ones you drink it you will not feel hungry*”. This talks to my own reflection in Chapter Two where I narrated that I grew up taking *ontaku* to school as my lunch (see Section 1.2.2). This is because my grandmother believed that if I drank my *ontaku* at school I would not be hungry during school hours (see Section 2.8). To date, most Oshiwambo Namibian learners from low income earning families still carry *ontaku* to school as their lunch.

5.2.3 The science behind the making of *ongundo* (malted sorghum) – new knowledge



Figure 5.1: Shows *ongundo* (malted sorghum)

Many questions were raised by the informants concerning the making of *ongundo/esheshela* (malted sorghum) and that triggered me to ask the ECM to do a reflection session with me where I asked her to provide clarity for questions that arose when I was transcribing the demonstration of *ontaku* making. *Ongundo* has been used in a number of studies, for example, Asheela (2017), Nikodemus (2017), Shinana (2019), and Nandjedi (2022). I, however, did not come across the description of how it is made even though it appears to be very interesting as per the number of questions the ECM was asked during her presentation. The following narrative will shed light on the science of making *ongundo* (malted sorghum) as it is directly useful in fermentation processes which then links to diffusion which is the key concept of this study. Shinana (2019) states that scientifically, in the presence of *ongundo* (malted sorghum), fermentation is likely to take place in *oshikundu* due to the sugar which is used to produce alcohol (ethanol) ($\text{CH}_3\text{CH}_2\text{OH}$) and carbon dioxide (CO_2) (Nandjedi, 2022). Thus, the fermentation process in turn enables the diffusion and visualisation of carbon dioxide as it can be collected. I deemed it fit to provide an outline of this unexpected data that emerged.

The ECM narrated that the seeds are soaked in water for some hours, depending on the season. During winter, the soaking might take a whole day because the temperature is low. However, the seeds usually just need to soak overnight in water. In the morning, the seeds are then taken out of the water and placed over a sack material forming a heap. The reason for using the sack material is to allow the excess water to drain out. The grains are never spread out to prevent seeds drying out as germination requires moisture. Thereafter, the seeds are then covered with any polythene material for 8–12 days. During this period, one needs to keep checking on the germination progress. When the shoots are white, it is then referred to as *Ongawa oya tenda*. One must lightly spread it out over sandy soil. The *Ongawa* will still be covered by a plastic cover to maintain moisture and provide a humid environment for the seeds to germinate. The cover is maintained until the shoots become green and the sorghum grains are ready for pounding (Simasiku, 2022).

During pounding, *uushutu* is added to make the sorghum grains less sticky. However, some people do not add *uushutu* (the first flour obtained from thrashing millet grains) during the *oshikundu* making as it was added during the preparation of *ongundo*. Instead, they just use mahangu flour and malted sorghum. After the pounding, the *ongundo* is spread out in the sun to dry. Drying is

done to preserve the *ongundo*. Thereafter, it is stored in clay pots (in Oshiwambo culture the clay pots are used to store and preserve food such as mahangu flour and seeds) (Mateus & Ngcoza, 2019). *Ongundo* can even be a year old and it will still ferment *oshikundu*. *Ongundo* is then ready to be used for *ontaku* making.

Through participatory observations and from the conversations exchanged during the expert community member’s presentations I came up with three themes as shown in Table 5.1.

Table 5.1: Themes that emerged from the data and supporting theory or literature

Themes	Theory/ literature
Teachers’ conceptual understanding of diffusion	Mavhunga and Rollnick (2013)
Teachers’ understanding of the link between IK and school sciences enhanced	Kasanda et al. (2005); Çepni et al. (2017); Chikamori et al. (2019)
Zone of proximal development	Southwood and Ngcoza (2015, 2019); Brodie and Borka (2016)

I now discuss each of these themes below.

5.3 Teachers’ Conceptual Understanding of Diffusion Using *Oshikundu* as an Easily Accessible Resource

When the *ontaku* paste was diluted, it was used to conduct a practical activity that would enable the collection of carbon dioxide and this talks to representations as a TSPCK component (Mavhunga & Rollnick, 2013). Representation refers to how learning content (in this context, diffusion), should be presented in such a way that it carries meaning to the learners. This can be achieved using aids that teachers consider have potential to support the teaching of the content. These representations could be illustrations, metaphors, demonstrations, experiments, analogies, models or stimulations (Mavhunga & Rollnick, 2013; Mavhunga et al., 2016).



Figure 5.2: Shows unfermented *ontaku*

Figure 5.2 above clearly shows that the *ontaku* was equally distributed into the same sized bottles. The bottles were marked A, B, C and D. Equal amount of *oshipithitho* (fermented *ontaku*) was added to two bottles only and the other two bottles were left without *oshipithitho*. On the mouth of each bottle, a balloon was placed to collect the gas that could be released by the process of fermentation. Two of the four bottles were placed in the fridge and the other two bottles were left at room temperature. The participant teachers were each provided with a prepared worksheet that asked them to use the PEEOE approach with the intention of finding out from them what would likely be taking place in the practical activity as suggested by Asheela et al. (2021).

In Figure 5.3, the *oshikundu* fermented and as a result, the balloon placed on the bottle became inflated, thus showing evidence that carbon dioxide “molecules moved from a high-concentration area to a low-concentration one due to their kinetic energies” (Kurt et al., 2013, p. 78). This practical activity afforded the participant a chance to visualise the definition of diffusion as they lamented that the syllabus just asks the learners to define the concept but in the regional and national examination, the learners are asked to answer application questions.



Figure 5.3: Shows fermented *ontaku*

The poor ePCK that emerged from the data in Chapter Four (see Section 4.1) offered us an opportunity to explore the use of *ontaku* in a practical activity thereby helping us gain an understanding of the concept diffusion. According to Wiebe et al. (2001), the use of indigenous technology as a cultural tool for mediating classroom science allows for the visualisation of scientific concepts, presenting learners (teachers in the context of my study) an opportunity to make sense of a science concept in new but familiar contexts. Cook (2006) describes visualisation as a teaching and learning approach in which science instruction is combined with visual and verbal information. Additionally, Rundgren and Yao (2014) accentuate that visualisation in science education is a cognitive domain that has the role of making invisible ideas visible and more importantly, illustrating abstract concepts and making them explicit. To Liloyd (2015), visualisation is a “language of image” (p. 5). Accordingly, learners can even see bubbles in *ontaku* moving to its surface. Thus, it helps learners conceptualise the concentration gradient as well which is a challenge to explain. In workshop two, both participants struggled to clearly narrate how they make their learners understand the concentration gradients.

In her journal reflection, T1 explained that: “The *practical activity triggers one to understand that local knowledge is very important for the learners as it enhances their understanding of Western scientific knowledge and help them develop new knowledge*”. This is further discussed in the next theme which is the link between IK and school science.

5.4 Teachers' Understanding of the Link between IK and School Science Enhanced

The asking of questions during the practical demonstration of making *oshikundu* mostly resulted in discussions. This was an indication that the practical demonstration stimulated our curiosity (Shinana, 2019). The questions and discussions were what helped us make sense of the scientific knowledge that emerged from the practical demonstration. This finding thus agrees with the views of Harlen and Qualter (2018), which stress that questions that stem from curiosity play a major role in learning. In addition, it was evident that the process of making *oshikundu* promoted the teachers' higher order thinking skills, such as posing complex questions, introducing consistent arguments, presenting solid opinions, critical thinking, analysing, evaluating and the skill to synthesise information and reason (Barak & Dori, 2009; Zohar & Dori, 2003). The scientific knowledge which is embedded in the practical demonstration of making *oshikundu* is not straight forward. Thus, the teachers needed to use these higher order thinking skills in order to make sense of those activities that were taking place in the process of making *oshikundu* and to extract the science behind those activities. The following are tabulated episodes that show how the participants made links between IK and Western (school) science.

Table 5.2: Some episodes linking IK with school science

Community member demonstration/explanation	Teachers' comments	Science topic/concepts
Adding cold water to mahangu flour first then hot water.	<i>I think cold water as opposed to using hot water will result in more residues as opposed to hot water which will result in smooth residues (T2).</i>	Effect of temperature in rate of reaction (Grade 10 chemistry).
Adding sorghum to mahangu paste and pronouncing that sorghum is called a natural sweetener.	<i>I think sorghum is added for fermentation (T1).</i> <i>Sorghum is a catalyst (T2).</i> <i>Can you smell something from the paste? (T4)</i>	Enzymes and respiration (Grade 10 Biology). Enzymes, biological molecules and chemical change (Grade 10) chemistry & Biology respectively. Diffusion and kinetic theory (Grade 8).

<p>Adding diluted ontaku to bottles for practice.</p>	<p><i>When I used to wash my daughter Ontaku bottles I use to find them oily that means oshikundu has some amount of fat. (T2)</i></p> <p><i>I grew up watching my mother brewing traditional beer, she used to pour it in drums (a big and small) she uses to control the smaller drum to improve the concentration of the binger drum. This brew would make people fat and drunk. (T3)</i></p>	<p>Nutrition and food test (Grade 10 Biology)</p> <p>Nutrition and food test (Biology Grade 10)</p> <p>Organic chemistry (Grade 11)</p>
<p>Explaining how malted sorghum (ongundo) is prepared.</p>	<p><i>In Biology the concept of seed germination explain that the seeds require water for the enzymes to be activated. The enzyme amylase will then convert starch a polysaccharide which is taste less in to disaccharide maltose and maltase enzyme will in turn convert maltose sugar into a monosaccharide sugar glucose which have a sweet taste. (researcher)</i></p>	<p>Enzymes and biological molecules (Biology Grade 10).</p> <p>Coordination in plants (Grade 11).</p>

As alluded to earlier, the practical demonstration of making *oshikundu* enabled the identification of scientific concepts. This is evident from the development of the mind maps shown in Figure 5.4 below.

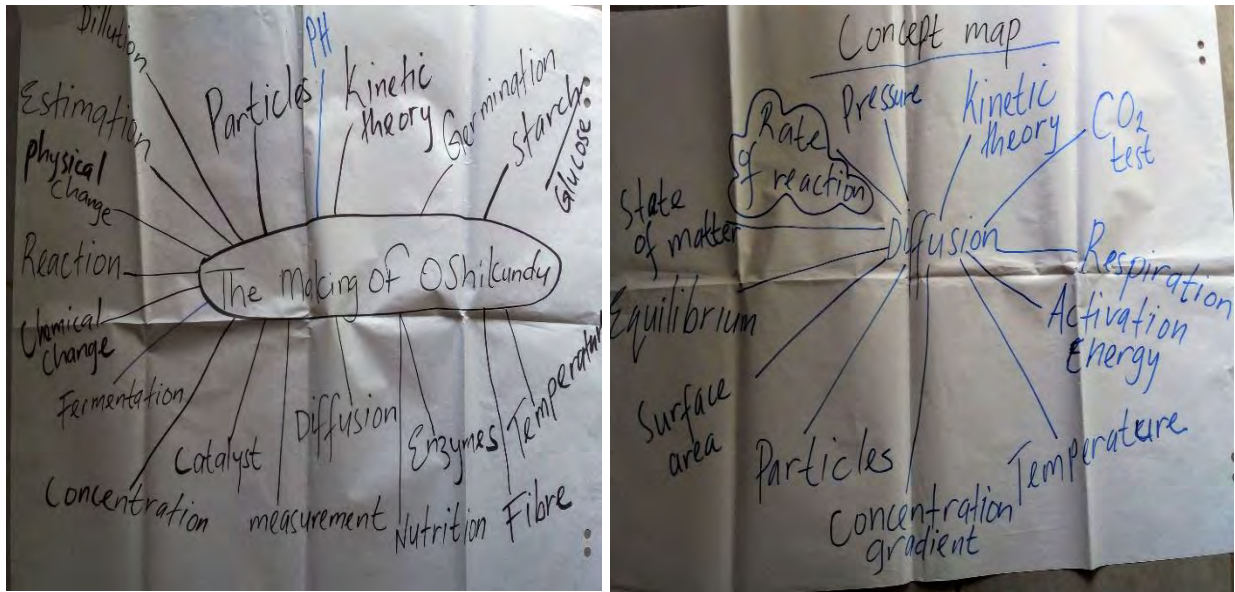


Figure 5.4: The scientific concepts in the form of mind maps

The concepts in these mind maps were further developed into a concept map which is shown in Figure 5.5 below.

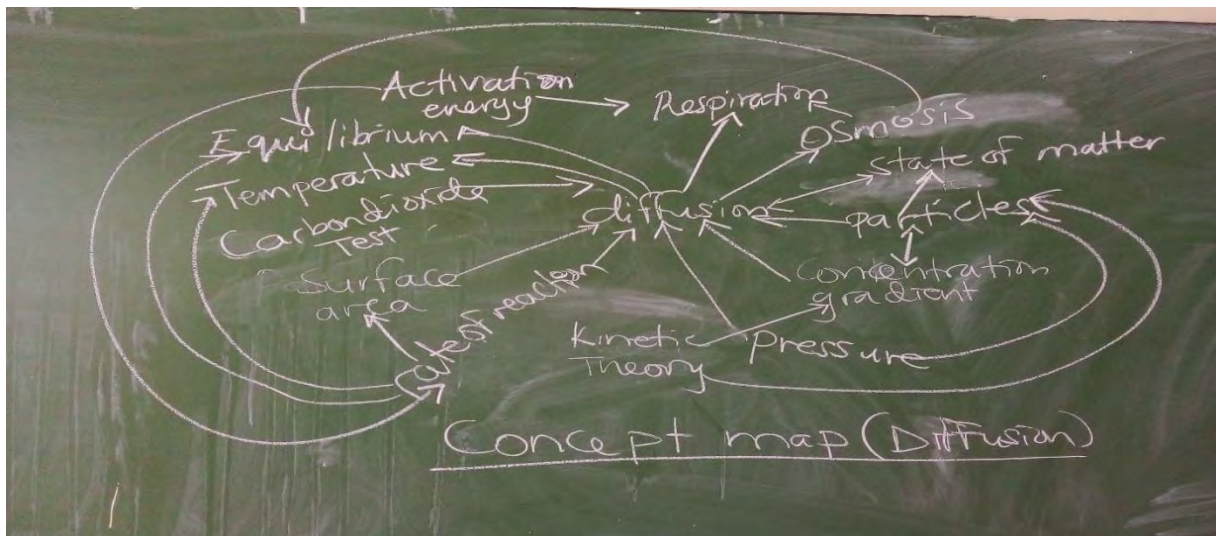


Figure 5.5: Shows the diffusion concept map by the participants

The identification of scientific concepts is an indication that the practical demonstration of making *oshikundu* can be used in the mediation of learning a variety of science concepts.

5.5 Observed Shifts in Teachers' Zone of Proximal Development and Pedagogy after the Expert Community Member's Presentation

Teachers were asked to reflect on the presentation. An improved understanding was observed in the teachers' PCK (Shulman, 1986). This was evident in their reflections presented in Box 5.1 below.

Box 5.1: Teachers' reflections

I learnt that local materials can also be used in teaching the concepts of diffusion, fermentation etc. the local knowledge used at home can also be applied in the formal education system (T1).

I learnt that local/IK can be used to help learners to comprehend the syllabus content as they can use it to relate what they see happening at home. These workshops can be done with the novice teachers (T2).

I learnt that local/IK can help learners to think about what they are learning and ask questions that can enhance their learning (T3).

Concepts are interrelated and their understanding can be made simpler if local examples can be used in our teaching (T1)

This form of workshops needs to be done by senior education officers to boost professional development (T2).

Group discussion in the workshops was key in teachers' reasoning and it enabled other colleagues to discover new knowledge (T3).

From the above excerpts, it could be hypothesised that the workshops served as a social unit which consisted of the teachers, the ECM and me. In this social unit, we interacted and learnt from each other during the practical demonstration. This too coheres with Vygotsky's (1978) sociocultural notion of social interaction which postulates that learning takes place in a social setting.

The knowledge which we acquired during the social interactions contributed to common PCK (Carlson & Daehler, 2019). The ECM acted as the MKO (Vygotsky, 1978). In this way, we tried to meet the teachers' needs as espoused by Bayar (2014) and Ngcoza and Southwood (2019). It could also be argued that this study attempted to promote transformative learning which according to Haapasaari et al. (2016), refers to breaking away from the given frame of action and taking the

initiative to transform it. This implies that transformative agency arises out of the need to change from teaching science content in an abstract manner with the intention of transforming it with the integration of IK to make it more accessible to learners. This view resonates with the purpose of this study, which intended to explore how to support Grade 8 Life Science teachers on how to integrate IK into their science teaching, especially as the integration of IK has the potential to contribute to improving learners' understanding of science concepts (Abah et al., 2015). This could afford learners and teachers alike with opportunities to comfortably learn and teach within their cultural contexts (Mavuru & Ramnarain, 2017).

Lastly, the reflections from the participants seemed to resonate with Brodie and Borke (2016), who emphasises the importance of providing teachers with opportunities for collaborative participation and collectivity, offering opportunities for teachers to grow together. Thus, Ngcoza and Southwood (2019) term this kind of workshop as a professional network that not only promotes dynamic spaces for learning but spaces for building capacity in educators, between educators and ultimately beyond.

5.6 Chapter Summary

In this chapter, I presented the data from the participatory observations and discussions on the expert community member's presentations as well as the data from the teachers' reflections. This chapter aimed at answering my second research question. Findings show that all the teachers found the IK in the making of *oshikundu* appropriate and useful to mediate the conceptual understanding of diffusion. The teachers' participation was commendable as they interacted both with the expert community member and her mediatory tools. In the next chapter, I present data gathered from the workshop on co-designing exemplar lessons that integrated IK.

CHAPTER SIX: CO-DEVELOPMENT OF EXEMPLAR LESSONS

6.1 Introduction

The main goal of this study was to mobilise the indigenous practice of making *ontaku/oshikundu* with the aim of co-developing an exemplar lesson to mediate learning of diffusion in Grade 8 Life Science lessons. In this chapter, I thus present data gathered from the workshop on co-development of an exemplar lesson that integrated IK. The data generated was aimed at addressing my research question three:

How do the Grade 8 Life Science teachers co-develop an exemplar lesson on diffusion that integrate indigenous knowledge?

6.2 The Co-development of an Exemplar Lesson

The co-development of an exemplar lesson on diffusion integrating IK science concepts embedded in the traditional practice of making *oshikundu/ontaku* was one of the objectives of this study. Essentially, engaging the three Life Science teachers in the ECM's presentations on the making of *oshikundu/ontaku* was meant to help the teachers become cultural knowledge brokers. This might then give them tools to explore and understand the IK embedded in this indigenous practice. The co-development of an exemplar lesson was thought of as a form of support for the Life Science teachers from which we could thereafter plan and implement their own lessons that integrated IK.

The workshop began with a discussion of the five components of TSPCK (Mavhunga & Rollnick, 2013). The informants were given a prepared information sheet (see Appendix K) with descriptions of what each component entailed and how the component could be used to transform content knowledge in a way that it is accessible to learners and enhances meaningful learning (Shulman, 1987). The components were discussed one by one and with each component we considered the following three aspects: First, what does the component entail? Second, how does

the component help us transform the content knowledge related to the diffusion concept in the planning of our exemplar lesson. Third, how do we plan the lesson in a way that helps learners acquire a conceptual understanding of the diffusion concept (see Appendix I for the exemplar lesson plan). I now present each component as follows.

a) Curriculum saliency

We commenced our lesson planning by looking at the basic competency as highlighted by the syllabus. Analysing the basic competency also helped us to identify the major concepts involved in the diffusion concept. This was guided by Shinana (2019), who explains that the CS component demands that the teacher identifies the major concepts of a topic (the big ideas) and the prerequisite concepts learners need to know before the topic is presented. In addition, consideration of the interrelatedness between the concepts, how to sequence them and understanding of what should be taught now and what needs to be taught later, is pivotal (Mavhunga & Rollnick, 2013). In this regard, T3 stated:

We need to change the order of presentation of the basic competence in the syllabus if we want the learners to understand the definition of diffusion. I suggest we carry out the investigation of diffusion first, and we use the oshikundu and the balloon.

The deduction made by T3 was a result of the discussion that took place as we planned the exemplar lesson where he suggested a change in the order of the basic competency to be enacted. This was to afford the learners a better understanding of the concept. The suggestion echoes Cobb and McClain (2011), who assert that discussions on pedagogical reasoning and practicing teachers' conversations revealed the emergence of diverse classroom instructions that would help learners solve instructional activities. Moreover, Mavhunga et al. (2016) state that interventions offered to teachers improve their understanding and they will demonstrate this in the choice of representations of the concept to be enacted.

Table 6.1: The following is a section from the Grade 8 Life Science syllabus

GENERAL OBJECTIVES <i>Learners will:</i>	GRADE 8 SPECIFIC OBJECTIVES <i>Learners should be able to:</i>
TOPIC 4 Passage of substances	
4.1 Movement of particles and molecules	
<ul style="list-style-type: none"> appreciate that diffusion, osmosis and active transport are important processes for the movement of molecules/particles 	<ul style="list-style-type: none"> define diffusion as the movement of molecules from a region of their higher concentration to a region of their lower concentration, down a concentration gradient discuss the importance of diffusion for living organisms define osmosis as the passage of water molecules from a region of their higher water potential to a region of their lower water potential, through a partially permeable membrane define active transport as the movement of ions (substances) from a region of their lower concentration to a region of their higher concentration against a concentration gradient
<i>The practical activities, approaches or demonstrations required for Grade 8 Topic 4, Passage of substances. These are considered basic and all learners should be exposed to them as a minimum requirement.</i>	
4.1 Movement of particles and molecules	
<ul style="list-style-type: none"> <i>investigate how diffusion and osmosis takes place in living tissue (potato strip), ammonia or using tea bags and artificial cell (Visking tubing)</i> 	

Based on the suggestion made by T3, the collective PCK from the participants is that firstly, the investigation of how diffusion takes place should be carried out first. After that the teacher can enact the basic competency that states that learners should be able to define diffusion and thereafter, the teacher could ask learners to discuss the importance of the concept of diffusion. The interpretation and discussion displayed by the informants showed that learning had taken place as they (informants) argued that carrying out a practical to investigate diffusion would be helpful to learners. Consequently, T2 explained that such a practical will help learners to:

...understand the theory behind the concept diffusion hence, if we use fermented Oshikundu and a balloon to collect the carbon dioxide it will help the learners to see the diffusion that we teach as opposed to just teaching them to memorise.

The explanation offered by T2 is congruent to what is espoused by Simasiku (2022), as he discourages using teaching methods that allow the teachers to use rote learning. Simasiku explains that teachers using rote learning teaching methods end up explaining processes that they do not even understand or have never come across.

Moreover, the finding above also resonates with Millar (2010) and Woodley (2009), who accentuate that effective practical activities enable learners to make links between theory and practice, ensuring that the learners are able to apply their scientific understanding to the real-world application of science (Gwekwerere, 2016). Thus, it was clear that teachers understood the complexity of diffusion and realised that attempting to make it accessible to learners would require mediation through investigation. This finding coheres with Vygotsky (1978), who defines mediation as the link between teachers and learners that directly affects learners' understanding of knowledge and skills in science. He further explains that mediation is used as a tool in cognitive change. The participants, therefore, decided collectively that we would invite the MKO to come and demonstrate the making of *oshikundu* to the learners as this would talk to their prior knowledge.

b) Learners' prior knowledge

Kuhlane (2011) explains that learners' prior everyday knowledge involves the knowledge that the learners have acquired from the previous grades (Mavhunga & Rollnick, 2013) and from their everyday experiences (Gwekwerere, 2016). In the context of this study, we focused on both knowledges. However, we wanted to show that the prior knowledge from everyday experiences can be used to foster the prior knowledge from previous grades.

Accordingly, we thought this was an important aspect in the planning of our exemplar lesson as highlighted in the previous component. For instance, T1 suggested that "*we will elicit our learners' prior knowledge by questioning the learners what they know about the making of oshikundu*". This suggestion has affinity with Mavuru and Ramnarain's (2017) proposition that teachers need to consider using the learners' sociocultural backgrounds as they have the potential to ease learners' learning difficulties by building a bridge to access Western classroom knowledge (Aikenhead & Jegede, 1999; Fataar, 2012; Mawere, 2015; Seehawer, 2018a).

Moreover, Shinana (2019) propounds that this component places emphasis on elicitation of learners' prior knowledge and pays attention to their misconceptions if there are any. Mavhunga and Rollnick (2013) and Mavhunga et al. (2016) support the idea of allowing learners to share their prior knowledge. According to these scholars, this could help to unearth the misconceptions

which the learners might harbour. Identification of learners' misconceptions is essential as it could reveal what makes it difficult for the learners to understand a topic.

c) What is difficult to understand?

This component, according to Mavhunga and Rollnick (2013) and Mavhunga et al. (2016), describes teachers' insights into the concepts of a topic that are difficult to teach, for example, the misconceptions which learners have that could possibly hamper their understanding. The participants collectively selected two themes: one, explaining concentration gradient and two, distinguishing diffusion from osmosis (Nangolo, 2018). The participants in this regard decided on using *oshikundu* as a hands-on practical activity that would enable learners to visualise the concentration gradient and hence work out the difference between diffusion and osmosis. For instance, T2 stated: *"Confusion between diffusion and osmosis is a result of lack of conceptual understanding of the diffusion concept. Thus, the misconception is carried to the osmosis topic which is secondary to diffusion"*.

The excerpt above links to Cooper (2014), Cooper et al. (1999) and Wyatt et al. (2017) who stress that science teachers need to become cultural knowledge brokers between the learners' own environment and the science they are doing at school (Chang, 2020). Furthermore, extending on Aikenhead and Jegede (1999), Chang (2020) proposes that cultural knowledge brokers (teachers) should build bridges that link or connect WS and the knowledge learners learn from their homes or in the community. When teachers build the bridge to allow learners to traverse between the two worldviews, they help learners to not experience cognitive dissonance (Le Grange, 2007).

Simasiku (2022) suggests that teaching science using real objects helps learners and teachers to visualise the processes involved. This might be one way of overcoming the learners' confusion with regard to osmosis and diffusion. This use of real objects has resonance with Chen et al. (2013, p. 6) who define visualisation as the study of "transformation from data to visual representations to facilitate the effective and efficient cognitive process in performing tasks involving data". Thus, seeing how carbon dioxide moves out of the fermented *oshikundu* might help learners visualise diffusion and work out the aspects that make it different from osmosis.

The discussion in this workshop on planning an exemplar lesson was on the use of the *oshikundu/ontaku* demonstration in the teaching of diffusion. This coheres with Mukwambo et al. (2014) who emphasise that there is a dialectical relationship between IK and WS. These scholars further propose that IK is embedded in WS. Thus, Mavuru and Ramnarain (2017) assert that teaching science concepts in a manner that shows the relationship between these two knowledge systems, specifically those topics that appear abstract to the learners such as diffusion, helps towards a better understanding of the concept. This is termed by Seehawer and Breidlid (2021) as dialogue between these knowledges (WS and IK) and it will thus in itself, contribute to contextualised, culturally responsive education (Mhakure & Otulaja, 2017) that is relevant for the students' daily realities (Gwekwerere, 2016).

d) Representations

To Shinana (2019), representation refers to how learning content should be enacted in a way that carries meaning to the learners. This can be accomplished by using tools that teachers consider have potential in supporting the teaching of content. These representations could be illustrations, metaphors, demonstrations, experiments, analogies, models or stimulations (Mavhunga & Rollnick, 2013; Mavhunga et al., 2016). Within this component, the discussions focused on what we could use in teaching diffusion for better understanding of the concept. The practical demonstration was, therefore, used as a form of representation. For instance, when discussing the definition of diffusion, the example shown in Figure 6.1 below seemed appropriate to use.

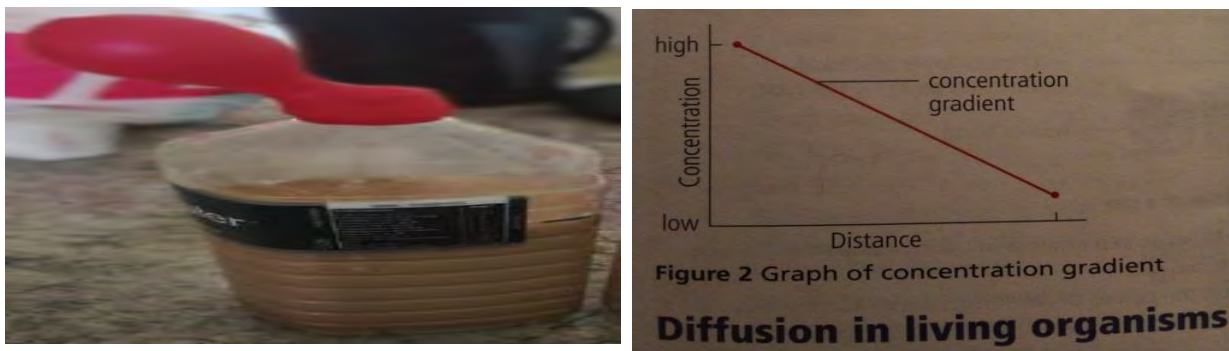


Figure 6.1a & b: The knowledge dialogue between IK and insert from a Life Science textbook on diffusion

The plan was to ask the community member to bring along fermented *oshikundu*. This *oshikundu* would be closed in the bottle with a balloon (the example shown in Figure 6.1.a) so that learners could observe the change in the size of the balloon as the particles of carbon dioxide moved from a region of high concentration to a region of lower concentration down a concentration gradient. In this regard, T1 also emphasised: “*In this practical activity, the learners can see that there is no semi-permeable membrane. Hence, the diffusion is not the same as osmosis*”. T2 added: “*The particles moving are not water molecules but gas particles thus this can be sufficient to eliminate the confusion that learners have regarding the two concepts of diffusion and osmosis*”.

These excerpts link to Gwekwerere et al. (2014) who revealed that teachers tend to be more knowledgeable and confident in applying scientific principles to local contexts and examples. Similarly, Gwekwerere (2016, p. 40) states that “successful contextualization results in confidence, greater authority and leadership and professional efficacy, greater adaptation of content and more creative use of resources in terms of classroom efficacy”. Indeed, the participants were confident and knowledgeable in adapting the IK into their exemplar lesson.

e) Conceptual teaching strategies

In this component of the conceptual teaching strategy, we selected the best method of enactment of diffusion content by inviting the ECM to come and demonstrate to the learners how *oshikundu* is made. We derived this teaching method from the considerations made from the other four components and excluded general teaching methodologies (Mavhunga et al., 2016). Shinana (2019) propounds that the choice of teaching strategies considers the misconceptions if there are any, the educational purpose as well as the learners.

Having deliberated on the first four components, we discussed the strategies which we needed to use in teaching this topic considering the misconceptions, the educational purpose and the learners. The practical demonstration of making *oshikundu* used in this study was a suitable representation which enabled the participants relate science to parts of learners’ everyday life experiences (Gwekwerere, 2016). T3 explained the reason why he prefers the ECM to demonstrate the making of *oshikundu* for the learners:

This choice is beneficial to learners because it will help them realise science starts at home. It is in our communities, and it will be fascinating for them to know that a local person who might not be formally educated but knows so much. This will give our learners new way of viewing science.

From the excerpt above, T3 seemed to understand the value that the community has in educating an indigenous child. He firstly acknowledged that the ECM is more knowledgeable with regard to the making of *oshikundu/ontaku*. This finding echoes Vygotsky's (1978) assertion who states that learning takes place through social interactions with peers or knowledgeable others (parents, teachers or learners). Moreover, it also resonates with Eun (2008), who explains that social interactions activities should be purposively framed by a more skilled person (MKO) to yield learning. T3 also acknowledged that the community member would offer learners a link between school science and local science. This concurs with Seehawer and Breidlid (2021) as they suggest that a dialogue between epistemologies (WS and IK) is a core aspect of quality education, because it is regarded as 'Two-Eyed-Seeing' (Marshall & Marshall, 2009) thus, the application of different knowledges in different local and global contexts give relevant skills in complex 21st century realities.

From the practical demonstration on *oshikundu*, learners would be offered a platform to turn their misconceptions into a learning opportunity. Moreover, this teaching method also allows the teachers an opportunity to integrate IK as per the call of our curriculum (education purpose) of imparting responsive education to the Namibian child. Lastly, the interaction between the learners, community member and teacher is a social unit that offers learning to learners as espoused by Vygotsky (1978), who also talks to LCE (Klein, 2011). Mateus and Ngcoza (2019) also point out that indigenous elders have the potential to support the education system in different ways that allow them to be part of their children's education. They can thus empower teachers to be confident cultural knowledge brokers when integrating IK into their science classrooms (Aikenhead & Jegede, 1999; Wyatt et al., 2017).

6.3 The Participants' Views on the Research Process and How It Influenced Their Teaching of the Concept of Diffusion Integrating IK

In this section, I briefly discuss the teachers' views on the research process and how it influenced their teaching of the concept of diffusion through integrating IK.

6.3.1 Teacher 1

In the preceding chapters, I highlighted that T1 seemed to be very passionate about the integration of IK. For instance, he stated that “*of course, IK is very important in the teaching and learning of our learners*”. However, he confessed that he is challenged in integrating IK by the language barrier presented by the diverse cultures in schools. Moreover, he also expressed his disappointment by stating that the national examination papers do not use local scenarios from local cultural activities. Instead, the exam papers promote Eurocentric scenarios hence he felt discouraged to integrate IK. However, in his reflections, he stated that this workshop showed him that despite the fact that IK is absent in examinations, understanding gained from integrating IK into their teaching would help learners understand better – hence, they would be able to answer the examination questions. He further stated that he was happy that the workshops discussed how prior knowledge from the learners' local communities can be used to come up with practical activities that can clear up misconceptions from previous grades.

6.3.2 Teacher 2

T2 confessed and highlighted in the semi-structured interview that even though she thinks IK is very important in teaching and learning, she does not incorporate it in her teaching on a daily basis. The reason for not integrating IK was revealed during the document analysis workshop as she displayed weak enactment PCK with regard to IK integration. In her reflection, she stated that she learnt a lot from the workshops:

As these types of platforms offered me a learning curve. Every workshop I learnt something new. Knowledge sharing contributed to my subject content and professional development. I learnt that we can also use IK to make subject content fascinating for learners thereby offering them learning space (T2).

From this excerpt, it seems T2 is in favour of professional learning communities (Chauraya & Brodie, 2017), for she stated that it helps science teachers to support one another (Chikamori et al., 2013) and to share ideas. She also showed that learning in workshop interactions was enhanced as teachers shared their experiences, knowledge, skills, problems, difficulties and possible solutions (Eun, 2008; Nhase, 2019). T2 further suggested that “*this type of workshops can be conducted by senior education officer for the novice (new) teachers*”. Her suggestion coheres with Guskey and Yoon (2009) as they allude that the idea of workshops contribute to more positive professional development.

6.3.3 Teacher 3

T3 was the only non-Oshiwambo speaker in this study. In Chapter Four, the findings revealed that he defined IK as knowledge a learner learns their environment. T3 further stated that the syllabus interpretation limits teachers’ teaching methods because:

...it promotes European type of science. Science is not originally from Europe. Science is everywhere. Teachers need to go a step further to change the status core of teaching theory that is promoting rote learning. As teachers we should strive for educating scientist that would think out of the box to become innovators and problem solvers in the society.

Part of the above excerpt coheres with Gwekwerere (2016) as he states that contextualising science helps teachers demystify science as a difficult subject and makes it more accessible to their learners; in turn, this made science more practical and less abstract, thus promoting understanding as opposed to rote learning. He further stated that once the learners develop an understanding of how scientific principles apply, they will be able to think of ways to improve available technologies.

Moreover, T3 also stated that the practical demonstration on *oshikundu* made him think of his childhood years. He narrated that he grew up close to his mother – that is why he can recall practices such as beer making that she used to do. Unfortunately, he never asked why she carried out the steps she did when brewing the beer. He thus cautioned that “*as a society, we need to break the stereotype of women tend to the kitchen and men have their own chores*”. He further stated: “*The boy learners are missing out on learning valuable knowledge from their grandmother and*

mother like I did". He further stated that kitchen science is being used to make science more understandable: *"It means I grew up seeing osmosis and diffusion take place at home, yet I struggled with theory that I was taught"*.

Moreover, he asked a very important question that challenged all of us in the workshop. He said: *"If indigenous science is not science, how come our grandmothers and mothers did not kill us when they recommended herbs for our stomach aches without formal education?"* He thus urged teachers to collaborate with ECMs as they are stakeholders according to the curriculum and we should not leave them out of their children's education. He elaborated: *"We can't just rely on them when we have disciplinary issues, yet we can't ask them help to present IK practices to enhance understanding of science content"*. The collaboration he mentioned resonates with Seehawer (2018) who postulates that through collaboration with science teachers, parents, communities, elders, traditional healers, teacher educators, local authorities, universities and curriculum designers, integration strategies can be explored and solutions found to integrate IK into science classrooms. As educators, we have to change our normal classrooms from the Western setup that does not recognise the integration of IK to the IK setup that allows science teachers to interweave IK into their science classrooms (Simasiku, 2022).

6.4 Chapter Summary

In this chapter, I presented, analysed and discussed the data gathered from the workshop on the co-development of an exemplar lesson. Findings from this workshop showed how the components of TSPCK can be used to plan the enactment of the concept of diffusion that integrates IK. It also showed how teachers successfully participated in co-developing an exemplar lesson collectively and their reflections on this study. In the next chapter, I present the summary of the findings, recommendations and the conclusion

CHAPTER SEVEN: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

7.1 Introduction

In the previous chapter, I presented, analysed and discussed the data generated from the workshop on the co-development of an exemplar lesson that integrated IK using the indigenous technology of making *oshikundu*. In this chapter, I present a summary of the findings and subsequent recommendations for this study. I also suggest areas for future research, limitations of the study and personal reflections thereof. The chapter ends with the overall conclusion of the study.

7.2 Overview of the Study

The goal of my study was to mobilise the indigenous technology of making *oshikundu* to mediate learning of diffusion. In order to achieve this goal, I employed a qualitative research design to generate data using a variety of methods. I used semi-structured-interviews, document analysis, workshop discussions and journal reflections. Data in this study were analysed using an inductive approach and the common sub-themes were grouped together to form themes which I discussed in relation to the literature and/or theory. The discussions were made using relevant literature, Vygotsky's (1978) sociocultural theory and Shulman's (1986) PCK, together with Mavhunga and Rollnick's (2013)'s TSPCK which were employed as theoretical and analytical frameworks.

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

1. *What are the Grade 8 Life Science teachers' experiences, understanding and pedagogical insights on the integration of indigenous knowledge into the topic of diffusion?*
2. *In what ways do Grade 8 Life Science teachers interact, participate and learn (or not) during the practical demonstration of making oshikundu by the expert community member?*
3. *How do the Grade 8 Life Science teachers co-develop an exemplar lesson on diffusion that integrates indigenous knowledge?*

7.3 Summary of Findings

I present the summary of the findings in relation to my research questions.

7.3.1 Research question one

What are the Grade 8 Life Science teachers' experiences, understanding and pedagogical insights on the integration of indigenous knowledge into the topic of diffusion?

Taking heed of Snively and Williams's (2008) advice, an understanding of how the Grade 8 Life Science teachers perceived or viewed IK was a vital point of departure in my pursuit to understand their perspectives and pedagogical insights on integrating indigenous knowledge in their teaching. For instance, the teachers involved in this study were requested to state their understanding of IK. For instance, T2 explained IK: *"For me it is basically what learners are coming with/ bring with to class or the knowledge that learners are exposed to at home or in their society"*. To T3, *"It is the knowledge one learns in your environment"*. It seems that both T2's and T3's definitions of what IK is coheres with Chikamori et al. (2019) and Kibirige and van Rooyen (2006) as they state that IK is the knowledge from the learners' environment.

In this regard, these scholars state that this legacy of knowledge and skills are unique to a particular indigenous culture, involving wisdom that has been developed and passed on over generations. Thus, Snively and Williams (2008) accentuate that every culture has its own science. These further resonate with Hays (2009), who defines IK as a "complete knowledge system with its own concepts of epistemology, philosophy and scientific and logical validity, which can only be learnt and understood by means of pedagogy traditionally employed by these people themselves" (p. 196).

These findings further revealed that these teachers seemed to appreciate the value and use of local knowledge. It is acknowledged, however, that the science content we teach our learners seems to be promoting a Western way of doing things and neglects our own way of doing things in Namibia. This links to "educational disengagement" as espoused by Fataar (2012, p. 55) and the alienation of a Namibian indigenous child, who might then in turn develop a perception that school education is irrelevant. The learners might thus internalise this colonial inferiority complex that regards

everything non-Western as worthless as stated by Breidlid (2013), which will then create learning problems for them.

Although the participant teachers described IK as very important, there seems to be a tension between their conceptions and the implementation. Findings show that they do not integrate IK timeously. The informants further revealed in the semi-structured interviews and document analysis workshop that they are challenged in their PCK for integrating IK. This finding resonates with Asheela (2017), Shinana (2019), and Kakambi (2021) who point out that the lack of integration could be due to the lack of guidance from the curriculum. It was thus from these findings that the need for a professional development platform was reaffirmed as suggested by Asheela et al. (2021). These scholars stated that collaborative learning settings such as the one offered by this study, serve as a motivation and reinforcement of a positive self-efficacy. Bandura (1994, p. 1) defines self-efficacy as “people’s belief about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives”. Concurring, Yukseland Alci (2012) posits that teachers’ actions and behaviour are related to their levels of self-efficacy. Likewise, Mutanho (2021) concurs by stating that a professional development platform like this study may provide solutions and address stated challenges as those pointed out by the participant teachers. He further alluded that the policy of integrating IK into science lessons cannot be realised unless teachers are equipped with the necessary conceptual tools to enable them to put theory into practice.

7.3.2 Research question 2

In what ways do Grade 8 Life Science teachers interact, participate and learn (or not) during the practical demonstration of making oshikundu by the expert community member?

In this study, a significant fact is that the participating teachers found the indigenous technology relevant and useful in the teaching of diffusion as it has the potential to help learners relate what is taught to their prior knowledge. This was revealed in the teachers’ reflections based on their everyday experiences. For instance, with excitement, T3 recalled:

Wow this reminds me of my childhood. I grew up very close to my mom and I remember how she used to prepare her traditional beer. Cultures are similar. Wow. The smell really reminds me of my mother acidic traditional beer (T3).

What T3 shared is accentuated by Gwekwerere (2016) who ascertains that there is a connection between science subjects taught in school and the real-life experiences and worldviews of the African child; hence, T3's recollection of his childhood. Likewise, T3's recollection also agrees with Akenhead (2011), who asserts that there is a gap between WS taught in schools and IK which this study tried to fill.

Moreover, the teachers also narrated how these workshops impacted their SMK and PCK compared to their previous teaching practices. In this regard, these informants reflected that they learnt that local materials can be used to bridge the gap between WS concepts such as diffusion or fermentation and IK. They further reflected that the integration of IK into our science classes has the potential to help learners relate to their everyday experiences which in turn helps them understand the phenomenon surrounding them. Thus, the informants then suggested that the workshops conducted in this study should be conducted with novice teachers to help them develop their PCK. Moreover, the activity of mind maps and concept maps development helped them realise that IK technological demonstrations can help simplify scientific content and also show how different concepts are related to one another. They thus further suggested that workshops of this nature are of great importance to teachers' professional development as indicated below:

This form of workshop needs to be done by senior education officers to boost professional development (T2).

Group discussion in the workshops was key in teachers' reasoning and it enables other colleagues to discover new knowledge (T3).

The two suggestions above indicated that the informants valued the discussions that took place in the workshops and felt that their PCK had evolved; thus, the same kind of workshops would benefit other science teachers. This coheres with Ellis (2000) who ascertains that the theory of learning starts not through interaction but during interaction and it is through successful interaction that a MKO can move another through the ZPD. Likewise, Eun (2008) points out that there is ZPD in

the professional development of teachers. Concurring, Ebadi et al. (2010) also contend that the use of mediatory tools such as mentors, artefacts and diary writing positively influences teachers' ZPD.

Moreover, during the *oshikundu* demonstration workshop, interaction took place as all the teachers participated in asking and answering questions. The participants initiated discussions and evaluated the science embedded in the demonstration of making *oshikundu* by the ECM. Collaboratively, the teachers were also able to point out concepts associated with diffusion in the presentations. The mutual conversations as espoused by Chauraya and Brodie (2018) promoted learning and improved the teachers' understanding of IK. It could be hypothesised that the improved understanding regarding the integration of IK in the mediation of the concept of diffusion was observed because of the ECM's presentation. Moreover, the teachers' understanding of the link between IK and school science was enhanced (Aikenhead & Jegede, 1999).

7.3.3 Research question three

How do the Grade 8 Life Science teachers co-develop an exemplar lesson on diffusion that integrates indigenous knowledge?

Central to this study was the activity of co-developing an exemplar lesson on diffusion integrating the indigenous technology of making *oshikundu*. Although the teachers did not have knowledge of the TSPCK components used in the development of the exemplar lesson, in the first place, they exhibited extensive knowledge when it came to choosing the appropriate items to discuss on each component. Moreover, the prepared information sheet (see Appendix C) with descriptions of what each component entails and how the components could be used to transform content knowledge given to the informants was of great value in this activity of lesson planning.

Consequently, it was a great surprise that the discussion on the component of conceptual teaching strategy saw T3 insisting on inviting an ECM to come and do a demonstration of making *oshikundu* for the learners. For instance, T3 stated:

This choice is beneficial to learners because it will help them realise science starts at home. It is in our communities, and it will be fascinating for them to know that a local person who might not be formally educated but knows so much. This will give our learners new way of viewing science.

The excerpt above indicates that a paradigm shift had taken place as teachers could point out the importance of the ECM without the help of the researcher and revealed that Vygotsky's ZPD took place. Moreover, the ECM demonstration integrating IK created potential for this participant to become a cultural broker as indicated by Simasiku (2022). This also resonates with Mukwambo et al. (2014) as they called for the Africanisation of the science curriculum in African schools, specifically in South Africa and Namibia. The context in which the science curriculum is taught should be made relevant to the learners. Furthermore, Gwekwerere (2016) indicates that "learners' sociocultural worldviews affect the way they learn, and African worldviews impact African learners' way of learning" (p. 33). The benefit of choosing the ECM to present is reiterated by Hashondili (2020), who asserts that expert community members' presentations can greatly enhance sense making of science concepts.

One could conclude then that the workshops held in this study helped the teachers involved to improve their professional development. This coheres with scholars on continuing professional development who advocate that educational workshops and training be geared towards advancing teachers' professional development (Eun, 2008; Ngcoza & Southwood, 2019). They maintain that this has the benefit of helping to change the teachers' teaching practices. Similarly, to Chauraya and Brodie (2018), the most salient lesson in this study was learning to work together as teachers in a community of practice with the expert community member to improve our PCK as reiterated by Shulman (1986).

7.4 Recommendations

This study exposed or surfaced tensions between curriculum policies on IK integration and enactment of IK in science learning. This might be because it was not part of their teacher training programme at their university or college. As a result, teachers have inadequately used their learners' prior everyday knowledge (Kibirige & van Rooyen, 2006; Roschelle, 1995). I thus recommend that all teachers' training institutions should consider revising and integrating IK in their curricula for teachers' courses as this will accommodate and empower graduating and younger teachers with IK.

For in-service teachers, I recommend school-based teachers' continuing professional development to enhance both the teachers' subject content knowledge and PCK (Mavhunga & Rollnick, 2013) on IK integration in particular. This may take the form of workshops organised at school level and could empower teachers at the departmental level. The head of department for science, for instance, could designate a week in which they explore science topics and identify relevant IK that could be used to contextualise such topics. During these workshops, they may invite an expert community member or they could visit an expert community member on the identified IK. This study has opened opportunities for possible further research. I would like to see a study conducted on the topic of air, particularly carbon dioxide as a greenhouse gas and its impact on the environment i.e., a study exploring how the Life Science learners can be afforded learning opportunities with the collected carbon dioxide from *oshikundu*.

7.5 Areas for Future Research

This study has opened opportunities for possible further research which could involve a larger sample in terms of schools and the number of teachers. In addition, a study of this nature could be conducted over four weeks, one workshop per week. In those workshops, more concentration could be placed on the development of practical skills through using easily accessible resources (Asheela et al., 2021; Shinana et al., 2021). Furthermore, attention could also be pointed to the expert community member so that the participants could gain more knowledge on cultural heritage to enable them to become cultural brokers. The rationale is to provide the participants enough time to familiarise themselves with the knowledge they gained from the workshops, thus giving the researcher ample time to assess the effect of the intervention workshop as well.

Another study could also look at how the teachers link the collected carbon dioxide from the *oshikundu* to teach the topic of gases of the air (carbon dioxide). The future research may look at Education for Sustainable Development (ESD) which is a type of education that promotes changes in knowledge, skills, values and attitudes in order to create a more sustainable and just society for all (Karatkevich, 2020). Education for Sustainable Development (ESD) focuses on the environment and human actions and works to achieve a desirable future through social development (UNESCO, 2018). The recommended study can look at Grade 8 Physical Science teachers as participants. This might enable them to build on their views of the environment as a

source of easily accessible resources. The assumption is that the teachers might become “informed agents who can bring about changes in existing society towards a sustainable society through thinking (in ways that are metaconceptual or ‘non-time’) about how the past has (or has not) brought them to the present and what actions at the present can take them forward towards a sustainable future” (Chikomori et al., 2019, p.14.). This means teachers will have a broad understanding of the environment, not only to find tools for mediating science teaching and learning from the environment, but to also teach their learners to have the potential to become powerful change agents for environmental conservation and stewardship (Shimwandi, 2021).

7.6 Limitations of the Study

There are three limitations to this study. The study only involved three teachers and this sample size is small and does not represent the whole population of Grade 8 Life Science teachers in the Otjozondjupa region and the country at large. For these reasons, these findings cannot be generalised. Nevertheless, findings from this study provided some insights on how Grade 8 Life Science teachers understand IK and use it to mediate the concept of diffusion in their classrooms.

Secondly, the workshops were conducted after teaching hours; this meant that the teachers might have come to the workshops tired from their normal teaching work. This could have affected their participation in the workshop activities. In addition, I had planned to collect my data within a minimum period of three consecutive weeks. However, the outbreak of COVID-19 restricted the time spent on the project. I also observed that teachers’ voices during interactions and discussions were sometimes not clear because they wore COVID-19 protective masks.

Thirdly, I did not collect observational data of teachers’ implementation of the knowledge they gained from the intervention workshops. Even though I videotaped those workshops, data from classroom observations would have been useful to see how these teachers enacted the co-developed exemplar lessons. In addition, I did not have the opportunity to watch these videos with the teachers, which is another lost opportunity to do stimulated recall interviews which could have been another validation technique (see Section 3.3.7).

7.7 My Personal Reflections

I started this research journey in 2017 when I enrolled for my BEd Honours degree at Rhodes University. Things were tough at the beginning as I was grappling with understanding what academic writing was. This was projected to research as well. In my final year, Professor Ngcoza and Dr Nhase introduced the notion of Ubuntu to all scholars doing the science education elective. Ubuntu is the spirit of together -ness whereby people are sensitive towards each other and care for each other (Venter, 2004). Professor Ngcoza's teachings about Ubuntu were quite useful to me as it helped us work in harmony as a community of practice. As we worked together, we cherished the African proverb which says: "If you want to go fast walk alone but if you want to go far, walk together". Indeed, we walked together and updated each other on the latest research articles related to our research studies.

I must say it was during the experience that I had in March 2019, when I had the privilege of attending a workshop on the introduction to research design at Rhodes University, South Africa that I experienced a paradigm shift on what research is and its implications. Moreover, I had an opportunity to be a participant in Mama Noling's presentation of making ⁵*umqombothi* in a multicultural lecture. Umama Noling is a church elder who is a MKO as a custodian of IK in her traditional practice of making *umqombothi* (Vygotsky, 1978). She demonstrated the making of *umqombothi* with resourcefulness in terms of her cultural skills with a lot of humility, composure and confidence. I was impressed by the humbleness and the spirit of Ubuntu/Unhu of Umama. This particular demonstration triggered my interest to carry out a research study on integration of IK in a multicultural science class (Nyamakuti, 2021). Thus, it was this experience that made me interested in inviting a community expert member to come and demonstrate in this study how teachers can use the making of *oshikundu* to mediate the learning of the concept of diffusion.

Ubuntu is really very important to us in Africa. More so, Mrs. Ester Shinana's Ubuntu in particular has benefited me as she was selfless in availing herself to help me during my research proposal stage. My first research proposal had to be resubmitted after I addressed the reviewers' suggestions

⁵ Umqombothi is a traditional alcoholic beverage made by many indigenous people in South Africa.

and comments. This made me heartbroken and discouraged. Mrs. Shinana, who by then had just received her results for her masters, took it upon herself to become my critical friend and really helped explain at times in Oshiwambo what the reviewers expected of me. This resonates with Simasiku (2022), who accentuates that indigenous language has a potential to trigger ones experiences in order to make meaning from the concepts in the local language before translating back to the language of learning and teaching. Hence, her explanation in Oshiwambo helped resolve my cognitive dissonance as espoused by Le Grange (2007). My second submission was approved and thereafter I was given my ethical clearance. Prof Ken, you have trained us well and I know you are a proud supervisor. Indeed, there is power in diversity as Prof Ngcoza is fond of saying. In our Ubuntu sharing circle we tapped into each other's wisdom and we were able reflect on and adapt our studies accordingly.

Due to my own personal challenges, I had a very tough academic year in 2020. To make matters worse Covid-19 halted all contact sessions which forced us to work on our own. This alienated me and I just retreated into a cocoon and shut down. I could not write anymore. I, however, managed to collect my data but I could not finish the analysis. I then decided to put my studies on hold because emotionally and financially I was not coping in the 2021 academic year.

Late 2021, Prof Ken and Dr Nhase reached out on an online platform. It was refreshing and I was encouraged to become resilient. Prof Ken kept saying you need to be resilient, Alma. Keep going. Early 2022, Prof invited us to a SAARMSTE Namibian chapter colloquium and I attended. As I sat there looking at others presenting their own work I felt inspired and motivated to finish what I had started. Moreover, I attended the NIED graduation for 2022. I witnessed it as my own class of 2019 graduated. Looking back, these platforms were instrumental in encouraging me to finish my thesis. I thus conclude my favourite Oshiwambo quote that states, "*Ondapo yandje ka yishi yamukwetu ye keshe gumwe oha matuka nondapo ye yemwene*" [my race is unique to me. It is dependent on my pace and not on another person's race]. And indeed, what God intended for me will always come to pass.

7.8 Conclusion

This study sought to mobilise the indigenous technology of making *oshikundu*, with the aim of co-developing an exemplar lesson to mediate learning of the concept diffusion. Three research questions were answered using data collected from the semi-structured interviews, workshop discussions on document analysis, participatory observation and teachers' journal reflections. The findings revealed that the participating teachers learnt many lessons from the workshop discussions. Among the lessons was that all teachers found the indigenous technology of making *oshikundu* relevant and useful in the teaching and learning of diffusion. From the analysis of documents, it dawned on the teachers that the NCBE and the syllabus for Life Science call on them to integrate IK.

During the presentations by the expert community member, the findings revealed that the teachers' understanding was positively influenced by the integration of IK which certainly assisted them to relate better to the science concept of diffusion. Furthermore, data revealed that the use of the TSPCK components provided the teachers with the opportunity to gain insights into how they could teach the concept of diffusion. This study therefore revealed that the integration of IK has potential for increasing understanding of science during lessons (Erinosho, 2013). Thus, there is a great need for teachers to advocate and more importantly consider learners' sociocultural backgrounds during teaching (Mavuru & Ramnarian, 2020; Vygotsky, 1978).

References

- Abrahams, I., & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education*, 30, 1945-1969.
- Abah, J., Mashebe, P., & Denuga, D. D. (2015). Prospect of integrating African indigenous knowledge systems into the teaching of sciences in Africa. *American Journal of Educational Research*, 3(6), 668-673.
- Adom, D., Hussein, E., & Joe, A. (2018). Theoretical framework and conceptual framework: Mandatory ingredients of a quality research. *International Journal of Scientific Research*, 7(1), 438-441.
- Adhikari, N., & Acharya, D. R. (2015). Effect of incorporation of malted sorghum flour on quality of biscuit. *Sunsari Technical College Journal*, 2(1), 33-37.
- Ahmed, A. (2008). *Improvisation of instructional materials for the teaching of Biology: An important innovation in Nigerian educational system*. Kano: Department of Biology, Federal College of Education.
- Afonso-Nhalevilo, E. A. (2013). Rethinking of history of inclusion of IKS in school curricula: Endeavoring to legitimate the subject. *International Journal of Science and Mathematics Education*, 11(1), 23-42.
- Aikenhead, G., & J. Jegede, O. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching*, 36(3), 269-287.
- Akuma, F. V., & Callaghan, R. (2016). Framework for reducing teaching challenges relating to improvisation of science education equipment and materials in schools. *EURASIA Journal of Mathematics, Science and Technology Education*, 12(10), 2697-2717.
<https://doi.org/10.12973/eurasia.2016.1305a>
- Atallah, F., Bryant, S. L., & Dada, R. (2010). Learners' and teachers' conceptions and dispositions of Mathematics from a Middle Eastern perspective. *US-China Education Review*, 7(8), 43-49.

- Amutenya, L. N. (2014). *Understanding how grade 11 Biology teachers mediate learning of Respiration: A Namibian case study* [Unpublished master's thesis]. Rhodes University.
- Ali, T., & Shishigu, A. (2020). Implications of ubuntu/synergy for the education system of Ethiopia. *Education Research International*.
<https://www.hindawi.com/journals/edri/2020/8838077/>
- Asheela, E. N. (2017). *An intervention on how using easily accessible resources to carry out hands-on practical activities in science influences science teachers' conceptual development and dispositions* [Unpublished master's thesis]. Rhodes University.
- Asheela, E. N., Ngcoza, K. M., & Sewry, J. (2021). The use of easily accessible resources during hands-on practical activities in rural under-resourced Namibian schools. In U. Ramnarain (Ed.), *School science practical work in Africa. Experiences and challenges* (pp. 14-31). Routledge.
- Aurini, J. D., Heath, M., & Howells, S. (2016). *The how to of qualitative research*. Sage.
- Bahar, M., Johnstone, A. H., & Hansell, M. H. (1999). Revisiting learning difficulties in biology. *Journal of Biological Education*, 33, 84-86.
- Bantwini, B. (2010). How teachers perceive the new curriculum reform. Lesson from a school district in the Eastern Cape Province, South Africa. *International Journal of Educational Development*, 30, 83-90.
- Barak, M., & Dori, Y. J. (2009). Enhancing higher order thinking skills among in-service Science teachers via embedded assessment. *Journal of Science Education*, 20(5), 459-474.
- Bandura, A. (1994). Self efficacy In V.S Ramachandran (Ed.), *Encyclopaedia of human behaviour* (Vol. 4, pp. 71-81). Academic Press.
- Bayar, A. (2014). The components of effective professional development activities in terms of teachers' perspective. *International Online Journal of Educational Sciences*, 6(2), 319-327.

- Blanchard, M. R., Southerland, S. A., Osborne, J., Sampson, V., Annetta, L. A., & Granger, E. (2010). Is inquiry possible in light of accountability? A quantitative comparison of the relative effectiveness of guided inquiry and verification laboratory instruction. *Science Education, 94*(4), 577-616.
- Breidlid, A. (2013). *Education, indigenous knowledges, and development in the Global South. Contesting knowledges for a sustainable future*. Routledge.
- Bertram, C., & Christiansen, I. (2020). *Understanding research: An introduction to reading research*. Van Schaik Publishers.
- Bowen, G. (2009). Document analysis as a qualitative research methods. *Qualitative Research Journal, 9*(2), 27-40.
- Bosman, L. (2016). Teaching science through inquiry in the foundation phase. In C. M. Naude (ed.), *Teaching life skills in the foundation phase* (pp. 69-116.). Van Schaik.
- Brooks, J., Reed, D. M., & Savage, B. (2016). *Taking off with a pilot: The importance of testing research instruments*. Proceedings of the 15th European Conference on Research Methodology for Business and Management Studies, 9-10 June, Kingston Business School, UK.
- Brodie, K., & Borika, H. (2016). *Professional learning communities in south African schools and teacher education programmes*. HSRC Press.
- Buczynski, S., & Hansen, C. (2010). Impact of professional development on teacher practice: uncovering connections. *Teaching and Teacher Education, 26*, 599-607.
- Chikamori, K., Tanimura, C., & Ueno, M. (2019). Transformational model of education for sustainable development (TMESD) as a learning process of socialization. *Journal of Critical Realism*. <https://doi.org/10.1080/14767430.2019.166709>
- Chauraya, M., & Brodie, K. (2018). Conversations in a professional learning community: An analysis of teacher learning opportunities in Mathematics. *Pythagoras, 39*, 1-9.
- Carlson, J., & Daehler, K. R. (2019). The refined consensus model of pedagogical content knowledge in science education. In A. C. Hume (ed.), *Repositioning pedagogical content knowledge in teachers' knowledge for teaching science* (pp. 77-92). Springer.

- Çepni, S., Ülger, B. B., & Ormanci, Ü. (2017). Pre-service science teachers' views towards the process of associating science concepts with everyday life. *Journal of Turkish Science Education, 14*(4), 1-15
- Chang, S. (2020). Multicultural educators as cultural brokers and language mediators. *Multicultural Perspectives, 22*, 146-152. <https://doi.org/10.1080/15210960.2020.1792300>
- Chen, M., Floridi, L., & Borgo, R. (2013). What is visualization really for? The philosophy of information quality. *Springer Synthese Library, 358*, 75-93.
https://arxiv.org/ct?url=https%3A%2F%2Fdx.doi.org%2F10.1007%2F978-3-319-07121-3_5&v=fccbc932
- Chikamori, K., Ono, Y., & Rogan, J. (2013). A lesson study approach to improving a biology lesson. *African Journal of Research in Mathematics, Science and Technology Education, 17*, 14-25.
- Chilisa, B., & Ntseane, G. (2010). Resisting dominant discourses: Implications of indigenous, African feminist theory and methods for gender and education research. *Journal for Gender and Education, 22*(6), 617-632.
- Chilisa, B. (2012). *Indigenous research methodologies*. Sage.
- Chukwuka, C. (2013). *Effect of improvised materials in teaching and learning biology in secondary schools in Njikoka Urban of Anambra State Urban Of Anambra State*.
<http://www.doublelist.com/teaching-learning-effect-improvisedmaterials-biology-secondary-school>
- Cimer, A. (2012). What makes biology learning difficult and effective: students' views? *Educational Research and Reviews, 7*(3), 61-71.
- Cobb, P., & McClain, K. (2011). The collective mediation of a high-stakes accountability program. In E. Yacker, K. Gravemeijer & A. Sfard (Eds.), *A journey in mathematics education research. Insight from the work of Paul Cobb* (pp. 215-230). Springer.
- Coburn, W. W., & Loving, C. C. (2001). Defining science in a multicultural world: Implications for Science Education. *Science Education, 85*, 50-67.

- Cobin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Sage.
- Cocks, M. L., Alexander, J., & Dold, T. (2012). Inkubeko Nendalo: A Bio-cultural diversity schools education project in South Africa and its implications for inclusive Indigenous Knowledge Systems (IKS) sustainability. *Journal of Education for Sustainable Development, 6*(2), 241-252.
- Cook, M. P. (2006). Visual representations in science education: The influence of prior knowledge and cognitive load theory on instructional design principles. *Science Education, 90*(6), 1073-1091.
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th ed). Routledge.
- Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.) Routledge.
- Cooper, C. R. (2014). Cultural brokers: How immigrant youth in multicultural societies navigate and negotiate their pathways to college identities. *Learning, Culture and Social Interaction, 3*, 170-176
- Cooper, C. R., Denner, J., & Lopez, E. M. (1999). Cultural brokers: Helping Latino children on pathways toward success. *The Future of Children, 9*, 51-57.
- Creswell, J. W., & Miller, D. L. (2000). *Theory into practice, getting good qualitative data to improve educational practice*. Taylor & Francis.
- Creswell, J. W. (2008). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (4th ed.). Sage.
- Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (5th ed.). Pearson Education.
- Creswell, J. W. (2015). *A concise introduction to mixed methods research*. Sage.
- Creswell, J. W., Ebersohn L., Eloff, I., Ferreira, R., Ivankova, N.V., Jansen, J. D., Nieuwenhuis J., Pietersen, J., & Plano Clark, V. L. (2016). *First step in research*. Van Schaik.

- Crick, R. D., & Yu, G. (2008). Assessing learning dispositions: Is the effective lifelong learning inventory valid and reliable as a measurement tool? *Educational Research*, 50(4), 387-402.
- Cronje, A., de Beer, J., & Ankiewicz, P. (2015). The development and use of an instrument to investigate science teachers' views on Indigenous Knowledge. *African Journal of Research in Mathematics, Science and Technology Education*, 19(3), 319–332.
- Damon, W. (2005). Personality test: The dispositional dispute in teacher preparation today, and what to do about it. *Journal of Teacher Education - Issues on Dispositions*, 2, 1-6.
- Daba, T., Anbassa, B., Oda, B., & Degefa, I. (2016). Status of biology laboratory and practical activities in some selected secondary and preparatory schools of Borena zone, South Ethiopia. *Educational Research and Reviews*, 11(17), 1709-1718.
- Dahlström, L. (1999). Toward learner-centred and democratic teacher education. In K. Zeichner & L. Dahlström (Eds), *Democratic teacher education reform in Africa: The case of Namibia* (pp. 47-63). Sage.
- Demerouti, M., Kousathana, M., & Tsapralis, G. (2004). Acid-base equilibria, Part 1: Upper secondary students' misconceptions and difficulties. *The Chemical Educator*, 9, 122-131.
- Department of Education. (2011). *Curriculum and Assessment Policy Statement*. Government Printers.
- Dikko, M. (2016). Establishing construct validity and reliability: Pilot testing of a qualitative interview for research in takaful (Islamic insurance). *The Qualitative Report*, 21(3). <https://nsuworks.nova.edu/cgi/viewcontent.cgi?article=2243&context=tqr>
- Dixon, E. M. (2015). *Ninth Grade students' understanding of diffusion and osmosis after participation. In direct or inquiry-based lessons: A mixed methods study* [Unpublished PhD thesis]. Baylor University.
- Driver, R., Leach, J., Millar, R., & Scot, P. (1996) *Young people's image of science*. Open University Press.

- Dziva, D., Mpofu, V., & Kasure, L. (2011). Teachers' conception of indigenous knowledge in Science curriculum in the context of Mberengwa District, Zimbabwe. *African Journal of Education and Technology*, 1(3), 88-102.
- Easterly, R. G., & Myers, B. E. (2011). Inquiry-based instruction for students with special needs in school based Agricultural education. *Journal of Agricultural Education*, 52(1), 36-46.
- Eisner, E. W. (2017). *The enlightened eye: Qualitative inquiry and the enhancement of educational practice*. Teachers College Press.
- Eilks, I., Witteck, T., & Pietzner, V. (2012). The role and potential dangers of visualisation when learning about sub-microscopic explanations in chemistry education. *Centre of Educational Policy Studies Journal*, 2(1), 125-145.
- Ebadi, S., Khatib, M., & Shabani, K. (2010). Vygotsky's Zone of Proximal Development: Instructional Implications and teachers' professional development. *English Language Teaching*, 3(4), 237-248.
- Embashu, W., Cheikhoussef, A., Kahaka, G., & Lendelvo, S. (2013). Processing methods of Oshikundu, a traditional beverage from sub-tribes within Aawambo culture in the Northern Namibia. *Journal For Studies in Humanities and Social Sciences*, 2(1), 117-127.
- Embashu, W. (2014). *Physicochemical, nutrient and microbiological analysis of Oshikundu: A cereal based fermented beverage from Namibia* [Unpublished master's thesis]. University of Namibia.
- Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford University Press.
- Ellis, R. (2001). Task based research and language pedagogy. *Language Teaching Research*, 4(3), 139-220.
- Erinosho, S. Y. (2013). Integrating indigenous science with school science for enhanced learning: A Nigerian example. *International Journal for Cross-Disciplinary Subjects in Education*, 4(2), 1137-1143.

- Eun, B. (2008). Making connections: Grounding professional development in the developmental theories of Vygotsky. *The Teacher Educator*, 43(2), 134-155.
- Eun, B. (2011). A Vygotskian theory –based professional development: implications for culturally diverse classrooms. *Professional Development in Education*, 37(3), 319-333.
- Fataar, A. (2012). Pedagogical justice and student engagement in South African schooling: Working with the cultural capital of disadvantaged students. *Perspectives in Education*, 30(4), 52–75.
- Fang, Z. (2004). Scientific literacy: A systemic functional linguistics perspectives. *Issue and Trends*, 89(2), 335-345.
- Gao, L., & Watkins, D. A. (2002). Conceptions of teaching held by school science teachers in P.R. China: identification and cross-cultural comparisons. *International Journal of Science Education*, 24(1), 61-79.
- Gay, L. R., Mills, G. E., & Airasian, P. W. (2000). *Educational research: Competencies for analysis and application* (10th ed.). Pearson Educational International.
- García, O. (2009). *Bilingual education in the 21st century: A global perspective*. Wiley-Blackwell.
- García, O., Skutnabb-Kangas, T., & Torres-Guzman, M. (2006). Weaving spaces and (de)constructing ways for multilingual schools: The actual and the imagined. In O. García, T. Skutnabb-Kangas & M. E. Torres-Guzman (eds.), *Imagining multilingual schools: Languages in education and globalization* (pp. 3-50). Multilingual Matters.
- Geddis, A. N., & Wood, E. (1997). Transforming subject matter and managing dilemmas: a case study in teacher education. *Teaching and Teacher Education*, 13(6), 611-26.
- Gibbons, P. (2003). Mediating language learning: Teacher interactions with ESL students in a content-based classroom. *TESOL Quarterly*, 37(2), 247-273.
- Goos, M. (2004). Learning mathematics in a classroom community of inquiry. *Journal for Research in Mathematics Education*, 35(4), 258-291

- Duggan, S., & Gott, R. (1996, March). Scientific evidence: the new emphasis in the practical science curriculum in England and Wales. *The Curriculum Journal*, 7(1), 17-33.
<https://doi.org/10.1080/0958517960070103>
- Govender, N. (2014). Re-envisioning pedagogy for African higher education: Students' status of science and IKS via argumentation discourses. *Alternation Special Edition*, 12, 358-384.
- Graven, M. (2012). The evolution of an instrument for accessing early learning mathematical dispositions. In *Early childhood educational research and development week programme proceedings* (pp. 53-55). Rhodes University.
- Grobschedl, J., Konnermann, C., & Basel, N. (2014). Preservice Biology teachers' acceptance of evolutionary theory and their preference for its teaching. *Evolution: Education Outreach*, 7, 18.
- Gwekwerere, Y., Mushayikwa, E., & Manokore, V. (2014). Empowering teachers to become change agents through the Science Education In-service Teacher Training Project in Zimbabwe. *Canadian and International Education Journal*, 42(2), Article 3.
- Gwekwerere, Y. (2016). Schooling and the African child: Bridging African epistemology and Eurocentric physical sciences. In G. Emeagwali & E. Shizha (Eds.), *African indigenous knowledge and the sciences, journeys into the past and present* (pp. 33-46). Sense Publishers.
- Guskey, T. R., & Yoon, K. S. (2009). What works in professional development? *Phi Delta Kappan*, 90(7), 495-500.
- Hasni, A., Roy, P., & Dumais, N. (2015). The teaching and learning of diffusion and osmosis: What can we learn from analysis of classroom practices? A case study. *Eurasia Journal of Mathematics, Science & Technology Education*, 12(6).
<https://doi.org/10.12973/eurasia.2016.1242a>
- Harlen, W., & Qualter, A. (2018). *The teaching of science in primary schools* (7th ed.). Routledge.
- Hays, J. (2009). *Learning indigenous knowledge systems*. www.hsrcpress.ac.za

- Hashondili, S. (2020). *Exploring working with Grade 6 elementary Agricultural Science teachers in understanding and developing model lessons that integrate local knowledge on food preservation* [Unpublished master's thesis]. Rhodes University.
- Haapasaari, A., Engeström, Y., & Kerosuo, H. (2016). The emergence of learners' transformative agency in a change laboratory intervention. *Journal of Education and Work, 29*(2), 232-262.
- Hatcher, A., Bartlett, C., Marshall, A., & Marshall, M. (2009). Two-eyed seeing in the classroom environment: concepts, approaches, and challenges. *Canadian Journal of Science, Mathematics and Technology Education, 9*(3), 141–153.
<https://doi.org/10.1080/14926150903118342>
- Hepute, N. R., Embashu, W., Cheikhyoussef, A., & Nantanga, K. K. M. (2016). Effect of precooking pearl millet (*pennisetum glaucum*) flour on the reduction of dregs in oshikundu. *Introduction to Science and Technology Journal of Namibia, 8*, 91-97.
- Higgs, P. (2008). Towards an indigenous African educational discourse. *A Philosophical Reflection, 54*, 445-458. <https://doi.org/10.1007/s11159-008-9088>
- Higgs, P. (2010). Towards an indigenous African epistemology of community in education research. *Procedia Social and Behavioural Sciences, 2*, 2414-2421.
<https://doi.org/10.1016/J.sbspro.2010.03.347>
- Higgs, P. (2016). *The African Renaissance and the transformation of the higher education*.
<http://doi:10.1080/18146627.2016.1186370>.
- Howie, S. (2004). A national assessment in mathematics within an international comparative assessment. *Perspectives in Education, 22*(2), 149-162.
- Hodson, D. (1990). A critical look at practical work in school science. *School Science Review, 70*(256), 33-40.
- Hodson, D. (2009). *Teaching and learning about science: Language, theories, methods, history, traditions and values*. Sense Publishers.

- Horsthemke, K., & Schäfer, M. (2007). Does 'African mathematics' facilitate access to mathematics? Towards an ongoing critical analysis of ethnomathematics in a South African context. *Pythagoras*, 65, 2-9.
- Ivankova, N. V. (2015). *Mixed methods applications in action research: From methods to community action*. Sage.
- Isaacs, S. (2019). *Towards the recognition of a Soweto boy's play capabilities in the formal education system* [Unpublished doctoral thesis]. University of Johannesburg.
- Jacobs, K. R. (2015). *The classroom implementation of indigenous knowledge in the science curriculum teachers in the Western Cape province, South Africa* [Unpublished PhD thesis]. University of Cape Town.
- Jansen, J. D. (1998). Curriculum reform in South Africa: A critical analysis of outcomes-based education. *Cambridge Journal of Education*, 28, 321-333.
- John-Steiner, V., & Mahn, H. (1996). Socio-cultural approaches to learning and development: A Vygotsky framework. *Educational Psychology*, 3, 191-206.
- Jones, M. G., & Rua, M. J. (2006). Conceptual representations of flu and microbial illness held by students, teachers, and medical professionals. *School Science and Mathematics*, 108(6), 263-278. <http://dx.doi.org/10.1111/j.1949-8594.2008.tb17836.x>
- Jokiranta, K. (2014). *The effectiveness of practical work in science education* [Unpublished doctoral thesis]. University of Jyväskylä.
- Kandjeo-Marenga, H. U. (2008). *A case study of the nature of Biology practical work in two secondary schools in Namibia* [Unpublished PhD thesis]. Western Cape University.
- Kambeyo, L., & Ngcoza, K. (2017). Using easily accessible resources to teach acids and bases: A Namibian Case Study. *International Journal of Educational Sciences*, 18(1-3), 47-55.
- Kapenda, H. M., Kandjeo-Marenga, H. U., Kasanda, C. D., & Lubben, F. (2002). Characteristics of practical work in science classrooms in Namibia. *Research in Science and Technology Education*, 20(1), 53-65.

- Kakambi, W. M. (2020). *Using the indigenous technology of dyeing and weaving African baskets as a cultural tool to mediate learning of chemical and physical changes* [Unpublished master's thesis]. Rhodes University.
- Kasanda, C., Lubben, F., Gaoseb, N., Kandjeo-Marenga, U., Kapenda, H., & Campbell, B. (2005). The role of everyday contexts in learner-centred teaching: The practice in Namibian secondary schools. *International Journal of Science Education*, 27(15), 1805-1823.
- Kasanda, C. D., & Kapenda, H. M. (2015). School learners' knowledge and views of traditional plant use in two regions in Namibia. In K. C-S. Chinsebu (ed.), *Indigenous knowledge of Namibia* (pp. 135-156). University of Namibia Press.
- Karatkevich, A. (2020). Environmental education and education for sustainable development. *Environmental Education Research*, 6(9), 2-34. <https://doi.org/10.46646/sakh-2020-1-173-177>
- Khupe, C., & Keane, M. (2017). Towards an African education research methodology: Decolonizing new knowledge. *Educational Research for Social Change*, 6(1), 25-37. <http://dx.doi.org/10.17159/2221-4070/2017/v6i1a3>
- Kozulin, A. (2003). Psychological tools and mediated learning. In A. Kozulin, B. Gindis, V. S. Ageyev & S. M. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 15-38). Cambridge University Press.
- Keane, M., Khupe, C., & Muza, B. (2016). It matters who you are: Indigenous knowledge research and researchers. *Education as Change*, 20(2), 145-162. <https://doi.org/10.17159/1947-9417/2016/913>
- Kibirige, I., & Hodi, T. (2013, October). Learners' Performance in Physical Sciences Using Laboratory Investigations. *International Journal of Educational Sciences*, 5(4), 425-432. <https://doi.org/10.1080/09751122.2013.11890104>
- Kibirige, I., & van Rooyen, H. (2006). Enriching science teaching through the inclusion of indigenous knowledge. In J. De Beers & H. van Rooyen (Eds.), *Teaching science in the OBE classroom*. Macmillan.

- Kibirige, I., & Tsamago, H. (2013). Learners' performance in physical sciences using laboratory investigations. *International Journal of Education Science*, 5(4), 425-432.
- Kind, V. (2009). Pedagogical content knowledge in science education: perspectives and potential for progress. *Studies in Science Education*, 45, 169-204.
- Klein, J. (2011). Indigenous knowledge and education - the case of the Nama people in Namibia. *Education as Change*, 15(1), 81-94.
- Kozulin, A. (2003). Psychological tools and mediated learning. In A. Kozulin, B. Gindis, V. S. Ageyev & S. M. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 15-38). Cambridge University Press.
- Koniceck-Moran, R., & Keeley, P. (2015). *Teaching for conceptual understanding in science*. NSTA Press.
- Kuhlane, Z. (2011). *An investigation into the benefits of integrating learners' prior everyday knowledge and experiences during the teaching and learning of acids and bases in Grade 7: A case study* [Unpublished master's thesis]. Rhodes University.
- Kurt, H., Ekici, G., Aktaş, M. & Aksu, Ö. (2013). Determining Biology student teachers' cognitive structure on the concept of "diffusion" through the free word-association test and the drawing-writing technique. *International Education Studies*, 6(9).
- Lavall'ee, L. F. (2009). Practical application of an indigenous research framework and two qualitative indigenous research methods: Sharing circles and Anishnaabe symbol-based reflection. *International Journal of Qualitative Methods*, 8(1), 21-40.
<https://doi.org/10.1177/1609406909000800103>.
- Le Grange, L. (2007). Integrating Western and indigenous knowledge systems: The basis for effective science education in South Africa? *International Review of Education*, 53(5- 6), 577-591.
- Lamb, D. (2013). Promoting the case for using a research journal to document and reflect on the research experience. *The Electronic Journal of Business Research Methods*, 11(2), 84-91.
- Lamm, Z. D. (2017). *Increasing student motivation and content knowledge through inquiry based teaching in Biology* [Unpublished master's thesis]. Montana State University.

- Leong, K. S. (2017). *The role of educational experiences on development of knowledge skills and dispositions of successful entrepreneurs in Hawai'i* [Unpublished PhD thesis]. University of Hawai'i.
- Lloyd, H. (2015). *Visual language*. Museum of New Zealand Te PaP Tongarewa.
- Liveve, A. K. (2022). *Revitalisation and indigenisation of the Science curriculum through drum making, drumming, music and dance* [Doctor of Philosophy]. Rhodes University.
- Mabingo, A. (2020). Ubuntu, indigenous communities, and dance practices in African cultures. In *Ubuntu as dance pedagogy in Uganda* (pp. 25-42). Palgrave Pivot.
- Mander, J. (2017). *How to use qualitative and quantitative research to your advantage*. <https://blog.globalwebindex.com/trends/qualitative-vs-quantitative>
- Maselwa, R., & Ngcoza, K. (2003). Hands-on, minds-on and words-on practical activities. *Proceedings of the Third International Conference on Science, Mathematics and Technology Education* (pp. 649-659). Rhodes University.
- Mapara, J. (2009). Indigenous knowledge systems in Zimbabwe. Juxtaposing postcolonial theory. *The Journal of Pan African Studies*, 3, 139-155.
- Mateus, V., & Ngcoza, K. M. (2019). The making of clay pots and its relevance to school science: reclaiming knowledge in the cultural practice of Ovawambo people in Namibia. *Indilinga African Journal of Indigenous Knowledge Systems*, 18(1), 64-77.
- Matemba, Y. H., & Lilemba, J. M. (2015). Challenging the status quo: Reclaiming Indigenous Knowledge through Namibia's postcolonial Education System. *Diaspora, Indigenous, and Minority Education*, 9, 159-174. <https://doi.org/10.1080/15595692.2014.99738>
- Mavhunga, E., & Rollnick, M. (2013). Improving PCK of chemical equilibrium in pre-service teachers. *African Journal of Research in Mathematics, Science and Technology Education*, 17(1-2), 113-125.
- Mavhunga, E., Ibrahim, B., Qhobela, M., & Rollnick, M. (2016). Student teachers' competence to transfer strategies for developing PCK for electric circuits to another physical sciences topic. *African Journal of Research in Mathematics, Science and Technology Education*, 20(3), 299-313.

- Mazibe, E. N., Coetzee, C., & Gaigher, E. (2020). A comparison between reported and enacted pedagogical content knowledge (PCK) about graphs of motion. *Research in Science Education, 50*, 941-964.
- Makabela, Q. N. (2015). Ubuntu as a foundation for researching African Indigenous Psychology. Indilinga. *African Journal of Indigenous Knowledge Systems, 4*(2), 284-291.
- Mhakure D., & Otulaja F. S. (2017) Culturally-responsive pedagogy in science education. In F. S. Otulaja & M. B. Ogunniyi (eds.), *The world of science education. Cultural and historical perspectives on science education: Handbooks*. Sense Publishers.
- Mavuru, L., & Ramnarain, U. (2017). Teachers' knowledge and views on the use of learners' sociocultural background in teaching natural sciences in Grade 9 township classes. *African Journal of Research in Mathematics, Science and Technology Education, 21*(2), 176-186.
- Mavuru, L., & Ramnarain, U. (2020). Learners' sociocultural backgrounds and science teaching and learning: A case study of township schools in South Africa. *Cultural Studies of Science Education*. <https://doi.org/10.1007/s11422-020-09974-8>
- Mavuru, L., & Dudu, W. (2021). Advances in inquiry-based science education in Zimbabwean schools. In U. Ramnarain (Ed.), *School science practical work in Africa* (pp. 32-49). Routledge.
- Maxwell, J. (2012). *A realist approach for qualitative research*. Sage.
- Mawere, M. (2015). Indigenous knowledge and public education in sub-Saharan Africa. *Africa Spectrum, 50*(2), 57-71.
- Maree, K. (2016). *First step in research*. Van Schaik Publishers.
- Mbembe, A. (2021). *Out of the dark: Essays on decolonization*. Columbia University Press.
- McMillan, J. H., & Schumacher, S. (2006). *Research in education: Evidence based inquiry* (6th ed.). Pearson education.
- McRobbie, C., & Tobin, K. (1997). A social constructivist perspective on learning environments. *International Journal of Science Education, 19*(2), 193-208.

- Millar, R. (2004). *The role of practical work in the teaching and learning of science. High school laboratories: Role and vision*. National Academy of Sciences.
- Millar, R. (2010). *Developing students' understanding of science: The role of practical work*. Metodelab conference, lecture notes, University of York.
- Miller, R. (2011). *Vygotsky in perspective*. Cambridge University Press.
- Mills, G. E. (2011). *Action research: A guide for the teacher researcher* (4th ed.). Pearson Education.
- Mika, R. (2018). *Exploring an effect of an intervention on the integration of local knowledge in Grade 9 Physical Science lessons* [Unpublished master's thesis]. Rhodes University.
- Mensah, D. (2015). *Using improvised instructional materials to teach chemical methods. Independent study*. New Mexico Tech: Educational and Psychology Department.
- Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.
- Merriam, S. (2009). *Qualitative research; A guide to design and implementation* (2nd). Jossey-Bass.
- Msimanga, A. S. (2013). *Talking science in South African high schools: Case studies of Grade 10–12 classes in Soweto* [Unpublished PhD thesis]. University of the Witwatersrand.
- Msimanga, A., & Lelliott, A. (2014) Talking science in multilingual contexts in South Africa: Possibilities and challenges for engagement in learners home languages in high school classrooms. *International Journal of Science Education*, 36(7), 1159-1183.
- Mandikonza, C. (2007). *Relating indigenous knowledge practices and science concepts: An exploratory case study in a secondary school teacher-training programme* [Unpublished master's thesis]. Rhodes University.
- Moser, S. (2008). Personality: A new positionality? *Area*, 40, 383-392.
- Mothwa, M. M. (2011). *Teachers' experiences of incorporating indigenous knowledge in Life Sciences* [Unpublished doctoral thesis]. University of Johannesburg.

- Mubita, C. (1998). Learner-centered education for societal transformation: An overview. *Journal for Education Reform in Namibia*, 5, 1-18.
- Mukwambo, M. (2016). Trainee teachers' experiences using contextual teaching and learning: Implications for incorporation of indigenous knowledge in instructional design. *Pedagogical Research*, 1(1), 3-12. <https://doi.org/10.20897/lectito.201611>
- Mukwambo, M. (2017). *Exploring and expanding situated cognition in teaching science concepts: The nexus of indigenous knowledge and Western modern science* [Unpublished doctoral thesis]. Rhodes University
- Mukwambo, M., Ngoza, K., & Chikunda, C. (2014). Africanisation, ubuntu and IKS: A learner-centered approach. In C.I.O. Okeke, M. M. van Wyk & N. T. Phasha (Eds.), *Schooling, society and inclusive education: An African perspective* (pp. 65-80). Oxford University Press.
- Mutanho, C. (2021). *Exploring indigenising the university's science curriculum through bottom up decolonisation: Affordances and hindrances* [Unpublished doctoral thesis]. Rhodes University.
- Mutanho, C. (2016). *Understanding how the incorporation of indigenous knowledge (IK) enables or constrains the teaching and learning of alcoholic fermentation in Life Sciences in Grade 11* [Unpublished master's thesis]. Rhodes University.
- Mushayikwa, E., & Lubben, F. (2009). Self-directed professional development: Hope for teachers working in deprived environments? *Teaching and Teacher Education*, 25, 375-382.
- Ministry of Education and Culture. (1993). *Toward education for all: A development brief for education, culture and training*. NIED.
- Ministry of Basic Education and Culture. (1999). *How learner centred are you?* NIED.
- Ministry of Education. (2010). *National Curriculum for Basic Education*. NIED.
- Ministry of Education, Arts and Culture. (2016). *Life Science, Grade 8-9*. NIED.
- Ministry of Education. (2014). *Report on the examinations JSC*. DNEA.

- Ministry of Education. (2015). *Report on the examinations JSC*. DNEA.
- Ministry of Education. (2016). *Report on the examinations JSC*. DNEA.
- Ministry of Education. (2017). *Report on the examinations JSC*. DNEA.
- Ministry of Education. (2018). *Report on the examinations JSC*. DNEA.
- Ministry of Education. (2018). *Report on the examination NSSCO*. DNEA.
- Ministry of Education. (2019). *Report on the examination NSSCO*. DNEA.
- Ministry of Education. (2020). *Report on the examination NSSCO*. DNEA.
- Ministry of Education. (2021). *Report on the examination NSSCO*. DNEA.
- National Planning Commission. (2004). *Vision 2030*. https://www.npc.gov.na/wp-content/uploads/2021/11/vision_2030.pdf
- National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. National Academy Press.
- Nangolo, S. N. (2018). *Exploring how Grade 11 Biology teachers mediate learning of osmosis when using easily accessible resources* [Unpublished master's thesis]. Rhodes University.
- Naidoo, P. D., & Vithal, R. (2014). Teacher approaches to introducing indigenous knowledge in school science classrooms. *African Journal of Research in Mathematics, Science and Technology Education*, 18(3), 253-263.
- Nakale, E. (2012). *Understanding how teachers scaffold learners to make sense of biological language and concepts when using English as a mediational tool: A case study* [Unpublished master's thesis]. Rhodes University.
- Ndevahoma, M. K. (2019). *Enactment of hands-on practical activities through using easily accessible resources in a Grade 10 Physical Science classroom* [Unpublished master's thesis]. Rhodes University.
- Nyamakuti, M. (2021). *The effect of the indigenous practice of oil extraction on Grade 10 Biology learners' conceptions, dispositions, and sense making of enzymes* [Unpublished master's thesis]. Rhodes University.

- Neuman, L. W. (2011). *Social research methods: Qualitative and quantitative approaches* (7th ed.). Pearson.
- Ngcoza, K. M., & Southwood, S. (2015). Professional development networks: From transmission to co-construction. *Perspectives in Education*, 33(1), 4-14.
- Ngcoza, K., & Southwood, S. (2019). Webs of development: professional networks as spaces for learning. *Pythagoras*, 40(1).
- Nguyane, N., McFadden, A., Tangen, O., & Beutel, D. (2013). *Video-stimulated recal interviews in qualitative research. Joint AARE Annual Conference*. Queensland University of Technology.
- Nhase, Z. (2019). *An exploration of how Grade 3 Foundation Phase teachers develop basic scientific process skills using inquiry-based approach in their classrooms* [Unpublished PhD thesis]. Rhodes University.
- Nhase, Z., Okeke, C. I., & Ugwuanyi, C. S. (2021, June 30). Using an inquiry-based approach to enhance Grade 3 learners' basic science concepts development. *Cypriot Journal of Educational Sciences*, 16(3), 1065-1072. <https://doi.org/10.18844/cjes.v16i3.5825>
- Nikodemus, K. S. (2017). *Exploring how Grade 11 Physical Science learners make sense of the concept of rates of reactions through the inclusion of the indigenous practice of making oshikundu: A Namibian case study* [Unpublished master's thesis]. Rhodes University.
- Nieuwenhuis, J. (2007). Qualitative research designs and data gathering techniques. In K. Maree (ed.), *First steps in research* (pp. 70-97). Van Schaik.
- Nsingo, L. (2015). *The use of examiners' reports in Biology instruction: A case of Kavango East educational region, Namibia* [Unpublished master's thesis]. University of Namibia.
- Nuntsu, S. N. (2020). *Mobilising stories about cultural beliefs and practices on traditional foods to contextualise the topic on nutrition in a Grade 6 township class* [Unpublished master's thesis]. Rhodes University.
- Nyambe, K. J. (2008). *Teacher educators' interpretation and practice of learner-centered pedagogy* [Unpublished PhD thesis]. Rhodes University.

- Nyambe, J. K., & Wilmot, D. (2012). New pedagogy, old pedagogic structures: A fork-tongued discourse in Namibian teacher education reform. *Journal of Education, 55*, 55-82.
- Nyika, R. (2017). Views and experiences of Gweru rural primary school teachers on integrating indigenous knowledge system in the teaching and learning of environmental science in Zimbabwe. *Scholars Journal of Art, Humanities and Social Sciences, 5*(4A), 280-286.
- Okeke, C. (2014). The meaning and practice of educational theory. In C. Okeke, M. van Wyk & N. Phasha (Eds.), *Schooling, society and inclusive education: An African perspective* (pp. 65-80). Oxford University Press.
- O'Leary, Z. (2014). *The essential guide to doing your research project* (2nd ed.). Sage.
- Oloruntegbe, K. O., & Ikpe, A. (2010). Ecocultural factors in students' ability to relate science concepts learned at school and experienced at home: Implications for chemistry education. *Journal of Chemical Education, 88*(3), 266-271.
- Ogunniyi, M. B. (2007a). Teacher's stances and practical arguments regarding a science-indigenous knowledge curriculum: Part 1. *International Journal of Science Education 29*(8), 963-986.
- Ogunniyi, M. B., & Hewson, M. G. (2008). Effect of an argumentation-based course on teachers' disposition towards a science-indigenous knowledge curriculum. *International Journal of Environmental and Science Education, 3*(4), 159-177.
- Ogunniyi, M. B., & Ogawa, M. (2008). The prospects and challenges of training South African and Japanese educators to enact an indigenised science curriculum. *International Journal of Science Education, 29*(8), 963-986.
- Onwu, G. O. (2012). Cultural issues in science education in South Africa. *Journal of African Culture and International Understanding, 1*(2), 1-24.
- Orngreen, R., & Levinsen, T. (2017). Workshops as a research methodology. *Electronic Journal of Learning, 15*(1), 70-81.
- Oviawe, J. O. (2016). How to rediscover the Ubuntu paradigm in education. *International Review of Education, 62*, 1-10.

- Oztas, F. (2013). High school students' difficulties in understanding diffusion & osmosis. *Procedia Social and Behavioral Sciences*, 116, 3679-3682.
- Oztas, F., & Bozkurt, E. (2010). Biology teacher candidates' misconceptions about surface tension, adhesion and cohesion. 2nd World Conference on Educational Sciences (WCES-2010), Bahcesehir Univ, Istanbul, Turkey, February 04-08, 2010. *Innovations and Creativity in Education Book Series: Procedia Social and Behavioral Sciences Volume: 2(2)*, 5700-5705.
- Oztas, F., & Oztas, H. (2012) Biology teacher candidates' alternative conceptions about the human respiration and source of metabolic energy. *Energy Education Science and Technology Part B-Social and Educational Studies*, 4(2), 749-756.
- Poni, M. (2014). Research paradigms in education. *Journal of Educational and Social Research*, 4(1). <https://doi.org/10.5901/jesr.2014.v4n1p407>
- Reitano, P. (2005). Using video stimulated recall and concept mapping in reflective teaching practice: Strengths, limitations and potential threats. In *Teacher education local and global* (pp. 382-389). Department of Education, Science and Training for Conference Publications.
- Roschelle, J. (1995). *Learning in interactive environments: Prior knowledge and new experience*. <http://www.exploratorium.edu>
- Rout, S., & Behera, S. K. (2014). Constructivist approach in teacher professional development: An overview. *American Journal of Educational Research*, 2(12A), 8-12.
- Rubstov, V. V. (2016). Cultural-historical scientific school: The issues that L.S. Vygotsky brought up. *Cultural-Historical Psychology*, 12(3), 4-14.
- Rutledge, M., & Mitchell, M. A. (2002). High school biology teachers' knowledge structure, acceptance and teaching of evolution. *The American Biology Teacher*, 64(1), 21-28.
- Rundgren, S. N.C., & Yao, B.J. (2014). Visualisation in research and science teachers' professional development. *Asia-Pacific Forum on Science Learning and Teaching*, 15(2), 1-21.

- Runhaar, P. (2008). *Promoting teachers' professional development* [Unpublished doctoral dissertation]. University of Twente.
- Samuel, P. (2017). *Investigating how Grade 10 Physical Science teachers help learners to make sense of concepts of electromagnetism using easily accessible materials in under-resourced schools* [Unpublished master's thesis]. Rhodes University.
- Salami, I., & Olotu, M. (2014). Teachers' awareness and improvisation skills of scientific visual resources as determinant of pupils learning outcomes in basic science and technology. *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, 19(2), 26-32.
- Saldana, J. (2009). *The coding manual for qualitative researchers*. Sage.
- Sallis, E. (2002). *Total quality management in education*. Taylor & Francis.
- Sawyer, R. K. (2008). Optimising learning: Implications of learning science research. In *Innovating to learn, learning to innovate* (pp. 45-65).
<https://doi.org/10.1787/9789264047983-en>
- Science Community Representing Education (SCORE). (2008). *Practical work in science: A report and proposal for a strategic framework*. Gatsby Technical Education Project.
- Sedlacek, M., & Sedova, K. (2017). How many are talking? The role of collectivity in dialogic teaching. *International Journal of Educational Research*, 85, 99-108.
- Seehawer, M. (2018). Decolonising research in a Sub-Saharan African context: Exploring Ubuntu as a foundation for research methodology, ethics and agenda. *International Journal of Social Research Methodology*.
<https://doi.org/10.1080/13645579.2018.1432404>
- Seehawer, M. (2018). South African science teachers' strategies for integrating indigenous and Western knowledge in their classes: Practical lessons in decolonisation. *Educational Research for Social Change (ERSC)*, 7, 91-110. <https://doi.org/10.17159/2221-4070/2018/v7i0a7>
- Seehawer, M., & Breidlid, A. (2021). Dialogue between epistemologies as quality education. Integrating knowledge in sub-Sahara Africa classrooms to foster sustainability learning and contextually relevant education. *Social Science and Humanities Open*, 4, 1-8.

- Simasiku, F.S. (2022). *The use of peer-learning communities and community experts in integrating indigenous knowledge into Grade 10 chemistry learning and teaching* [Unpublished PhD thesis]. Rhodes University.
- Simasiku, F. S., & Ngcoza, K. (2019). Cross fertilization of ideas between indigenous knowledge and western science: The complexity of including indigenous knowledge in science lessons. *Southern African Association for Research in Mathematics, Science and Technology Education*, 718-722.
- Simpson, L. B. (2014). Land as pedagogy: Nishnaabeg intelligence and rebellious transformation. *Decolonization: Indigeneity*, 3(3), 1-25.
- Simsek, P., & Kabapinar, K. (2010). The effect of inquiry-based learning on elementary students' conceptual understanding of matter, scientific process skills and science attitudes. *Procedia, Social and Behavioural Sciences*, 2, 1190-1194.
- Schmid, S., & Bogner, X. F. (2015). Does inquiry-learning support long-term retention of knowledge? *International Journal of Learning, Teaching and Educational Research*, 10(4), 51-70.
- Singh, G., & Richards, J. C. (2006). Teaching and learning in the language teacher education course room: A critical sociocultural perspective. *RELC Journal*, 37, 149-175.
<https://doi.org/10.1177/0033688206067426>
- Shinana, E. N. (2019). *Mobilizing the indigenous practice of making Oshikundu using the inquiry method to support Grade 8 Life Science teachers in mediating learning of enzymes* [Unpublished master's thesis]. Rhodes University.
- Shinana, E., Ngcoza, K. M., & Mavhunga, E. (2021). Development of teachers' PCK for a scientific inquiry-based teaching approach in Namibia's rural schools. *African Journal of Research in Mathematics, Science and Technology Education*.
<https://doi.org/10.1080/18117295.2021.1913375>
- Shizha, E. (2007). Critical analysis of problems encountered in incorporating indigenous knowledge in science teaching by primary school teachers in Zimbabwe. *Alberta Journal of Educational Research*, 53, 302-319.

- Shizha, E. (2013). *Indigenous discourses on knowledge and development in Africa*. Routledge.
- Shimwandi, T. *A base line of environmental knowledge and activities amongst learners in Erongo region, Namibia* [Unpublished PhD thesis]. Namibian University of Science and Technology.
- Shabani, K. (2016). Application of Vygotsky's sociocultural approach for teachers' professional development. *Cogent Education*, 3, 2-10.
- Shulman, L. S. (1986). *Those who understand: Knowledge growth in teaching*. Educational Researcher.
- Shulman, L. S. (1987). Knowledge and teaching: Foundations of new reform. *Harvard Educational Review*, 57(1), 1-21.
- Snively, G. J., & Williams, L. B. (2008). "Coming to know": Weaving Aboriginal and Western science knowledge, language and literacy into the science classroom. *L1- Educational Studies in Language and Literature*, 8(1), 109-133.
- Tam, A. C. F. (2015). The role of a professional learning community in teacher change: a perspective from beliefs and practices. *Teachers and Teaching*, 2, 22-43.
<https://doi.org/10.1080/13540602.2014.928122>
- Tan, R. M., Yangco, R. T., & Que, E. N. (2020). Students' conceptual understanding and science process skills in an inquiry-based flipped classroom environment. *Malaysian Journal of Learning & Instruction*, 17(1), 159-184.
- Taylor, N. (1999). Curriculum 2005: Finding a balance between school and everyday knowledges. In N. Taylor, & P. Vinjevold (Eds.), *Getting learning right: Report of the President's Education Initiative Research Project* (pp. 105-130). Joint Education Trust.
- Taylor, D. L., & Cameron, A. (2016). Valuing IKS in successive South African physical sciences curricula. *African Journal of Research in Mathematics, Science and Technology Education*, 20(1), 35-44. <https://doi.org/10.1080/10288457.2016.1147800>
- Teddle, C., & Tashakkori, A. (2009a). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Sage.

- Tekumru-Kisa, M., & Stein, K. M. (2017). Designing, facilitating, and scaling -up video based professional development: supporting complex forms of teaching in science and mathematics. *International Journal of STEM education*, 4(27), 3-9.
- Thangeda, A., Baratiseng, B., & Mompati2, T. (2016). Education for sustainability: Quality education is a necessity in modern day. How far do the educational institutions facilitate quality education? *Journal of Education and Practice*, 7(2), 3-12. <https://doi.org/ISSN2222-1735>
- Thomas, G. (2013). *How to do your research project: A guide for students in education and applied social sciences* (2nd ed.). Sage.
- Topçiu, M., & Myftiu, J. (2015). Vygotsky theory on social interaction and its influence on the development of pre-school children. *European Journal of Social Sciences Education and Research*, 2(3), 172-179.
- Toplis, R., & Allen, M. (2012). 'I do and I understand?' Practical work and laboratory use in United Kingdom schools. *EURASIA Journal of Mathematics, Science & Technology Education*, 8, 3- 9.
- van Teijlingen, E. (2014). *Semi-structured interviews*. Bournemouth University.
- Vygotsky, L. S. (1978). *Mind in society: Interaction between learning and development*. Harvard University Press.
- Venter, E. (2004). The notion of ubuntu and communalism in African educational discourse. *Studies in Philosophy and Education*, 23, 149-160.
- Viennot, L. (2008). Learning and conceptual understanding: Beyond simplistic ideas, what have we learned? In M. Vincentini, & E. Sassi (Eds.), *Connecting research in physics education with teacher education* (pp. 1-17). International and Pan American Copyright Conventions.
- Wang, D. (2019). *Multilingualism and translanguaging in Chinese classrooms*. Pallgrave Macmillan. <https://doi.org/10.1007/978-3-030-02529-8>
- Wahyuni, D. (2012). The research design maze: Understanding paradigms, cases, methods and methodologies. *Journal of Applied Management Accounting Research*, 10, 69-80.

- Woodley, E. (2009). Practical work in school science –Why is it important? *School Science Review*, 91,49-51.
- Wilson, S. (2008). *Research as ceremony: Indigenous research methods*. Fernwood Press.
- Wiebe, E., Clark, A., & Haase, E. (2001). Scientific visualisation: Linking science and technology education through graphic communication. *Journal of Design and Technology Education*, 6(1), 1360-1431.
- Wyatt, T. R., de Dousa, E. B. C., & Mendenhall, S. C. (2017). Professional development as a process of cultural brokering: Positioning coaches as cultural brokers. *Journal of Educational Research and Practice*, 7, 95-110.
- Yin, R. K. (2015). *Qualitative research from start to finish*. Guilford Publications.
- Yitbarek, S. (2012). Low-cost apparatus from locally available materials for teaching-learning science. *African Journal of Chemical Education*, 2(1).
- Zohar, A., & Dori, Y. J. (2003). Higher order thinking skills and low achieving students: Are they mutually exclusive? *Journal of the Learning Sciences*, 12, 145-183.
- Yuksel, G., & Alci, B. (2012). Self efficacy and critical thinking as predictors of success in school practicum. *International Online Journal of Educational Sciences*, 4(1), 81-90.
- Zuckerman, J. T. (1998). Representations of an osmosis problem. *American Biology Teacher*, 60(1), 27-30.

Appendices

Appendix A: Ethical Clearance



Ms Endjala Alma Panduleni
cc. Prof K Ngozoa
Faculty of Education
Rhodes University

15 September 2020

Dear Ms Panduleni,

Research Ethics Clearance for Endjala Alma Panduleni 17E8182 (M.Ed.)

Ethics Clearance Number 2020-05/5.

I hereby grant full research ethics approval for your M.Ed. study titled "Exploring how the traditional practice of making Oshikunda can be mobilised by Grade 8 Life Science teachers to mediate learning of diffusion in their classrooms".

We have received a permission letter from the authority: **Otjozondjupa Regional Council: Directorate Education, Arts and Culture, Namibia.**

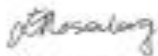
I bring to your attention the following conditions outlined in this permission letter:

- Omalavu has to be non-alcoholic (noted that you have changed to oshikunda)
- Children younger than 18 should be under the supervision of a teacher
- The research should under no circumstances disrupt teaching or learning

Approval is granted for one year. A progress report will be requested in order to renew approval at the end of 2020. Please notify the Committee Chair should any substantive change(s) that deviate from this application, be made during the research process. Please also provide a brief report to the Committee on the completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, or if any problems arose that the ethical standards committee should be aware of. If the research results in the completion of a thesis lodged in the Rhodes University Library, please provide the Committee with the details of the submission as well.

Kindly safeguard this approval letter as it will be required for examination and publishing purposes.

I wish you every success with your research.



Prof Ereta Rosenberg (E.Rosenberg@ru.ac.za)
Education Faculty Ethics Chair

CC: Mr Siyanda Manqele, Rhodes University Research Ethics Coordinator

Appendix B: Directorate Letter of Consent



REPUBLIC OF NAMIBIA
OTJOZONDJUPA REGIONAL COUNCIL



DIRECTORATE OF EDUCATION, ARTS AND CULTURE

"Committed and Dedicated For Quality Education"

Tel no: 264 67 308000
Fax no: 264 67 304871
Enq: J. Siliso
Email: ja@oec058@gmail.com

Private Bag 2018
Erf. 280, Scaevog Street
OTJAWARONGO
Namibia

10 June 2020

Ref No: 14/9/10

Student Number: 17E8182 (M.Ed.)
Endjala Alma Pandufeni
Rhodes University

Dear Ms. Endjala

SUBJECT: PERMISSION TO CONDUCT RESEARCH IN THE REGION

Your letter dated 14 May 2020 bears reference and is hereby acknowledged.

Regarding the above mentioned subject, the Directorate of Education, Arts and Culture is pleased to inform you that permission is granted as per your request to conduct a research study titled "exploring how the traditional practice of making Omalavu can be mobilized by Grade 8 Life Science teachers to mediate learning of diffusion in their classrooms".

You are kindly requested to make sure that, the research process should by no means whatsoever disrupt the teaching and learning at schools. The Omalavu should be non-alcoholic as it is not allowed in schools. You are also reminded that children under the age of 18 should be strictly under the supervision of teachers.

Your cooperation in this regard will be highly appreciated.

Yours faithfully


MS. J. MUTENDA
REGIONAL DIRECTOR

All official correspondence must be addressed to The Regional Director

Appendix C: Principal letter of Consent

 +264 81 4620 336
+264 85 4620 336

 jgvanderwath21@gmail.com

 P O Box 40
OKAHANDJA



J.G. VAN DER WATH
Est. 1921
SECONDARY SCHOOL

Ref: Mr R. B Williams

10 June 2020

To
Mrs A. P. Endjala

RE: PERMISSION TO CONDUCT A RESEARCH PROJECT WITH TEACHERS AT J.G.VAN DER WATH SECONDARY SCHOOL.

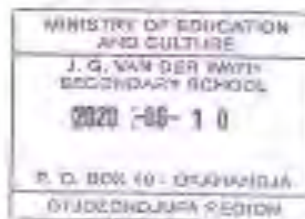
With reference to your letter dated 05 June seeking permission from the principal to conduct research at our school in connection of your master's degree in Education at the University of Namibia. Permission is hereby granted for you to carry out your research at the

It is very important that your research does not interfere with the normal teaching and learning process at school and that participation is on voluntary basis.

Thank you for allowing interest to conduct research at our school. It is our sincere hope that the information you are going to get will be quite useful to your education career.

Yours faithfully,


Robert Williams



BOARD MEMBERS: Mr R. Williams (Principal), Mr B. Epinge (Chairperson), Ms A. Gawona (Secretary), Ms I. van Niek (Treasurer),
Mr J. Nankwamba, Mr J. Ndjiverine-Muesse, Ms O. Kambooge-Combwe, Mr I. Mijona, Mr J. Tjipane,
Ms SN. Mesties, Ms P. Nelongo (Head girl), Mr N. Mijona (Head boy).

Appendix D: Teachers' Consent Letter

Letter to Teachers

Dear Sir/ Madam

Re: Participation in research on the integration of local or Indigenous Knowledge when teaching diffusion.

I am Alma Endjala, a part-time student doing master's in science Education at Rhodes University, South Africa. I hereby humbly request your permission to be a research participant in my research project. I plan to conduct the study for about two weeks in June/July 2019-2020.

The focus of the study will be on *diffusion*, and it will be conducted in six phases. In the first phase we will have an orientation workshop of which I am going to give an overview of the study. In workshop one we will analyse curriculum documents to understand context for the study. Moreover, one community member will run the workshop on how to make *oshikundu*. In the last workshop we are going to reflect and co-develop model lessons that integrate the knowledge shared by the community members.

Kindly be informed that your participation in this research study is completely voluntary and you can withdraw at any time you wish. I will ensure that your identity and views will be treated with high degree of confidentiality. It is recognised, however, that anonymity might be a challenge since we will be working together in this research project. Nonetheless, data that will be gathered will not be used for other purposes apart from this study.

If you have any questions about the research, please feel free to contact me at 0814677065, almahailapa@gmail.com or my supervisors Prof Ngcoza at k.ngcoza@ru.ac.za and Ms Zukiswa Kuhlane, z.kuhlane@ru.ac.za, or S.Manqele@ru.ac.za for any ethical issues that may arise.

I henceforth request you to indicate your choice regarding attending the workshops, to be interviewed, video-recorded and to complete a journal by ticking [√] in the appropriate box below.

Agree Not agree Signature:

Your cooperation will be highly appreciated

Yours Sincerely

Alma Endjala

Appendix E: Letter to the Expert Community Member [English]

Dear Sir/Madam

Re: Participation in research on the integration of Indigenous knowledge in science

My name is Alma Panduleni Hailapa-Endjala, currently registered as a part-time master’s full thesis in Science Education student (student number: 17E8182) at Rhodes University. I write to kindly request you to participate in my study. My research area is investigating how Life Science teachers integrate indigenous knowledge in their classes when teaching diffusion, and develop model lessons that integrate IK in their teaching.

The study will involve an intervention comprising of one workshops from the community member of which you are going to present how to make *oshikundu*. Being someone knowledgeable about the practice of making *oshikundu*, I trust that you can run a workshop for teachers on how to make *oshikundu*.

Your participation in this research study will be highly appreciated and is completely voluntary which means that you can withdraw at any time if you wish to do so. The data collected in this study will only be used for academic purposes and shall not be released to anyone else without your consent. I also ask for your permission to take videos of the demonstrations so that I can be able to analyse the lessons after the workshops. Your identity, views or contributions will be treated with a high degree of confidentiality and anonymity.

For more information you may contact my supervisors Prof Kenneth Ngcoza (E-mail: K.Ngcoza@ru.ac.za) and Ms Zukiswa Kuhlane (E-mail: z.kuhlane@ru.ac.za) or S.Manqele@ru.ac.za for any ethical issues that may arise.

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

Agree Not agree

Signature:

Yours sincerely

Alma Endjala

DECLARATION BY PARTICIPANT

I agree to participate in the research and I understand that I am free to withdraw at any time.

Name.....

Signature..... Contact number.....

Appendix F: Semi-structured Interview Schedule



RHODES UNIVERSITY

Where leaders learn

Semi-structured interviews protocol for Teachers

Research Title

Exploring how the traditional practice of making *Oshikundu* can be mobilised through workshops with Grade 8 Life Science teachers to mediate learning of diffusion in their classrooms.

Question 1

What is the Grade 8 Life Science teachers' perspectives and pedagogical insights on integrating local knowledge in their teaching?

1. What do you understand by the term local knowledge?
2. What are your views on the integration of local knowledge in science lessons (diffusion concept)?
3. What are the advantages of integrating learners' local knowledge in the teaching of the topic of diffusion?
4. What are the disadvantages of integrating IK in the teaching of the topic of diffusion?
5. State the topics in Life Science Grade 8 syllabus that offers you're the opportunity to integrate local or indigenous knowledge in your lesson presentation?

Appendix G(a): Collated Teachers Responses for Semi-Structured Interviews

The semi-structured interview

Local /IK definition

T1

If one has to talk about it you have to look at what people use for example material within our local environment. We are having some materials that are natural laying in our environment we can use it for the knowledge or develop knowledge for the learners. For example, there are manmade and made by scientific world. But they are not part of us in Namibia or rather Africa. The moment we use our local materials to teach our learners things that they are exposed to then we are talking about local knowledge and we develop it from there.

T2

For me it is basically learners coming with bring with to class or the knowledge that learners are exposed to at home or in their society.

T3

Local knowledge for me as a teacher I believe that this are skills or the knowledge that you can associate or integrate on you own basically from the resources you have around you so it is the knowledge you learn in your environment.

Importance of IK in our teaching

T1

Off Course it is very important if you have to go back to Cambridge examination, you will find a Life Science question paper having typical examples of people in Europe. That is not based on us. To integrate what is happening currently here, for example you are teaching a topic fermentation, brewing of oshikundu, making of ombike or mangu depend from different cultural background. the learners could be able to relate because they are already exposed to those local activities our

grand parents have invented some of these activities, but they do not understand the scientific part of it. But these days when we have to integrate using those examples off cause learners will be able to open up and understand the science knowledge.

T2

Yes, it can be very is important because it can be used as the base on which teachers build on with the content. Otherwise, learners can understand better with that knowledge that they bring with to class. I mean I think that is very important because as for me it is something that I think I incorporate. Not to say on daily basis but ah in some case like you mentioned diffusion you can mention making a cup of tea, could be one simple example that can be used for diffusion.

T3

Yes mem it is very much important in order for us as teacher to make sure that the learners understand what we are teaching them it is better for them to relate it to what they know already other than teaching them abstract so in terms of the topic at hand it is important that the kids should use the local materials that they are aware of how to manipulate and this can enhance their understanding. So local knowledge is very much imperative in this case in science in order for our kids to understand all the concepts that we teach.

Advantages of integration of local/IK

T1

Yes, of cause our science is still very young not just in Namibia but in Africa. Ahh, the more we use some things that learners know then we cannot limit them. They can even develop more knowledge of science. You know if we are using things that are already in existence the learners can be able to grow more and come up with some new things. If we are local knowledge, we are applying what is already in existence. This is a steppingstone to assist learners to move from point one to two in science. Off course we are more in theory. But the more we bring these typical examples that involve practical's activities the learners can discover and come up with new knowledge.

T2

It can be and it is an adv because the learners have this knowledge of how the tea is moving from the tea bag into the water, nee and from the beginning one or the learners can see the changes that are happening. And if you have to use this example in the class room the learners will understand better and will be able to apply these theories when given practical examples in the exam or in their activities.

T3

Yes, for me as a teacher I see that local knowledge always make it permanent. The kids can relate to local materials in order to carry out the either an experiments or a project it remains permanent other than the foreign stuff that they are not quite converse with. So, for me the benefit is really that it makes it more perfect in the kids. The techniques or the skill they get go with them all the way to high institutions

Disadvantages

T1

One of the problems that I have to bring in is our indigenous languages. Most of the typical examples that I gave you are presented in indigenous languages. Even our fore parents can do things that are scientific but thy do not understand it in scientific manner. the usage of language can be a disadvantage because our official language is English so for example if we want to understand something deeper, there is a language barrier. Like these days some of our learners cannot speak their home languages therefor for them to understand something that we take for example from our elders from the villages who cannot express themselves properly in English I think that would be a challenge because to get all the straight information translated from one

language to another you will lose some very important information. Therefore, if one could use indigenous languages where we apply it in science such Physical Science can be taught in any other local language from Namibia the content being transferred can make sense. so the transferee of information from one language to another create a barrier because the information will not be given to the extent it was supposed to be. But then again, some scientific words are also not in local languages such as in Oshiwambo or Rukwangali and some knowledge can become lost in the process of transferring between English and local languages.

T2

A very huge disadvantage will be misconceptions because it is time consuming and because you can not only take one child's ideas you have to listen to all other learners' ideas, and also it can be a disadvantage one way, or it can be an advantage. the misconception, because if learners come to class with misconceptions, it might take a teacher also time to make them understand. certain contents but also it can be a learning curve for some of the learners as moving from a misconception to something which is real. learners can get to learn what the difference between what is wrong and what is right. Also, not all learners come from the same communities so the teachers would be required to sought more information in order to accommodate all learners.

T3

The disadvantage will be that because in local language we do not have the English terms that we have in the syllabus so sometimes it become difficult for us as teachers to explain the terms that are used in most cases, they are more abstract to them for us to translate that into our local languages from English it takes a very cumbersome process for them. but in any other case we try as much to integrate as much of their local knowledge into the English languages most of these subjects are written in English we do not have them so the terminologies might even be differ. So those are some of the challenges that we face.

Topics in Life Science where integration is happening.

T1

Off cause at some points yes at some points no. because already most of the concepts the way they are made that are not made for use. If you look at the written sources (textbooks) of information, but off cause I remember in Life Science there is a topic that look at adaptation of plants to arid conditions. Local plants are given as examples and how they survive the harsh conditions. Example, welvitchia, Nara and Mopane tree. When I teach the dessert ecosystem, I like to refer learners to karas surrounded by the desert and the sea in walvisbay and Swakopmund. The savannah is where we are.

Some of the things we teach they are the in the Western culture even the education system is not our own system. We do not have our own system. Other than borrowing others cultural backgrounds. another example I can remember traditional medicines and scientific medicines. So, integration is there but not where it is supposed to be.

T2

Passage of substances

Health education

T3

Ecology and health education

Appendix G(b): Themes from Teachers Semi-Structured Interviews

Table 4.3: Themes and sub-themes that emerged from the SCI

Research question 1: What are Grade 8 Life Science teachers' perspectives and pedagogical insights on integrating local knowledge in their teaching?		
Themes	Sub-themes	Literature/Theory
Teachers' understanding of the term indigenous knowledge	<ul style="list-style-type: none"> ▪ Understanding of the term IK ▪ Learners' prior knowledge ▪ Easily accessible resources 	Mosimege and Onwu (2004); Kibirige and Van Rooyen (2006); Roschelle (1995); Tylor (1999); Kuhlana (2011); Dziva et al. (2011); Higgs (2010); Mukwambo et al. (2014); Matemba and Lilemba (2015); Tylor and Cameron (2016); Mavuru and Ramnarian (2017)
Teachers' experiences and pedagogical insights in the integration of IK in the teaching of Life Science.	<ul style="list-style-type: none"> ▪ Benefit of integration of IK <p>Knowledge construction, Hands-on practical experience, Visualisation, Discovery learning, Sensemaking, conceptual understanding, retention, Mediation.</p> <ul style="list-style-type: none"> ▪ Disadvantages of integration of IK <p>Language barrier, Translanguing, Misconceptions, time consuming, cultural diversity.</p>	<p>Kuhlana (2011); Shulman (1986); Fataar, (2012); Kibirige and Van Rooyen (2006); Hashondili (2020); Mukwambo et al. (2014) Mavhunga and Rollnick (2013) Shinana (2019)</p>

Link between Life Science and indigenous knowledge	<ul style="list-style-type: none">▪ Contextualisation▪ Sense making▪ Facilitate interaction with learners▪ Easily accessible materials used in practical activity	Asheela et al. (2021); Shinana (2019)
--	--	---------------------------------------

Appendix H: Journal Reflection by Teachers

Instruction: Answer all the following questions

1. What have you learned (or not) from the workshops presentation?

.....
.....
.....
.....
.....

2. How will the workshops presentation and discussions change your teaching?

.....
.....
.....
.....
.....
.....
.....

3. Is there a need to include local Knowledge in science? Explain

.....
.....
.....
.....
.....

4. What do you think about the presentation made in the workshops?

.....
.....
.....
.....

Appendix I: Predict-explain-explore-observe-explain (PEEOE) worksheets

Activity 1

Name:

Hands-on, minds-on and words-on activity 1

1.1 Preparation of the traditionally brewed non-alcoholic Oshiwambo beverage called Ontaku/Oshikundu

Ingredients and apparatus/equipment needed:

- Omahangu flour
- Flour from Omahangu/Sorghum germinated seeds
- Residue from already fermented ontaku/oshikundu called oshipithitho
- Hot water (just below boiling point)
- Cold water (at room temperature)
- Bucket
- Plastic bottles x 4
- Balloons x 4

Procedure

1. Pour approximately equal volumes of the dilute mixture into four containers of approximately equal volumes
2. Prepare four different samples (A, B, C, D) of the ontaku/oshikundu as follow:
 - A. Ontaku/oshikundu with Oshipithitho and leave it at room temperature (control)
 - B. Ontaku/oshikundu without Oshipithitho and leave it at room temperature

C. Ontaku/oshikundu with Oshipithitho and put it in a refrigerator (or allow it to overnight in a cold place outside the room)

D. Ontaku without Oshipithitho and put it in a refrigerator (or allow it to overnight in a cold place outside the room)

3. Once all the four samples of ontaku/oshikundu have been prepared, put a deflated balloon on the mouth of each bottle A, B, C, D and leave it over night (or approximately 5 hours) for further observations the following day. Take pictures of the samples.

Predictions and explanations for predictions

- First individually, then in groups, predict what you would observe in each of the samples of ontaku/oshikundu A, B, C and D after +/-8 hours
- Write down explanations for your predictions. What do you think would happen in each sample and why?

	OBSERVATIONS	EXPLANATIONS FOR THE OBSERVATIONS
A		
B		

C		
D		

ACTIVITY:2

SCIENTIFIC CONCEPTS

As a group write a mind map to indicate as many scientific concepts as possible that are associated with the ontaku/oshikundu.

Explanations for predictions	Explanations for predictions
Observations	Observations
Explanations for observations	Explanations for observations

Worksheet 2

Name:.....

Continuation of ACTIVITY 1: Preparation of the traditionally brewed non-alcoholic Oshiwambo beverage called ontaku/oshikundu.

OBSERVATIONS AND EXPLANATIONS FOR OBSERVATIONS Observe what happens to the samples of ontaku/oshikundu A,B, C and D the following day and write down your observations and explanations, individually and as a group.

OBSERVATIONS EXPLANATIONS FOR THE OBSERVATIONS

	OBSERVATIONS	EXPLANATIONS FOR THE OBSERVATIONS
A		
B		

C		
D		

ACTIVITY 3: Eggs in different liquids

Group work

What we need:

- About 6 eggs
- Vinegar
- Lemon juice
- Coca-cola
- 6 x beakers
- Distilled water

What to do?

1. Prepare three containers of vinegar(V1 V2 and V3)
2. Prepare other three containers with lemon juice, distilled water and Coca-Cola respectively (the volume should be approximately equal)
3. Label the containers as V1,V2 and V3 (vinegar) L (lemon Juice), W (distilled water) and C (coca-cola).
4. Immerse an egg in each of the liquids respectively (V1,V2,V3, L, W, C).
5. Write down your predictions and explanations for your predictions in the table below. What do you think would happen to the egg in each case (V1,V2,V3, L, W, C)?

OBSERVATIONS	EXPLANATIONS FOR THE OBSERVATIONS
--------------	-----------------------------------

A		
B		
C		
D		

Group Activity 4: Preparation of yeast and sugar solution

Ingredients and apparatus/equipment needed:

- A plastic bottle (preferably 2 litre)
- Like-warm water
- Yeast sachet
- White sugar
- Brown sugar

Procedure

1. Pour lukewarm water in a container such as a bucket.
2. Add a generous amount of sugar to the lukewarm water (about half a cup)
3. Add one sachet of yeast to the solution
4. Stir continuously until the mixture is evenly mixed
5. Pour the mixture into a 2 litre plastic bottle
6. Put a deflated balloon at the mouth of the plastic bottle
7. Observe for about 5 hours
6. Write down your predictions and explanations for your predictions in the table below. What do you think would happen to the **yeast and sugar solution**?

A	OBSERVATIONS	EXPLANATIONS FOR THE OBSERVATIONS

B		
C		
D		

Appendix K: Table for TSPCK components

<p>CONTENT SPECIFIC COMPONENTS</p>	<p>INDICATORS</p>
<p>Learner Prior Knowledge (LP)</p>	<p>What learners already know and includes common misconceptions known in a topic.</p>
<p>Curriculum Saliency (CS)</p>	<p>Refers to the identification of the most important meaning of the major concepts in a topic, without which understanding of the topic would be difficult for learners.</p> <p>It also includes the knowledge to logically sequence the learning and the knowledge of pre-concepts needed prior to teaching a topic.</p>
<p>What Is Difficult To understand (WD)</p>	<p>Refers to gate-keeping concepts which are difficult to understand often because they cause conflict with previously established understanding.</p> <p>Representations</p>
<p>(RP)</p>	<p>Refers to a combination of representations at</p>

	<p>macro, symbol, and sub-microscopic levels that may be employed to support an explanation.</p> <p>Example, illustrations, metaphors, analogies, models, stimulations.</p>
<p>Conceptual Teaching Strategies (CTS)</p>	<p>Refers to teaching strategies derived from the considerations made from the other components e.g. (particular misconception, particular learner/learners, and particular educational purpose. It excludes general teaching methodologies.</p>

Appendix I: Exemplar Lesson

Lesson preparation Form										
Teacher: Co exemplar lesson Plan	Grade: _____	A	B	C	D	E	F	G	H	DATE: _____
SUBJECT: Life Science										
THEME: Movement of Substances		TOPIC/SKILL: Diffusion								
1. TEACHING AIDS & RESOURCES TO BE USED		- mashing flour - Sorghum flour - Fermented ochukwanda								
2. SPECIFIC COMPETENCIES/OBJECTIVES: (Refer to Textbook; Learners should be able to)		1. Investigate the process of diffusion. 2. Define diffusion. 3. Discuss the importance of diffusion in living organisms.								
3. MONITORING OF HOMEWORK DONE		Check if the learners brought the previously requested resources to be used during the lesson.								
4. INTRODUCTION:		Introduce the community member and her/his purpose in the class. Inform the learners what the lesson is all about.								
5. Presentation of subject content and learning tasks:										
PRESENTATION OF SPECIFIC COMPETENCIES/OBJECTIVES		TIME	CLASS EXERCISES (should be relevant to the specific competencies/objectives)							
1. The community member will introduce her resources to the learners.			The learners will be allowed to interact with the community member by asking questions.							
2. The community member will demonstrate the making of Ochukwanda.			The learners will be involved in the set-up of the apparatus. (Boys & girls)							
3. The teacher (main) will monitor and lead discussion why certain steps are taking place.			Group work, learners can come up with the concept map of all concepts involved during the experiment.							
4. The community member will pose questions to the learners and the teacher link concepts (quantity).			The learners will fill in prediction and explanation handouts.							