Using the Indigenous Technology of Organic Crop Farming to Mediate Learning in Grade 12 Agricultural Science Classes

A thesis submitted in fulfilment of the requirements for the degree

Of

MASTER OF EDUCATION
(Science Education)

In the
Education Department
Rhodes University

By

Lydia Ndapandula Sheehama (19S9466)

Supervisor: Prof Kenneth M. Ngcoza

Co-supervisor: Dr Chrispen Mutanho

February 2024

Declaration of Originality

I, Lydia N. Sheehama (19S9466), hereby declare that this thesis is my original work and has not been previously submitted in any form for assessment or a degree in any other higher education institution. Where I have used work from other scholars, such ideas have been acknowledged using quotations and references according to Rhodes University Education Department Guidelines.

February 2024

Signature Date

Dedication

This thesis is dedicated to my beloved late father, Lukas Nghituwamata Ya Ndimulunde Ya Hamupolo (1939-2009). May his soul continue resting in perpetual peace and light.I further dedicate this thesis to my lovely husband Benjamin Itashipu Sheehama and our lovely children for your utmost support and patience during this journey. Sweetheart, your tender support, love and care in this academic journey will always be cherished. May the powerful God (*Kalunga kaNangobe*) richly bless you always!

Acknowledgements

First and foremost, I would like to thank God, the Almighty for giving me wisdom, strength and for carrying me through this academic journey despite the health challenges I experienced.

Secondly, I would like to thank my family, friends, Fellow MEd scholars and my supervisors at work for their unwavering support, patience, and motivation during this academic journey. To Ester Shinana, thank you so much for you guidance and support in my academic journey. May God richly bless you and your family! More so, I wish to extend my special thanks to the four Agricultural Science teachers, my critical friend and the two Indigenous Knowledge Custodians (IKCs) for participating in my research study and making my dream come true. May God richly bless you and increase your wisdom (*Kalunga nemuyambeke yee nahapupaleke ounongo weni*). Thirdly, I wish to extend my word of gratitude to the Oshana Regional Director (Mrs Amukana) and the School Principals for permitting me to conduct this research study in the best interest of the Namibian child and Africa as whole.

I would also like to extend my profound appreciation to Prof Kenneth Mlungisi Ngcoza (Mthembu) and Dr Chrispen Mutanho (Ndlovu) for being my supervisors, mentors and above all a support system every scholar would dream of. You are such a blessing! May God richly bless you always! (*Kalunga nemuyambeke alushe*)!

Lastly, I would like to thank Ms Nikki Watkins for professionally editing my thesis.

Abstract

The Namibian Curriculum for Basic Education states clearly that Indigenous Knowledge (IK) should be integrated into science teaching. However, the irony is that it does not give clear pedagogical guidelines on how it should be integrated. The implication is that the curriculum assumes that all teachers are aware of how to integrate IK into their teaching. This assumption has therefore led to little or no integration of IK in many classrooms in Namibia, something which could be in part a contributing factor to poor learners' academic performance in science subjects and Agricultural Science in particular.

This tension in the curriculum plus the apparent gap in the literature regarding the integration of IK has triggered my interest to conduct this interventionist qualitative case study. Essentially, this study aimed to explore affordances and/or hindrances when using the indigenous technology of organic crop farming to mediate learning in Grade 12 Agricultural Science classes in peri-urban schools in the Oshana region in Namibia. The study was underpinned by the interpretivist and Ubuntu paradigms. Vygotsky's (1978) socio-cultural theory and Shulman's (1986) pedagogical content knowledge (PCK) framework were used as lenses to analyse my data. Within PCK, I also used Mavhunga and Rollnick's (2013) Topic-Specific PCK as an analytical framework.

The findings of the study revealed that the integration of Indigenous knowledge in Agricultural Science education has great potential in improving both the teaching and learnng of science. It also revealed that the Agricultural Science teachers were positive towards the integration of IK in their lessons. However, they conceded that they lacked pedagogical insights on how to integrate IK as they were never trained on how to integrate it. As a result, they found the presentations by the Indigenous Knowledge Custodians (IKCs) informative and shed light on how they could integrate IK during teaching and learning. That is, they became cultural knowledge brokers making science relevant and accessible to their learners. The study thus recommends that teacher training institutions should modify the curriculum to include a pedagogy course module on IK to equip students with the essential PCK on IK integration in science teaching.

Keywords: Agricultural Science, indigenous technology, organic crop farming, socio-cultural theory, Pedagogical Content Knowledge, TSPCK

Table of Contents

List of Figures

List of Tables

List of Abbreviations and/or Acronyms

BEd – Bachelor of Education

CAPS – Curriculum and Assessment Policy Statement

DNEA – Directorate of National Examinations and Assessments

FAO – Food and Agriculture Organization

GMOs – Genetically Modified Organisms

IK – Indigenous Knowledge

IKCs – Indigenous Knowledge Custodians

IKS – Indigenous Knowledge Systems

ITK – Indigenous Technological Knowledge

MEAC – Ministry of Education, Arts and Culture

MKOs – More Knowledge Others

MKOs – More Knowledgeable Others

MOE – Ministry of Education

NCBE – National Curriculum for Basic Education

PCK – Pedagogical Content Knowledge

PhD – Doctorate of Philosophy

SCT – Socio-Cultural Theory

SDGs – Sustainable Development Goals

TMESD – Transformation Model of Education for Sustainable Development

TSPCK – Topic-Specific Pedagogical Content Knowledge

UN – United Nations

ZPD – Zone of Proximal Development

CHAPTER ONE: SITUATING THE STUDY

1.1 Introduction

The main goal of this study was to explore how the use of the indigenous technology of organic crop farming can support Grade 12 Agricultural Science teachers on how to integrate Indigenous Knowledge (IK) in their Agricultural Science lessons. What triggered my interest in conducting this study was, firstly, my personal experience which I will discuss later, and, secondly, the overwhelming evidence in the literature indicating that school science is taught in decontextualised methods (Bifuh-Ambe, 2020; Govender, 2014; Gwekwerere, 2016; Mutanho, 2021). This thesis, therefore, argues that the use of IK has the potential to provide affordances for contextualisation making science more relevant and accessible to learners. This approach may also revitalise science (Cocks et al., 2012; Liveve, 2022; Smith, 1999) and make science relevant to learners 'everyday lives (Gwekwerere, 2016).

In this chapter I discuss the background to the study. Firstly, I discuss the international context of local or IK integration and then the local context, based on Namibia's National Curriculum for Basic Education. This is then followed by a statement of the problem, purpose, and significance of this study. The research goals, questions, and summary of the theoretical and analytical frameworks that guided my study are presented. Lastly, I describe the data-gathering methods, key concepts used in the study and the thesis outline. The chapter ends with a summary.

1.2 Background to the Study

Historically, African people have had their Indigenous Knowledge Systems (IKS) and their education systems long before the introduction of Western education by European colonialists and missionaries (Ogunniyi, 2007). Ogunniyi (2007) defines IKS as localised or traditional forms of knowledge prevalent within a given community that represent the intellectual and aesthetic

heritage of the community, orally passed from one generation to another generation (Muchenje et al., 2021) to sustain the everyday life of individuals (Matsika, 2012). Long before the colonial era, African IKS enabled the survival of African communities and societies, from sustainable food production to medicine (Kibirige & Van Rooyen, 2006; Schrottner, 2010). In concurrence, Shizha (2013 argues that before colonisation, Africans were socialised and educated within African indigenous cultural contexts. However, Western education came to underrate the value of IK, particularly in science curricula. Put differently, Western education has regarded knowledge that African children brought from home as irrelevant, unscientific and outdated (Abah et al., 2015; Horsthemke & Schafer, 2007).

Consequently, curriculum designers in Africa seem to have accorded Eurocentric epistemology superiority over Afrocentric knowledge systems (Mukwambo et al., 2014; Shizha, 2013) as to date Western knowledge appears to continue dominating the contemporary African curricula. This has subjected African learners to learning school science in unfamiliar contexts (Gwekwerere, 2016; Shizha, 2013) that are generally foreign to the reality of their worldviews. According to Bifuh-Ambe (2020), indigenous learners in their postcolonial classes are offered a 'one-size-fits-all' instructional approach. As a result, this approach has drastically lowered the quality of education received by indigenous learners in their classrooms (Kakambi, 2021) as they continue to learn in unfamiliar or foreign languages, such as English.

It appears that in most African countries English has been used as a standard measurement tool of intelligence. For instance, in Namibia, learners are required to obtain at least a D- symbol or better in English at the matric level, for them to qualify for admission to institutions of higher learning (colleges or universities). However, many learners completing matric seem to find it difficult to score at least a D- symbol or C in English as a second language. Sadly, these learners are denied admission to pursue courses of their choice where they have achieved the required points, (other than in English) for instance, agricultural programmes and other science-related fields of studies that do not necessarily require a D- symbol or better in English as a determining factor for one to excel in such programmes.

It could thus be argued that the African education system has a biased view of science as it favours Eurocentric rather than Afrocentric epistemologies in science curricula (Mutanho, 2021; Sen, 2007) instead of complementing the two knowledge systems as proposed by scholars such as Seehawer and Breidlid (2021). In concurrence, Govender (2014) affirms that indigenous learners in most African classrooms learn science in an abstract context. That is, African learners are taught without any reference to their everyday lived experiences (Gwekwerere, 2016). In other words, indigenous learners are subjected to learning school science in unaccustomed contexts. Such choices have undeniably resulted in poor academic performance as well as the serious struggle faced by science teachers when mediating the learning of certain science topics or concepts (Kakambi, 2021).

In my personal experience I have observed and noticed with dismay learners 'poor conceptual understanding of most science concepts, such as organic crop farming. Vos (2014) posits that a lack of improved learning and poor results in science might be caused, in part, by a weak relationship between concepts and contexts. This resonates with Mavuru and Ramnarain's (2017) assertion that when learners learn science in unfamiliar contexts, there seems to be no linkage between school science and their everyday experiences (Aikenhead, 2006; Godlo, 2024; Le Grange, 2007). It is against this background that several scholars are advocating a review of science curricula taught in African classes as it does not reflect the African ways of *knowing* and *being* (Aikenhead & Jegede, 1999; Kibirige & Van Rooyen, 2006; Mukwambo et al., 2014; Semali & Kincheloe, 1999). In a similar argument, Mavuru and Ramnarain (2020) posit that science teachers should make some efforts to take into consideration learners' diverse socio-cultural backgrounds to enhance the learners 'conceptual understanding of science concepts.

Indeed, literature has revealed numerous benefits associated with the integration of IK into science lessons. For instance, Roschelle (1995) and Kuhlane (2011) assert that learning commences from prior knowledge and only later from presented ideas. Sharing a similar sentiment, Kibirige and Van Rooyen (2006) advance that IK has the potential to enrich science teaching by drawing on IK as indigenous *prior* knowledge in science lessons. The integration of IK into science teaching may also show learners the relevance of science to their own lives and interests (Govender, 2014; Ogunniyi & Ogawa, 2008; Rosales & Sulaiman, 2016; Webb, 2013).

Similarly, Mhakure and Otulaja (2017), Mutanho (2016), Nikodemus (2017) and Shinana (2019) posit that drawing on learners' cultural heritage makes the learning of science relevant and improves learners' understanding of science. Supporting this view, Kuhlane (2011) emphasises that the beginning of each stage of the learning process is essentially the learners 'existing knowledge. Thus, learners require their cultural heritage to make sense of scientific knowledge. That is, learners effectively assimilate newly acquired knowledge if they can link it to their everyday experiences. Taking this argument further, Tonbuloglu et al. (2016) argue that this might afford learners from diverse socio-cultural backgrounds equal opportunities to succeed at school.

It seems fair to argue that neglecting the indigenous practices of African people makes science abstract to African learners (Mukwambo et al., 2014), and failing to consider the integration of IK may create racism and segregation in the education system (Nyamakuti, 2021). Hence, learners should be accorded an opportunity to negotiate meaning across IK and Western Science (WS) and integrate them (Ogunniyi, 2007). In the same vein, Ogunniyi and Hewson (2008) affirm that learners learn better when they negotiate conflicting and contradictory ideas where WS and IK co-exist. Therefore, emphasising learners' socio-cultural background and the integration of IK can be an alternative approach to mediating learning in science (Mavuru & Ramnarian, 2017; Naidoo & Vithal, 2014) and enhance learners 'participation in science lessons (Sedlacek & Sedova, 2017; Vygostky, 1978).

Moreover, it is believed that IK can contextualise school science (Aikenhead & Jegede, 1999). School science textbooks typically present issues, such as the treatment of water by chlorination, which are rooted in Western contexts. As such, learners who are mostly from rural areas might not be familiar with chlorine. Hence, the concept of water treatment can be contextualised by using the indigenous technology of adding wood ash or through boiling which are familiar local methods of treating water. Based on these benefits, it could be anticipated that IK may enhance learners' academic performance, whereas neglecting IK may have the opposite effect (Kakambi, 2021).

There have been calls to integrate other forms of knowledge to improve teaching pedagogies and learners' comprehension of school curricula around the world in countries such as Canada (Aikenhead, 2006), New Zealand (Ministry of Education, 1993), and South Africa (Department of Basic Education, 2011). Scholars advocate the introduction of teaching pedagogies that can be

integrated to accommodate learners from the African context, the 'Afrocentric curriculum' in Mukwambo et al.'s (2014) terms. Similarly, other scholars call for the global and regional mobilisation of IK integration in science teaching (Aikenhead, 1999; Mukwambo et al., 2014; Shiza, 2013) to make science accessible and relevant to African learners as alluded to earlier.

Notably, the global call for the integration of IK in science teaching has now found momentum in most African countries (Naidoo & Vithal, 2014). In South Africa, for example, one of the general aims of the Curriculum and Assessment Policy Statement (CAPS, 2011) is to value IKS. Furthermore, CAPS (2011) states that science learned at school should produce learners who understand that school science can be relevant to everyday life. That is, enriching the connections between science and society. Similarly, the Namibian National Curriculum for Basic Education [NCBE], (2016, p. 5) calls for knowledge that encompasses indigenous or local knowledge. It thus suggests that teachers should select learning content and methods within the learners 'immediate environment and community (Mavuru & Ramnarain, 2017). Similarly, the Agricultural Science syllabus for grades 10–11 (MoE, 2019, p.2) points out that "Teachers should take an active part in rural development by integrating local agricultural activities into the school curriculum".

In the same vein, the Namibian school curriculum calls for home and community to support actively the holistic development of learners aligning with the concept of Ubuntu, which translates to "I am because of others" (Seehawer, 2018). The curriculum claims that new knowledge and skills are acquired when people interact with one another. This resonates with Vygotsky (1978) who believes that knowledge can be co-constructed in social contexts with More Knowledgeable Others (MKOs) through interacting with the environment (Glasson et al., 2010).

In addition, the curriculum cautions against the detrimental effect of ignoring learners 'cultural heritage, stating that teaching which does not build on learners 'prior knowledge might limit their thinking. As a result, learners might not see the link between the world outside the school and what is taught and learned in school (Aikenhead & Jegede, 1999; Kuhlane, 2011).

1.3 The Nature of the Namibian Science Curriculum

Natural Science is one of the compulsory fields of study offered at secondary schools in Namibia. Agricultural Science is one of the subjects that make up the Natural Science area of learning. One of the key aims of teaching science is to provide worthwhile educational experiences for learners to become confident citizens in the technological world and develop an informed interest in matters of scientific importance (MoE, 2017). Thus, learners' interest in science could be stimulated when their prior everyday knowledge (Kuhlane, 2011) is considered in the teaching and learning of science, particularly Agricultural Science in the context of this study.

The Namibian curriculum stipulates that Agricultural Science should be an optional subject from the primary phase up to the secondary phase. The curriculum developers seem to have underrated the importance of agricultural education in society as "*Agriculture is a way of life and oxygen to the national economy*" (my emphasis). As such, it could have been made compulsory in the primary phase to ensure that most Namibians are equipped with the necessary basic knowledge and skills on how to produce food sustainably to realise a healthy, and self-reliant nation in terms of food production as enshrined in *Vision 2030*. However, the National Curriculum seems not to be responding to the goal of *Vision 2030* which calls for the field of science to produce an innovative, educated, self-reliant society by the year 2030, in particular to produce agriculturalists and scientists for the country.

The Namibian curriculum was revised in 2016 to expand learners 'competencies and enhance their participation during teaching and learning. However, the new curriculum has not included traditional or IK as an alternative approach to instruction to be integrated across the science curriculum. The curriculum advocates the integration of IK into science education, but it fails to explain how teachers should integrate IK into their teaching. It appears the curriculum assumes that teachers already know how to integrate IK. Simply put, there is a yawning gap between curriculum formulation (policy and curriculum developers), implementation (teachers) and attainment (learners) and this seems to be a vicious cycle. Moreover, the fact that the new curriculum's content has been altered and is more complex compared to the old curriculum, might make it more challenging for teachers to make science relevant to the learners (Davidowitz &

Rollnick, 2011). Hence, there is an urgent need for teachers to adapt pedagogies that learners can relate to, to understand science concepts as recommended by Mavuru and Ramnarain (2020).

In my view, Agricultural Science is a subject that is very close to Africans' ways of living, particularly the traditional ways of growing crops. As such, it would have been the easiest science subject for both teachers and learners if home or local knowledge was integrated into the school curriculum. However, the fact that most concepts in prescribed textbooks are presented abstractly and theoretically tends to make Agricultural Science foreign to indigenous learners and it is challenging to the teachers to make it relevant and meaningful to the learners 'everyday lived experiences (Gwekwerere, 2016). Hence learners fail to see the connection between the agriculture they practice at home and the subject they study at school. Hence, there is a need for teachers to become cultural knowledge brokers as suggested by (Sleeter, 2001) to allow cultural border crossing from home or community to school as espoused by Aikenhead and Jegede (1999). In this regard, the Ministry of Education, Arts, and Culture (MEAC, 2015, p. 4) stipulates:

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

Concurring with this notion, Mavuru (2022) points out that in the community there are people with expertise in cultural knowledge who can be approached to support the teaching and learning of science. Furthermore, a body of literature accentuates that teaching strategies that build on learners' existing knowledge and experiences from everyday socio-cultural interactions are pertinent to the learners' subsequent learning (Kasanda et al., 2005; Nyika, 2017; Ogunniyi, 2007; Roschelle, 1995). This amplifies the call by Erinosho (2013) and Vygotsky (1978) for teachers to employ teaching methods that challenge learners to use their sociocultural background experiences and cultural worldviews in class which can potentially reinforce their learning. Taking the argument further, Kreisler and Semali (2001) argue that opportunities are likely to be lost when teachers ignore their learners 'prior knowledge and indigenous ways of knowing. However, it is recognised that not all the prior learning experiences that learners bring to the learning environment may be acceptable or useful in learning specific content knowledge (Kasanda et al., 2005; Taylor,

1999). Hence, teachers are urged to be skillful in eliciting and refining learners' prior knowledge to accommodate new information.

Drawing on my experience and findings of the examiners' reports, I found it fitting to explore the use of the indigenous technology of organic crop farming to possibly make sense of the abstract science concepts in Agricultural Science, particularly of crop production. My assumption in this study is that the teachers' failure to integrate IK into their teaching is due in part to their lack of awareness of IK integration, especially the ability to make the linkage between IK and the school science concepts.

Having been a science teacher for 20 good years, I can safely confirm that most teachers in Namibia have not received training in IK integration at the various teachers' training institutions. There are several studies conducted in Namibia exploring IK integration in Agricultural Science teaching. For example, Siseho's (2019) study focused on integrating IK into the animal production section and Hashondili's (2020) study focused on how to integrate local knowledge into food preservation. However, none of these scholars focused on equipping Agricultural Science teachers in how to integrate IK in the crop production section which is a core segment in the Agricultural Science syllabus. This is the knowledge gap that my study sought to close. Essentially, my study focused on using the indigenous technology of organic crop farming to support Grade 12 Agricultural Science teachers in integrating IK into their classes. It is, however, recognised that a researcher's personal life and upbringing as well as educational background might influence how research is conducted. Thus, in the section that follows, I discuss my personal experience as a learner and a science teacher.

1.4 My Personal Journey – Situating Myself in the Study

I was born and raised in a rural area in northern Namibia surrounded by indigenous practices which formed part of my livelihood. Being raised by my parents, who were also raised in rural areas ('village champions'), allowed me to learn more about my tradition as an Owambo girl. For instance, my parents taught me how to grow crops such as *mahangu* (millet) and *omakunde (*beans); little did I know that these were cereal and legume crops respectively. My mother, in particular, also taught me how to collect, prepare and preserve *ombidi* (African wild spinach) using

sunlight, how to cook *oshifima* (mahangu pap), prepare *oshikundu*, weave baskets (Kakambi, 2021) and make clay pots (Mateus & Ngcoza, 2019) as well as how to purify rainwater collected from ponds using *omutoko* (wood ash). I vividly recall that my mother liked *okuhenga* (extract oil from marula nuts) (Nyamakuti, 2021) and make *omalodu* (a traditional beverage) every time we had a guest/s at home or whenever there were celebrations such as birthdays, baptisms, confirmations, and wedding parties among others.

I also recall that my parents used to listen to the sounds of cocks to determine the time of the day. The elders taught us that if the cock cried (make a sound) at mid-day, then it was one o'clock. Essentially, every time a cock made a coockruusu sound, it indicated a certain hour. The elders could also use the appearance of a lot of ants and birds and poor or rich fruiting of certain indigenous fruit trees such as *omilunga* (palm trees) and *eemwandi* (African Ebony trees) to predict high or low rainfall that could lead to flood or drought. My mother also taught me that if I found a cluster of small flies flying around a mopane tree it indicated the presence of honey in the stem of that mopane tree. Moreover, during a rainy season if I found an *oshivanda* (ant hill) with several cracks it was an indication that there was *oova* (a type of mushroom) growing from that ant hill. When cracks were observed on flat land it was an indication that it was *okahauxwilili,* an umbrella-like mushroom that was about to grow from the cracked soil. Both *oova* and *okahauxwilili* were cooked as soup that was eaten with *mahangu* pap. Little did I know that these were merely fungi (decomposers). This indicates that elders studied the environment to make sense of the world (Mosimege & Onwu, 2004).

Unfortunately, none of these rich home experiences featured in my schooling. As a result, I learned science through memorisation without any conceptual understanding. Consequently, I developed a negative attitude towards science as it was difficult for me to relate to the knowledge imparted because my everyday knowledge was not considered valuable (Kuhlane, 2011). Recounting my own experience, I could describe my schooling as alienating because it did not enact what I experienced or taught at home but largely contradicted or neglected what I was taught at home (Mukwambo, 2013; Ogunniyi, 2007; Simpson, 2014). Sharing a similar experience, Simpson (2014, p. 6) reflects:

> 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 continually being measured against a set of principles that required surrender to an assimilative colonial agenda to fulfil those principles.

Like Simpson's (2014) experience of education described above, my experience of education was not in any way relevant to my home experience, despite the IK I brought along to school. However, I do not blame my science teachers for this bad experience since they themselves were not trained in how to integrate IK into their teaching. Notably, this is still the status quo, hence, this research study.

Worth noting is that, during my 20 years of teaching science, I have always preferred the use of English second language during lessons over indigenous languages. Equally, I have also undervalued the learners 'everyday knowledge as I used not to consider their home experiences as prior knowledge during lessons. Instead, I only used to ask them questions based on the content they had covered the previous day or grade (Mavhunga & Rollnick, 2013). Simply put, I only used to teach based on the prescribed textbooks and syllabus. On reflection, when learners asked questions in class in their local languages, I used to tell them: "*I am not your Oshiwambo teacher, thus you cannot speak Oshiwambo during my lessons*".

I could not see anything wrong with my practice as I had not been trained in how to integrate learners' home experiences or languages into science lessons. I also believed that the use of learners' everyday experiences and/or languages was not necessary since textbooks were written entirely in English anyway. Moreover, assessments were done entirely in English and home experiences were not considered in the examinations. In other words, I did not know that using learners' indigenous language and everyday experiences in the lessons had the potential to be substantial resources for the indigenous learners and not a barrier as I perceived.

I only came to realise the significance of IK in science teaching when I enrolled for the Bed Honours at Rhodes University. During the first science elective lesson, we were introduced to the concept of IK by my supervisor and how it could be integrated into science lessons. It was from

the science education elective discourse that I discovered that IK was pertinent to African learners and could make science relevant and meaningful to them. To that end, we were given an assignment about IK and language in science, accompanied by numerous articles to read; we were also urged to read extensively about the assignment to get an in-depth understanding of the IK concept.

In sum, the in-depth lesson discussions we had during the vacation classes and extensive reading about the assignment that we were given about IK and language in science served as an eye-opener for me to realise the great potential IK has to mediate the learning of science concepts. It is from this educational experience at Rhodes University and exposure to various scholarly works about the integration of IK in science that I have learned that IK could be integrated into school science to mediate the learning of various concepts. On reflection, I regret not knowing that IK could be used as a foundation on which new knowledge can be built as proposed by Roschelle (1995) and other scholars, as it may have made my earlier years of teaching more meaningful and productive.

1.5 My Positionality and Reflexivity

Positionality refers to factors that "impact the way we do our research and how people we work with perceive us" (Moser, 2008, p. 89). Moser further adds that these factors include race, gender, ethnicity, age, position, and power dynamics. This suggests that the issue of positionality and power plays a role in conducting research. In this vein, Thomas (2013) argues that interpretive researchers (like me) have an undeniable position in the research process and this position can affect how observations and interpretations are made. Concurring, Holmes (2020) elaborated that as a researcher, you cannot detach yourself from the social reality you live in to study it objectively. Considering these, I provided "an open and honest disclosure and exposition to show where and how" I thought my belief and position might have influenced the study (Holmes, 2020, p. 3). In addition, I was reflexive throughout the research process to understand the effect of my positionality on the research design, process, and outcome. For instance, during the semi-structured interviews, T3 responded by saying, "*Thank you ma'am for the question*", which demonstrated respect towards me as a married woman which is central to our African culture. This cements the notion that positionality is more than just a position that one holds in the research

study. Instead, it is also about culture, ethnicity, language, marital status, age and so on as argued by Holmes (2020).

As a master's student at Rhodes University and because of my vast teaching experience in the subject, I was cognisant of the fact that my position might affect the power dynamics during this study, as my research informants might have perceived me as a more knowledgeable other in Vygotskian terms. Yet, we were all learning in this process. To counteract these power dynamics, I ensured that all the informants in this study knew and understood that they were not obliged to participate in this study and that they were free to withdraw at any stage. It is worth noting that this was communicated to the informants humbly and respectfully as it might have sounded disrespectful to their culture (Mutanho, 2021). However, since the culture of informants was guided by the spirit of Ubuntu, all participants looked forward to completing the entire research process as everyone's contribution was invaluable. Furthermore, I also explained to them that I was doing this research *with* them and not *on* them as explained by Ngcoza and Southwood (2015). Simply put, I positioned myself as a co-learner during the presentation by the Indigenous Knowledge Custodians (IKCs) who are knowledgeable about traditional ways of growing crops. I acknowledged that the elderly community members were the custodians of the cultural heritage of growing crops. Thus, they were regarded as MKOs (Vygotsky, 1978). We all benefited from their presentations in terms of how to integrate IK into organic crop farming by co-developing an exemplar lesson that integrates local knowledge.

Moreover, since this interventionist study was conducted in a local language (Oshiwambo), I was cognisant of the fact that since English was a second language to all of us, we might struggle to translate some Oshiwambo words into English. To counteract this, I requested one of the language teachers at our school who had specialised in English and Oshikwanyama to be our translator in case we encountered some Oshiwambo words that we might have struggled to translate into English. We tried to the best of our ability to translate all the Oshiwambo words into English.

1.6 Statement of the Problem

The Namibian Curriculum for Basic Education promotes the integration of IK during the teaching and learning of science. However, the curriculum documents seem to be silent on how IK should

be implemented or enacted in science classrooms. It appears that the curriculum assumes that all teachers understand how to integrate IK into their lessons. Consequently, this assumption has led to little or no integration of IK in science classrooms.

This coheres with studies carried out by numerous scholars in Namibia and South Africa (Asheela et al., 2021; Hashondili, 2020; Mutanho, 2016; Siseho, 2019) confirming that science teachers seem to struggle to integrate learners' IK in their classes as they lacked IK awareness, as well as the pedagogical insight and skills needed to integrate it. My assumption in this study was that the teachers 'failure to integrate IK in science teaching could be due in part to their lack of awareness of IK integration, especially the ability to make connections between IK and the school science concepts. It was assumed that if science was made relevant and accessible to the learners it might enhance their comprehension of science concepts.

Learners' academic performance in Agricultural Science in most secondary schools in the Oshana region is below the national average (50%). The Directorate of National Examinations and Assessments (DNEA) yearly examiners' reports (DNEA, 2019–2023) indicate that nationally, the quality of learners' achievement in Agricultural Science is of grave concern as most learners score below the national target (50%). In addition, the yearly examiners' reports for 2019-2023 have further revealed that most learners could not soundly answer questions based on organic crop farming both in grades 11 and 12 syllabuses. It was also highlighted that generally, some learners could not distinguish between organic farming and conventional farming methods (DNEA, 2019–2023). This is so despite learners coming to school armed with local agricultural knowledge, particularly on organic crop farming.

Thus, it could be argued that the lack of integration of IK in science could contribute in part to the poor academic performance of learners in science. Furthermore, this could be caused by the teaching of science which tends to alienate African learners as it is generally out of touch with the reality of the learners' world (Aikenhead & Jegede, 1999; Erinosho, 2013). This interventionist study, therefore, sought to explore how the use of the indigenous technology of organic crop farming may support the Grade 12 Agricultural Science teachers in integrating IK into their lessons.

1.7 Purpose and Significance of the Study

The purpose of this interventionist study was to explore how the use of the indigenous technology of organic crop farming can support Grade 12 Agricultural Science teachers on how to integrate Indigenous Knowledge (IK) in their Agricultural Science lessons. This came as a possible part answer to the poor performance in Agricultural Science in the Oshana region and beyond. Put differently, the study aimed to make science accessible and relevant to the teachers and learners in the context of this study, by integrating learners 'everyday knowledge into science teaching and hopefully helping learners cross the river that seems to be a serious obstacle on their way to learning science (Godlo, 2024). To achieve this, I tapped into the cultural heritage of knowledge of the IKCs on the traditional ways of growing crops, particularly on the methods of fertilising the soil and controlling crop pests. It was hoped that the practical demonstrations by the IKCs might assist the participating teachers (including myself) to embrace the importance of integrating IK into our science teaching. Simply put, this study's findings might make science accessible and relevant to the learners by using easily accessible cultural resources (Asheela et al., 2021; Shinana et al., 2021) such as natural methods of fertilising the soil and controlling crop pests. In essence, this study aimed to address the existing gap between curriculum formulation (curriculum developers), curriculum implementation or enactment (teachers) and curriculum attainment (learners) in Namibia's National Curriculum.

Central to this study, therefore, was the use of indigenous technological knowledge (ITK) in organic crop farming that assisted in co-developing an exemplar lesson plan to mediate learning in Agricultural Science classes, particularly in the crop production section. It was hoped that this study could be a form of support in terms of continuing professional development for the Grade 12 Agricultural Science teachers involved in this study and me in terms of enhancing our personal PCK (Carlson & Daehler, 2019) in terms of IK integration into our lessons. Hopefully, this might lead to culturally responsive instructional practices as recommended by Mhakure and Otulaja (2017).

1.8 Research Goal and Research Questions

The main goal of this study was to explore how the use of the indigenous technology of organic crop farming can support Grade 12 Agricultural Science teachers on how to integrate Indigenous Knowledge (IK) in their Agricultural Science lessons.To achieve this goal, the following research questions were addressed:

1. What are Grade 12 Agricultural Science teachers' perspectives, experiences and pedagogical insights regarding the integration of IK into their classrooms?
2. What learning opportunities are created (or not) for Grade 12 Agricultural Science teachers to interact, participate and learn during the presentations on organic crop farming made by the IKCs?
3. How can the IK on organic crop farming presented by the IKCs be used to co-develop an exemplar lesson?

1.9 Theoretical Frameworks

This study was informed by Vygotsky's (1978) socio-cultural theory (SCT) and Shulman's (1986) pedagogical content knowledge (PCK) frameworks. Vygotsky (1978) believes that meaningful learning occurs through social interactions between learners and MKOs. It draws more on the importance of social contexts and culture in learning. Within this theory, I focused on the mediation of learning, culture and language, social interactions, and the zone of proximal development (ZPD).

Shulman's (1986) PCK asserts that subject teachers need to present the subject matter knowledge from learners' prior knowledge to enhance learners' understanding of the subject content. Within the PCK, Mavhunga and Rollnick (2013) identified five topic-specific pedagogical content knowledge (TSPCK) components, namely students' prior knowledge (including misconceptions), curricular saliency, what is difficult to teach, representations including analogies and conceptual teaching strategies. These strategies were used as the analytical framework.

1.0 Data-Gathering Techniques

- Semi-structured interviews;
- workshop discussions;
- participatory observation; and
- journal reflections.

1.11 Definition of Key Concepts Used in the Thesis

Indigenous Knowledge (IK), local knowledge, or traditional knowledge can be used interchangeably. However, I will use IK throughout the thesis. Here are definitions of some of the key concepts used in the thesis:

Agricultural Science: Science that deals with the production of crops and keeping livestock and how food is processed.

Indigenous Knowledge (IK): IK is an all-inclusive knowledge that covers technologies and practices that have been and are still used by indigenous and local people for their existence, survival, and environmental adaptations (Mosimege & Onwu, 2004).

Indigenous Knowledge Systems (IKS): IKS refers to localised or traditional forms of knowledge prevalent within a given community that represent intellectual and aesthetic heritage of the particular community which are passed on from one generation to another (Muchenje et al., 2021) to sustain the everyday life of individuals (Matsika, 2012).

Organic crop farming: This is a farming system that sustains the health of soil, ecosystems, and people, relies on ecological processes, biodiversity, and cycles adapted to local conditions, and avoids the use of artificial inputs such as synthetic fertilisers and pesticides with possible adverse effects (Willer & Kilcher, 2009).

Socio-cultural theory: A social learning theory that advances that learning occurs as a result of interactions between people and their society and how culture and cultural beliefs affect the interactions (Vygotsky, 1978).

Pedagogical content knowledge: A concept that describes the pedagogical knowledge that teachers should have to make the subject matter comprehensible to the learners (Shulman, 1986).

Western Science (WS): In the context of this study, the term refers to school science whose content and contexts are Western and foreign and alienating to Africans.

1.12 Thesis Outline

This study was conducted at Letu and Pandu secondary schools (pseudonyms), peri-urban schools in the Oshana region in Namibia. The thesis is composed of six chapters.

Chapter One: Situating the Study

This chapter presented the background of the study and provided the reasons for conducting this study. The context highlighted the challenges of teaching science and the integration of Indigenous Knowledge (IK) in science classes. Thereafter, the statement of the problem, that is, the yawning gap in the Namibian curriculum implementation, the purpose and significance of the study, the research goal, and the questions were elaborated upon. The theoretical and analytical frameworks informing this study were briefly discussed. Lastly, the data-gathering techniques were introduced, and the key concepts used in this study were defined.

Chapter Two: Literature Review and Theoretical Frameworks

In this chapter, I present an overview of the literature relevant to my study. The literature throws some light on the concept of organic crop farming, curriculum requirements, IK integration into science teaching and professional development. The chapter ends with a discussion of the theoretical and analytical frameworks.

Chapter Three: Research Methodology

This chapter presents an overview of the research design, paradigm and data-gathering techniques used to gather data and the rationale behind their use. The research goal, questions, and process of the study are also presented. Lastly, data analysis and issues of validity, trustworthiness, ethical consideration and positionality are discussed.

Chapter Four: Analysis of Semi-structured Interviews

In this chapter, I present, analyse and discuss the qualitative data generated from the semi-structured interviews to answer research question one. This chapter commences with the teachers ' profiles.

Chapter Five: Workshop Discussions, Participatory Observation and Reflections

Presentation, analysis, and discussion of the data generated from the participatory observations during the presentations made by the expert community members on traditional ways of growing crops are discussed. The data gathered from reflection as a tool used in this study are also discussed.

Chapter Six: Summary of Findings, Recommendations, and Conclusion

This chapter presents a summary of the findings of the study. It presents recommendations and limitations of the study. Areas for future research and personal reflections are also highlighted. This chapter ends with the conclusion of the study.

1.13 Chapter Summary

This chapter was intended to assist the reader in navigating the study. The context of the study, the nature of Namibia's National Curriculum for Basic Education and its stance on the integration of IK into science teaching were discussed. A statement of the problem, the purpose and significance of this study, the research goal, questions and a summary of theoretical and analytical frameworks were also discussed. Lastly, the data-gathering techniques, key concepts used in the thesis as well as the thesis outline were highlighted.

CHAPTER TWO: LITERATURE SYNTHESIS AND THEORETICAL FRAMEWORKS

2.1 Introduction

This study aimed to explore the use of the indigenous technology of organic crop farming to support Grade 12 Agricultural Science teachers when mediating learning in their classes. It was triggered and motivated by the need to make science relevant, meaningful and accessible to indigenous learners.

In this chapter, I discuss literature relevant to my study. I first discuss the concept of organic crop farming versus modern conventional farming, what IK is, the IK of the traditional practices of growing crops in terms of fertilising the soil and controlling pests. The benefits and challenges faced by teachers when integrating IK into science lessons are also discussed. I also discuss literature on the use of language in science classrooms. Lastly, I discuss the theoretical frameworks that underpin this study.

2.2 Organic Crop Farming

The fundamental challenge facing human existence today is meeting the food demands of the teeming global population. According to the United Nations Food and Agriculture Organisation (FAO), it is estimated that by 2050 we will need to produce 60 per cent more food to feed a world population of 9.3 billion (Da Silva, 2012). That means that agricultural production would also need to increase to feed such a massive population. The role of modern (conventional) farming practices in intensifying agricultural production through the green revolution and the use of genetic engineering, machinery, irrigation systems, and chemical inputs is well documented (Rahman, 2021). From a historical point of view, the green revolution has truly increased agricultural production on a global level. However, it has done so at the cost of harming the environment and natural resources (Altieri, 2009; Bazuin et al., 2011).

In concurrence, Rahman (2021) and Santhoshkumar et al. (2017) assert that conventional farming involving the use of chemical fertilisers and pesticides poses severe environmental and health concerns such as soil degradation, reduced biodiversity, emission of greenhouse gases, and contamination of surface and groundwater sources over the years. Howden (2008) accentuates that the present situation of widespread food insecurity in the world particularly in developing countries illustrates the inability of conventional farming systems to meet the current food needs in the world. The majority of the chronically hungry are smallholder farmers in developing countries such as in Africa, who produce much of what they eat and often lack access to chemical inputs (UNEP-UNCTAD, 2008).

Considering this, Da Silva (2012) stresses that food demand cannot be met by using the usual approach of farming as it would take too heavy a toll on our natural resources. To address this problem, he suggests that the world needs a paradigm shift to increase sustainable food production where farmers can be assisted to improve productivity while protecting natural resources. Simply put, Da Silva (2012) advocates the introduction of organic crop farming that is accessible to small-scale farmers by being adapted to the climatic conditions they face with an emphasis on local crop varieties and harnessing traditional knowledge to sustain, rather than fight natural ecosystem processes. That is organic crop farming is based on traditional knowledge and local ecosystems and focuses on smallholder farmers who tend to have limited access to resources, technology, training, and lower yields compared to large-scale producers (FAO, 2018). That means that farmers 'knowledge of local conditions and traditional practices is central to the success of organic crop farming.

History has it that the concept of organic crop farming was developed in the early 1900s by Sir Albert Howard and others who believed that the use of animal manures (often composted), cover crops, crop rotation, and biologically based pest controls resulted in a better farming system (Adamchak, 2021). Howard worked in India as an agricultural researcher, and he was inspired by the traditional and sustainable farming practices he encountered there and advocated their adoption in the West. The demand for organic food is then said to have been stimulated in the 1960s by the publication of *Silent spring*, by Rachel Carson, which documented the environmental damage

caused by insecticides. Furthermore, the demand for organic foods is said to have increased steadily since the late 20th century (Adamchak, 2021).

Essentially, organic crop farming also termed 'organic agriculture' is described as the practice of growing crops using methods that avoid the use of synthetic pesticides and fertilisers, bioengineering, ionising radiation, and sewage sludge (Archer et al., 2017). According to the International Federation for Organic Agriculture Movement, organic crop farming is a farming system that sustains the health of soils, ecosystems and people, and relies on ecological processes, biodiversity, and cycles adapted to local conditions, rather than the use of artificial inputs with possible adverse effects (Willer & Kilcher, 2009). According to Adamchak (2021), organic farming is an agricultural system that uses ecologically based pest controls and biological fertilisers derived largely from animal and plant wastes and nitrogen-fixing cover crops.

Organic farming aims to protect human health and conserve natural resources, preserving the environment for future generations while being economically sustainable (Escobar & Hue, 2007). The diagram below illustrates the effects of organic crop farming on the soil and the environment.

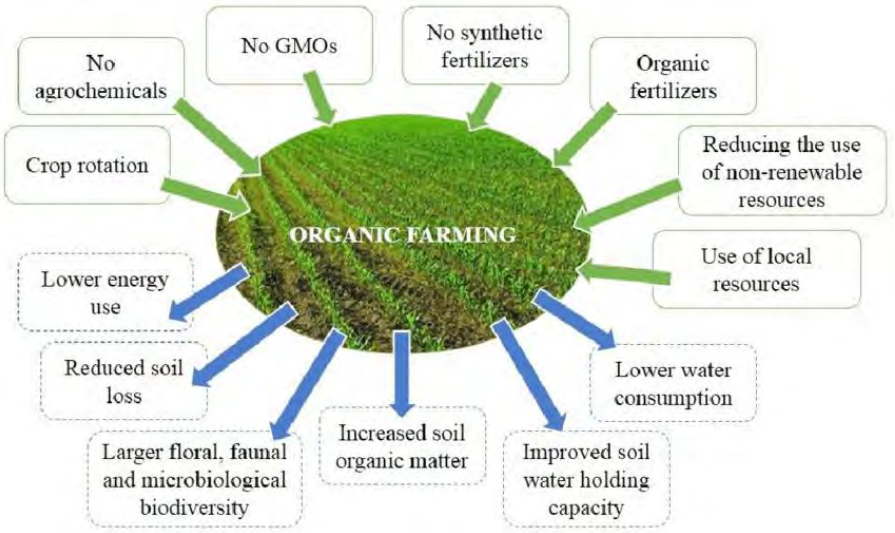


Figure 2.1: The effects of organic farming on soil microbiological parameters (adapted from Furtak & Galazka, 2019, p. 260)

Simply put, this farming method intends to protect the environment and seeks to promote sustainable agricultural development. This is in line with the second of the United Nations' Sustainable Development Goals (SDGs) (United Nations, 2015) which seek to end hunger in all its forms by 2030 and achieve food security, through promoting sustainable agriculture. Organic crop farming is composed of various components.

- **Components of organic crop farming**

The key components of organic farming systems are biological nitrogen fixation by legumes, crop rotation, natural compost, farmyard manure, green manure, and biological pest control (Usama & Siddiqui, 2016). Additionally, vermicomposting has recently emerged as a major component in organic crop farming which is found to be very effective in enhancing soil fertility and plant growth (Santhoshkumar et al., 2017). However, in the context of this study, I focused on organic ways of fertilising the soil and pest control methods. Figure 2.2 below shows some of the key components of organic crop farming (Adapted from Suryavanshi, 2020, p. 1).

Figure 2.2: Some of the key components of organic farming (adapted from Suryavanshi, 2020, p. 1)

As alluded to earlier, this farming method aims to promote sustainable agricultural development, which is in line with the second United Nations' SDG (2015). Taking the argument further, Adamchak (2021) avers that modern organic farming was developed as a response to the

environmental harm caused using chemical pesticides and synthetic fertilisers in conventional agriculture and it has numerous ecological benefits. Unlike conventional farming, organic crop farming uses fewer or no pesticides, reduces soil erosion, decreases nitrate leaching, and recycles animal wastes back into the farm (Adamchak, 2021). Essentially, organic agriculture gives priority to long-term ecological health, such as biodiversity and soil quality contrasting with conventional farming which concentrates on short-term profit gains (Trewavas, 2001).

However, although organic crop farming holds much potential, some researchers question its effectiveness. For instance, Murphy et al. (2007) contend that organic crop farming is low-yielding and unable to produce enough food to supply the world's population. Opposing this view, De Bon et al. (2018) assert that organic yields can sometimes be higher than conventional ones, especially among vegetable producers in Senegal. Similarly, in his study, Howden (2008) revealed that agricultural yields in developing countries such as Africa do not fall but at least remain stable when converted from systems that use relatively low amounts of synthetic inputs. This finding coheres with Svotwa et al. (2009) who state that organic farming is a better alternative farming approach as it can protect the environment from degradation and contamination by agrochemicals used in conventional crop farming practices to achieve sustainable agriculture. Echoing this view, Reganold and Watchter (2016) argue that organic crop farming systems are more profitable, environmentally friendly, deliver more nutritious foods that contain less (or no) pesticide residues and are genetically modified crops (GMOs) free. Moreover, it has the potential to contribute to local food security at a low cost compared to conventional farming (Adebayo & Oladele, 2013d).

Besides these criticisms, research has shown that organic crop farming has become popular in recent years (Avery, 2007; Biao et al., 2003). For instance, most countries in the developed world – particularly in Europe – have shifted to promoting and practising eco-friendly farming systems termed 'organic crop farming '(Stolze et al., 2000; Usama & Siddiqui, 2016). Echoing this sentiment, EI Bilali (2020) believes that the growing consumer awareness of food quality and safety as well as protection of the environment has increased the demand for organic food, especially in industrialised countries. Simply put, as the awareness about the harmful effects of chemicals used in conventional farming on health, soil, and the environment is increasing, most conventional farmers are shifting to organic crop farming.

On the African continent, however, despite the preservation in some regions of traditional farming systems without chemical inputs, the development of organic crop farming is still fragile and generally recognised under its certified form for export (De Bon et al., 2018). That is, it is directly controlled by importers rather than by farmers themselves. For instance, in Uganda and Tanzania, organic agriculture has developed on a large scale with many small producers for exporting crop products such as coffee, cotton, tropical fruit, and fresh and processed vegetables without government support (De Bon et al., 2018). In other words, farmers respond to the demand for tropical organic products in developed countries. To this end, there is still too little recognition of organic crop farming's potential for agricultural development and feeding local populations (De Bon et al., 2018).

Sadly, in some African countries including Namibia, governments tend to put more emphasis on the use of synthetic fertilisers and pesticides in vegetable and cereal production which pose health risks to their environments and citizens, instead of using the traditional ways of producing food which has proven to be GMO-free and safer to their health and the environments for centuries. This could be partly due to the little attention African governments and research institutions have paid to this sector to raise awareness of its significance for sustainable agricultural development (De Bon et al., 2018).

Moreover, the features of organic crop farming – such as the low level of mechanisation and the use of locally available resources – make it a mode of production that is potentially suited to African agriculture as it requires less financial input and places more reliance on the natural and human resources available (De Bon et al., 2018). Furthermore, De Bon et al. (2018) postulate that the organic crop farming system is labour intensive, and as such can be a source of employment for young people and women in rural areas. The current sky-rocketing food-prices and continuous rise in fuel prices across the globe also highlight the significance of making agriculture less energy and external-input-dependent (Howden, 2008) to make food accessible and available at the local level and to create job opportunities and grow the local economy.

Considering the above, I argue that this interventionist study might enable the Agricultural Science teachers to teach in a contextualised manner. This would assist learners to comprehend the concept of organic crop farming and related concepts better. By extension, I believe that localised

knowledge would enable learners to become self-reliant as they may engage in income-generating projects using low-cost IK practices (Muchenje et al., 2021). For instance, they would set up processing plants where they would process composted farm manure and plant wastes into soluble granules, powder or liquid form that they can package and sell to local farmers who currently seem to be struggling to get adequate fertilisers for their crop fields.

Like synthetic fertilisers, processed organic fertilisers would be equally effective and fast-acting as they would easily dissolve or be absorbed by plant roots. That means that organic fertilisers would effectively improve plant growth and increase organic crop yield. In other words, the contextualisation of the concept of organic crop farming would create an opportunity to intensify sustainable food production and ultimately create jobs in rural communities, especially youth and women who tend to make up the bigger portion of the unemployed categories. I believe that if organic crop farming is to be given maximum attention in schools it has the potential to shift the colonial mentality of job-seeking to job creation among the youth. That is, more jobs would be created, and ultimately this would boost the local economy. Learners would become empowered to provide solutions to problems faced by their local communities on a day-to-day basis leading to the socio-economic transformation and development of their communities (Muchenje et al., 2021).

Moreover, the United Nations (2008) highlighted that most African countries including Namibia have been practising traditional organic farming techniques that have evolved through centuries to create agricultural systems adapted to the local environment and cultural conditions. That is, many African countries and other developing countries practise organic, traditional farming systems where no synthetic agricultural inputs such as artificial fertilisers and pesticides are used, but only ecological approaches are applied to enhance agriculture (United Nations, 2008). In support of this view, Abah et al. (2015) assert that traditional agriculture in Africa is seen as an indigenous agricultural system that has developed over the years with cropping patterns based on an agricultural knowledge system expressed in the local language and viewed to be in dynamic equilibrium with the environment. As such, traditional knowledge should be seen as an integral part of organic crop farming instead of being seen as an obstacle to progress (Ramesh et al., 2005). Thus, this study aimed to explore the indigenous ways of growing crops to mediate learning of the concept of organic crop farming in peri-rural schools in Namibia.

Considering the above argument, Ogunniyi (2007**)** argues that African learners come to school with IK from their home backgrounds, which should be taken advantage of in science classrooms. Along the same lines, the Namibian National Curriculum of Basic Education (NCBE, 2016) calls for the integration of IK in science classrooms, to make science relevant to the learners 'everyday experiences (Gwekwerere, 2016). By contrast, however, it appears that Agricultural Science teachers do not integrate IK into their teaching, particularly when mediating learning on organic crop farming.

In the Oshana region, for example, where traditional crop growing is practiced at the community level, the concept of organic farming seems to be taught as a completely modern and foreign concept in Agricultural Science. That is, it is taught with little or no reference to the everyday or IK learners bring along to school from home, hence missing the opportunity to enhance their conceptual understanding of organic crop farming and ultimately sustainable agriculture in their communities.

This may be due in part to the curriculum documents and materials' failure to explicitly highlight how IK should be integrated into science teaching. In addition, prescribed textbooks appear to be largely dominated by Western knowledge, thus, creating a gap between school and home agricultural knowledge for indigenous learners. Hence, it was hoped that the workshop presentations and discussions by the Indigenous Knowledge Custodians (KCs) would allow us (Agricultural Science teachers) to get an understanding of what IK was and how best we could integrate it into the topic of organic crop farming.

2.3 Indigenous Knowledge

Mosimege and Onwu (2004) define IK as all-inclusive knowledge that covers technologies and practices that have been and are still used by indigenous people for their existence, survival, and environmental adaptation. To Kibirige and Van Rooyen (2006), IK is a legacy of knowledge and skills unique to a particular indigenous culture which encompasses wisdom that has been developed and passed on over generations. To Quigley (2009), IK refers to the acquisition of knowledge and practices that are developed by groups with long histories of intimate relationships

with their natural environment. Similarly, Nyika (2017), explains IK as knowledge acquired by people from birth as they live and work in their communities or society.

In the same vein, Seehawer (2018) posits that IK has been developed locally for the people and by the people of that locality and has been passed on from parents to their children. Furthermore, Abah et al. (2015) describe IK as practical, personal, and contextual knowledge that cannot be detached from an individual or community as it includes the major community development processes – agriculture, traditional medicine, and food preservation – on which people depend for survival. Moreover, IK is manifested through the indigenous elders through, among other things, cultural songs, the local language, games, technologies, food, artefacts, cultural beliefs and norms, rituals and ceremonies (Magwentshu, 2020; Nyika, 2017; Seehawer, 2018). In this regard, Ogunniyi (2004) refers to IK as a form of traditional wisdom which often employs a trial-and-error approach. Concurring and adding more weight to this view, Kibirige and Van Rooyen (2006) accentuate that IK has been gathered through trial and error, observation, experimentation, innovation and application over many generations of intelligent reasoning informed by societal engagement with the environment for survival. Indigenous Knowledge (IK) has been viewed as current knowledge the indigenous people possess which has been shaped by previous cultures and civilisations (Ogawa, 1995). Further, Nyika (2017) points out that the community makes use of IK daily to make decisions about their livelihood. Simply put, IK is lived and experienced through daily interactions as a way of living.

In the African context, however, IK is viewed as the knowledge that existed long before the colonial masters settled in Africa (Ogunniyi & Hewson, 2008). It is worth noting, therefore, that the Western settlers brought their knowledge to Africa which could be termed ‘indigenous’ as well. It is for this reason that IK exists and continues to exist in both the Western and African worlds (Nyamakuti, 2021). Notably, different IK may still exist among the diversified African cultures, tribes or ethnicities, because IK is unique to a particular geographic area and possessed by people in a given cultural framework (Mkabela, 2015). By extension, Nyamakuti (2021) posits that IK forms part of the local people’s everyday ways of reasoning. Henceforth, IK is embedded within social interactions (Vygotsky, 1978), education, language, a system of classification, resources, and use of practice (Dziva et al., 2011).

On the other hand, Battiste and Henderson (2000) find it inappropriate to spend time defining IK with efforts to compare it to other knowledge systems as there are no valid existing ways to make such comparisons. Hence, instead of defining IK, they propose that we should rather attempt to comprehend and accept that there are different worldviews with different realities. In this vein, Walker (2004) posits that the term 'world' in 'worldview' appears to describe a Eurocentric context and deliberately ignores the indigenous people's worldviews. It is the marginalisation of IK that continues to be utilised as the "major tool of colonisation" (Walker, 2004, p. 531).

Given this form of continuous oppression and suppression, Hart (2010) posits that there is a need to reconsider applicable research interventions which recognise the views of indigenous people. Furthermore, Hart (2010) argues that such research interventions should consider the perspective of the local community's values and aspirations to recognise that indigenous culture matters to the indigenous people. In concurrence, Higgs (2008) maintains that all critical and transformative educators in Africa must embrace and integrate indigenous African worldviews. It is in response to this situation that this study worked together with community elders as MKOs (Vygotsky, 1978).

It was therefore hoped that such collaborations would enable me to capitalise on a missed opportunity to document IK for future use and reference. It was also hoped that the integration of IK might alter the narrative of viewing an African child learner not as a "bundle of Pavlovian reflexes, but as a human being who is culturally and cosmologically located in authentic valued systems" (Higgs, 2010, p. 447). It is against this backdrop that this study focused on exploring the use of the indigenous technology of organic crop farming to mediate learning in Agricultural Science classes.

2.4 The Indigenous Management Practices of Cultivating Crops

Namibia is a country with enormous cultural diversity. Several ethnic groups have various traditional practices unique to them. For instance, growing mahangu is a typical traditional practice of the Ovawambo people. Ovawambo people are situated in the northern part of Namibia particularly located in the four regions, namely, Ohangwena, Oshikoto, Omusati, and Oshana where this study was conducted. Traditionally, Ovawambo engage in small-scale farming in their

communal areas for domestic consumption (Liveve, 2022). They mostly cultivate mahangu as their staple food which is grown together with other crops such as sorghum, beans, bambara nuts, ground nuts, maize, watermelons, and pumpkins. The Ovawambo cultural way of producing food seems to share a range of features with the *milpa,* a widely known agricultural and traditional food production system practised by the indigenous population in the rural areas of Mexico, which focuses on the planting of maize, pumpkins and various legumes (Sandoval-Rivera & Mendoza-Zuany, 2021). Furthermore, the Ovawambo people also keep livestock such as cattle, goats, donkeys, and poultry (mostly chickens). This cultural knowledge is orally passed from one generation to another (Kibirige & Van Rooyen, 2006; Simpson, 2014). Thus, it was hoped that the participating teachers in this study would be familiar with the traditional practice of growing crops.

Cheikhyoussef and Embashu (2013), however, caution that IK is a valuable local people's cultural heritage and if not preserved or documented, it may be lost forever. Thus, integrating it with WS as a teaching pedagogy would be a way of revitalising and preserving the African traditions and cultures (Cocks et al., 2012) that have been ruined by Western culture. Therefore, in the case of this study, it was hoped that the presentations made by IKCs on how crops are grown traditionally would help us to document IK for future use or reference as reiterated by Chikamori et al. (2019).

Furthermore, it was hoped that using this knowledge to facilitate science concepts might present logical and meaningful science lessons which might enhance learners' conceptual understanding as espoused by Abah et al. (2015). This resonates with Aikenhead and Jegede's (1999) notion of cultural border crossing from home to school science. Godlo (2024) describes this notion as 'crossing a huge river' that seems to stand on the learners' way of moving from home knowledge to school science. In this regard, science embedded in the traditional practice of cultivating crops could be used to mediate the learning of science concepts to avoid rote learning or regurgitation of facts.

2.4.1 Indigenous soil fertilisation management practices

Traditionally, farmers in the tropics were organic farmers (Edje et al., 1988). That is, they used neither artificial fertilisers nor pesticides. Instead, they used a system of fallowing or shifting cultivation. However, with increasing population pressure, they resorted to manuring, crop

rotation, and composting of crop residues to increase soil fertility (Edje et al., 1988). Corbeels et al. (2000) point out that different traditional methods are used to restore soil fertility, for instance, fallowing, crop rotation, crop residues, and manuring among other methods. In their study, conducted in Tigray in Ethiopia, farmers found that fallowing used to be the main way of improving soil fertility. However, farmers abandoned it as their land holdings became too small because of the increasing population (Corbeels et al., 2000).

Furthermore, farmers indicated that they burnt some crop residues as they believed that ash acted as a fertiliser and increased crop yields; they also buried some of the crop remains to allow for decomposition to release plant nutrients into the soil (Corbeels et al., 2000). Similarly, Edje et al. (1988) pointed out that a burnt area with an ash layer is rich in nutrients such as phosphorus, calcium and potassium and increases the soil's pH and improves soil structure which leads to increased crop yields. It is also believed that burning reduces the weed population. In the same vein, Wakui (2009) avers that materials for enriching soil are produced by composting locally available materials such as dead twigs and fallen leaves, weeds, household food wastes, and animal wastes by putting them into pits and covering them with topsoil to decompose. Simply put, organic farmers enrich soil fertility by using compost and animal manure.

Research has shown that compost preparation is prominent in Asian countries (Yadav et al., 2017). For instance, India has a long history of using composted organic manure to improve soil fertility (Manna et al., 2003). In China, organic manure has been used since the Shang dynasty of 3000 BC (Liu et al., 2013). In Southern Africa, the use of composted farmyard manure is a traditional practice, particularly in the Kilimanjaro region of Tanzania, using materials from livestock wastes including chicken and goat waste and ashes. Applying organic resources to fertilise the soil is a common practice among smallholder farmers in the tropics because they cannot afford to buy costly chemical fertilisers (Palm et al., 2001).

Composting is an important tool for social, ecological, and economic sustainability (Proietti et al., 2016; Scarpato & Simeone, 2013). Organic matter plays a significant role in making nutritional contributions as well as initiating physical and biological processes which improve soil fertility. In addition to composting, Mapwe (2022), a Zambian organic crop farmer, explains that he also uses banana peels, eggshells, and rabbit urine as organic fertilisers. He further adds that banana

peels and eggshells are dried and pounded into powder which they then apply into the soil around the stems of their crops, while rabbit urine is diluted at a ratio of 1 litre urine: 2/3 litres of water. The diagram below shows how compost can be prepared and its significance to the soil.

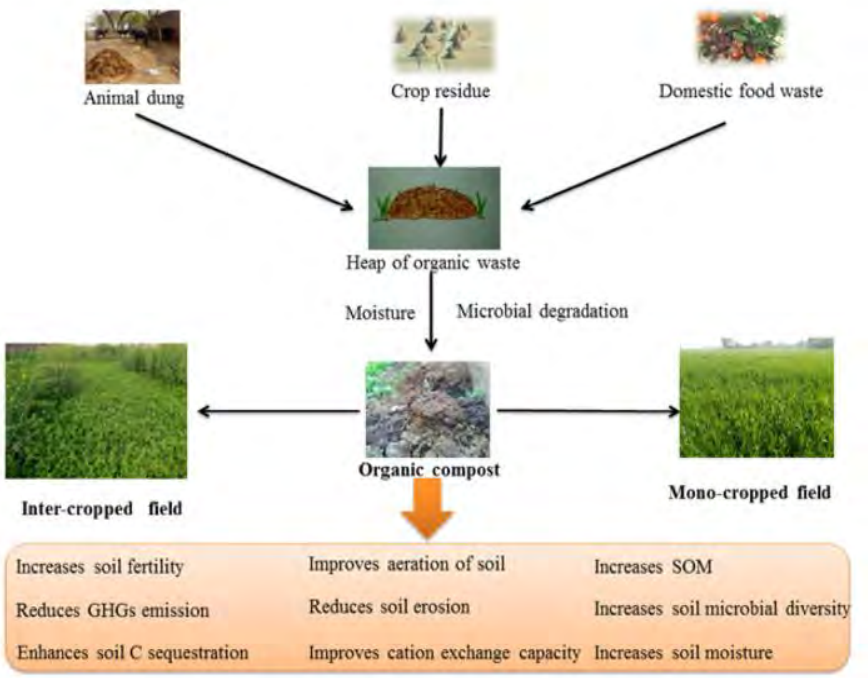


Figure 2.3: A simplified model of traditional organic composting (adapted from Singh & Singh, 2017, p. 305)

In addition to composting, Wakui (2009) also found that traditional farmers plant different types of crops in the form of crop rotation and mixed planting as they believed that the combination of leguminous crops and other crops is effective in soil enrichment and reduces pest and diseases damages (Sandoval-Rivera & Mendoza-Zuany, 2021). Farmers believe that legume plants supply nutrients to the soil and when various crops are grown together, can reduce outbreaks of specific pests and diseases.

2.4.2 Indigenous management practices for controlling pests

Traditionally, farmers do not use pesticides to control pests. Instead, they encourage the growth of natural enemies around crops to avoid insect damage. For example, insects such as ladybugs,

spiders, lizards, and small birds are used as natural enemies (Singh & Singh, 2017). Furthermore, as I alluded to earlier, farmers practise intercropping and crop rotation to reduce pests and disease outbreaks. They also allow certain herbal plants such as *etwelakuku*[1] to grow among their crops. Simply put, herbal plants have a strong smell that deters pests. In the same vein, Mwape (2022) a Zambian crop farmer reports that traditional organic farmers also use leaf powder from indigenous trees such as Neem to control crop pests. He further asserts that some farmers, including himself, now use rabbit urine both as nitrogen-rich organic fertiliser and as a pesticide that is very effective when diluted with water.

Traditional agricultural practices such as intercropping have also gained increased attention globally as a climate-smart approach (Singh & Singh, 2017). That means that climate change mitigation is also one of the salient features of traditional agriculture systems (Srivastava et al., 2016). It seems that the integration of traditional agriculture practices with modern agriculture may be a necessity for the current challenges of a changing climate, to improve the socio-ecological integrity of agro-ecosystems (Singh & Singh, 2017). Thus, it is important that when teachers are mediating learning of organic crop farming, they should familiarise learners with the relationship between education, climate change and organic food production (Sandoval-Rivera & Mendoza-Zuany, 2021). Climate change is a global phenomenon that can be considered the greatest concern of the 21st century (Gonzalez & Meira, 2019). Hence, educational processes that generate understanding and solutions to the problem through adaptation and mitigation of its impacts are relevant to this study, as food production is undoubtedly one of the areas of greatest risk of climate change (Dixon, 2012; Vincentnathan, 2012). The diagram below indicates traditional agricultural practices that are categorised as a climate-smart approach.

[1] Commonly used among Awambo people to treat a long-lasting cough (*Acrotome inflata*).

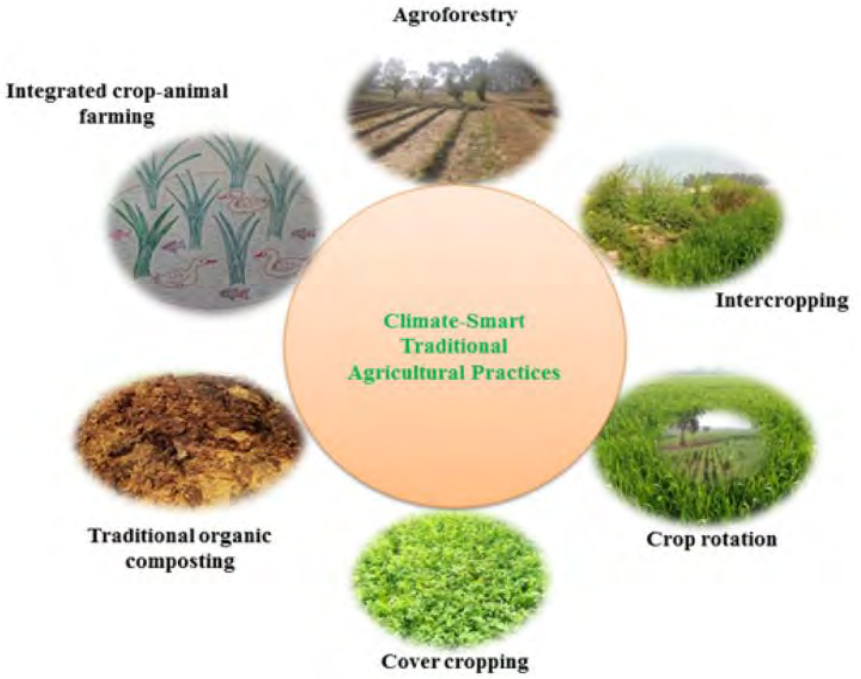


Figure 2.4: Climate-smart traditional agriculture practices (adapted from Singh & Singh, 2017, p. 302)

These researchers provide literature on the concept of organic crop farming. This information played a pertinent role in this study, as it helped to find the scientific reasons behind the traditional practices of growing crops, particularly the traditional ways of fertilising the soil and controlling pests respectively, which would serve as learners' prior knowledge (Mavhunga & Rollnick, 2013) or prior everyday knowledge (Kuhlane, 2011) to enhance their understanding of scientific concepts in the crop production section.

Seemingly, prior knowledge has been limited to learners' formal learning experiences such as previous lessons and grade knowledge. In other words, IK has been neglected as a fundamental ingredient of prior knowledge. That means that learners' everyday knowledge has been under-used as prior knowledge. In this regard, Kuhlane (2011) and Hashondili (2020) argue that prior knowledge could be in the form of learners' local knowledge or knowledge learned from home or the community.

In concurrence, numerous scholars have underscored the importance of eliciting learners' prior knowledge before teaching new knowledge. For instance, Ozmen (2004) avers that learners have pre-existing conceptions about scientific phenomena which might interfere with the learning of scientific principles. As such, eliciting learners' prior knowledge can assist to reveal their difficulties and or misconceptions before, during, or after the instruction (Ozmen, 2004). Sharing a similar sentiment, Roschelle (1995) stresses that the knowledge and experiences learners bring to class are critical factors that teachers need to consider when designing teaching instructions.

Similarly, numerous scholars maintain that eliciting learners' prior knowledge helps learners to refine their everyday experiences or conceptions to fit the classroom instructions (Mawere, 2015; Stein et al., 2008; Tobin et al., 1990). Considering this, Tobin et al. (1990, p. 3) recommend that to ensure the meaningful acquisition of new knowledge, prior knowledge should be "elaborated and changed based on fresh meanings negotiated with peers and the teacher". It is for these reasons that this study explored using the indigenous technology of organic crop farming to support teachers on how to integrate such knowledge in Agricultural Science classes as learners' prior knowledge.

2.5 Benefits of Integrating Indigenous Knowledge

A body of literature suggests that the integration of IK into science lessons would be beneficial to African children in various ways, as children are believed to use their cultural knowledge to view and understand the world around them (Abah et al., 2015; Kibirige & Van Rooyen, 2006). For example, Kibirige and Van Rooyen (2006) posit that the integration of IK into science lessons can enrich science learning when it is used as a starting point to explore science concepts. In agreement with this, several scholars aver that the use of resources and examples related to learners 'existing knowledge stimulates learners' interest and motivation to learn the subject and enhance an effective understanding of science concepts (Mavuru & Ramnarain, 2017; McKinley, 2005; Ngcoza, 2019). In the same vein, Abah et al. (2015) contend that artefacts available in local environments are vital tools that can be used to lessen the gap between classroom science and knowledge existing outside the classroom. Essentially, these scholars seem to advocate the

teaching of science in local languages as a means of providing an authentic context for promoting community identity and the proper learning of indigenous learners (McKinley, 2005).

Similarly, in their study, Mukwambo et al. (2014) found that IK was responsive to the environment and if used as prior knowledge in the science classroom, could counterbalance the challenges posed by WS. In other words, effective science teaching can only be realised if science teachers integrate learners' everyday knowledge and their social environment, to make teaching and learning more culturally inclusive, because science classrooms are culturally and socially constructed and not neutral (Mavuru & Ramnarain, 2017; Mhakure & Otulaja, 2017). This finds resonance with Vygotsky's (1978) SCT which is used as a theoretical framework in this study.

Furthermore, Kibirige and Van Rooyen (2006) acknowledge that when IK is integrated into science teaching, it enhances active participation because learners can experience or feel the connection between what they are learning and what they do at home. Aikenhead and Jegede (1999) refer to this phenomenon as border crossing. To Shizha (2007), when IK is integrated into science lessons, it allows learners to develop confidence and self-esteem in the subject. Thus, IK is understood as a cultural tool to facilitate learners' access to 'real' science (Aikenhead & Jegede, 1999; Seehawer, 2018). In other words, if IK is not integrated into science, learners tend to find it difficult to move between the micro-culture of family and the school and this will have a detrimental effect on their performance in science (Aikenhead & Jegede, 1999).

Moreover, Baquete et al. (2016) argue that "if indigenous knowledge could be incorporated into school science curricula, it could provide familiar contexts within which to learn scientific concepts, as well as help the younger generation to recognise its value". Similarly, Weiland (2015) asserts that learning is improved when it occurs in contexts that are culturally, linguistically and cognitively meaningful. Concurring, Mukwambo et al. (2014) and Taylor and Cameron (2016) maintain that culturally sensitive curricula and pedagogy minimise the foreignness of science content and make science concepts accessible to learners. Abah et al. (2015) postulate that if IK is properly integrated into science teaching, teachers will be able to present logical and meaningful science lessons which will enhance learners' comprehension of science concepts beyond rote learning.

Brayboy and Castagno (2008) postulate that the integration of IK does not only bridge science to IK but also provokes learners' thinking, leading to critical thinking skills (Magwentshu, 2020). In his study, Shizha (2007), found that learners tended to engage more when they learned what they could relate to. To this end, Le Grange (2007) and Mukwambo et al. (2014) advocate the integration of IK, citing that it paves the way for the true Africanisation of the curriculum. Strengthening their argument, Le Grange (2007) and Mukwambo et al. (2014) accentuate that IK integration could make remarkable strides in contributing to the cultural revaluing of IK. My position in this regard is that the integration of IK has great potential to liberate learners and teachers to learn and teach within their cultural contexts (Mavuru & Ramnarian, 2017). Mhakure and Otulaja (2017) refer to this as culturally responsive pedagogies.

2.6 Challenges Faced by Teachers in Integrating IK into Their Science Lessons

Even though IK is viewed by many scholars as a valuable in dimension in the teaching of science, some teachers seem to find it difficult to integrate IK into their teaching. For instance, in Hashondili's (2020) study, teachers indicated that they often struggled to integrate IK into teaching science to make it more interesting to the learners. Teachers also pointed out that they did not know whose IK they should use in their classes because IK varied from culture to culture. This can be attributed in part to curriculum documents that fail to explicitly provide clear guideline on how teachers should integrate IK. Furthermore, Nikodemus (2017) also accentuated that not all cultural beliefs and practices are scientific. Concurring, Mukwambo et al. (2014) revealed that IK was usually accompanied by some myths and superstitions that are not scientific. It is for this reason that these scholars warn that not every indigenous belief should be accepted and embraced as science. In accord with this, Kibirige and Van Rooyen (2006) suggest that teachers should allow learners to debate such cultural beliefs to reduce misconceptions in the classroom.

Teachers also find it difficult to engage every learner's cultural belief, especially in multicultural classes. Notwithstanding this challenge, teachers are encouraged to engage all social-cultural beliefs learners bring to class, to clarify misconceptions and myths, as this would be detrimental to the learners' conceptual understanding if left unattended. Moreover, teachers are believed to be confused as most of them are products of a Westernised education system. This has unfortunately

made it difficult for teachers to challenge Westernised science and instead de-emphasise the value of IK in science teaching (Abah et al., 2015). Seehawer's (2018) study revealed that teachers' training institutions do not prepare teachers for the integration of IK. In a similar vein, Kibirige and Van Rooyen (2006) posit that teachers can only recognise the value of IK in the science classroom if they are taught and/or trained on how to deal with or integrate it into the science lessons. Hence, there is a need for teacher training institutions to teach IK to student teachers for them to be able to teach it in schools as recommended by Mutanho (2021) and Neporo (2022) respectively. Nyamakuti (2021) argues that IK forms an important part of learners' cultural heritage, thus, educators should make the effort to harmonise the use of both WS and IK in their teaching. More so, the harmonisation of WS and IK is needed to enable the African children to become complete beings with a balanced life (Nuntsu, 2020). I am not proposing that IK is the only way of knowing: however, I am suggesting that there are many ways of knowing that need to be recognised (Hart, 2010).

Considering the above view, Hodson (2009) argues that electing to exclude some forms of knowledge from the curriculum will create obstacles and deny access to science. In this regard, Hodson further stresses that although there are valid and sound pedagogical arguments for the integration of IK into science, there is a need to be cautious not to include "anything and everything in the curriculum under the banner of science" (p. 118). In the same vein, Klein (2011) cautions that "IK should not be presented as the answer to all problems and shortcomings in Africa" (p. 82). Romanticising IK (Le Grange, 2007; Mhakure & Otulaja, 2017; Ogunniyi, 2007) might lead to another form of discriminatory system which could hamper the speed of development and sustainability. Integrating IK into lessons may cause conflict between scientific and everyday language (Le Grange, 2007) as some words in English do not have the same meaning in the indigenous (local) language, thus resulting in confusion and cognitive dissonance.

There are, however, some counterarguments against the integration of IK into science teaching. For instance, critics such as Cobern and Loving (2001) propose a separatist approach to IK recognition rather than integration into science teaching. They reason that it would be better if IK were to stand on its own and not be integrated into school science is to prevent it from being dominated by WS as is the case now. Horsthemke and Schafer (2007) and Hodson (2009) seem to

be in support of this cognitive apartheid. For instance, while acknowledging the benefits and value of Indigenous Knowledge, Hodson (2009) maintains that IK works well in the contexts in which it was developed. Thus, it should be valued on its own merits and cannot be accorded the status of science.

Sinvely and Corsiglia (2001) vehemently oppose this proposition arguing that "indigenous science offers important scientific knowledge that Western modern science (school science) has not yet learned to produce" (p. 82). In this regard, Le Grange (2007) proposes that these knowledges (IK and WS) should be treated as complementary rather than regarded as mutually exclusive. Concurring, Seehawer and Breidlid (2021) argue that there should be a dialogue between these knowledge systems. However, some proponents of IK integration in science teaching have cautioned against romanticising IK as the solution to the teaching of science (Afonso-Nhelevilo, 2013; Keane et al., 2016; Mhakure & Otulaja, 2017; Ogunniyi, 2018). These scholars underscore that not everything under the banner of Indigenous Knowledge (IK) is valuable and suitable for use in science lessons, highlighting the myths and unscientific beliefs associated with IK. In the same vein, Tylor (1999) cautions that not all everyday knowledge provides suitable entry points in the classroom. He further warns that if prior knowledge is not properly integrated, it might lead to misconceptions and misunderstandings instead of making learners' everyday knowledge relevant to the learned knowledge.

2.7 Hands-on Practical Activities and Visualisation

Hands-on practical activities can be described as learning experiences that are designed to create a connection between the observations and the theories and ideas of science through action (Asheela et al., 2021). To Millar (2010) practical work in science teaching and learning refers to an activity in which learners work individually or in groups and handle or observe the object they are studying. Millar further argues that practical activities ensure the linkage and connection of theory to practice of science concepts thereby promoting understanding. Similarly, Asheela et al. (2021) maintain that hands-on practical activities enhance learners' conceptual understanding of science concepts as they are encouraged to predict, explain, explore, and observe when carrying out practical activities. Supporting this argument, Woodley (2009) and Asheela et al. (2021) posit that practical activities assist learners to develop their comprehension of scientific concepts and

make sense of them. Sedlacek and Sedova (2017) also claim that hands-on practical activities provide opportunities for learners to understand scientific knowledge and skills mediated by the teacher in class.

In light of this, the Namibian Agricultural Science syllabus (2020) recommends hands-on practical activities in each topic for learners to observe and develop an in-depth understanding of science concepts (Asheela et al., 2021; Nhase, 2019). Furthermore, Shinana et al.'s (2021) study reveals the usefulness of hands-on practical activities in science classrooms; thus, they recommend that teachers should carry out meaningful practical investigations by using locally available and low-cost resources to mediate learning. Sharing a similar sentiment, Nikodemus (2017) recommends that relevant IK and practices should be integrated during hands-on practical activities to help learners to cross smoothly between cultural science and school science (Aikenhead & Jegede, 1999). It should also be recognised that hands-on practical activities are a form of visual representation.

Visual representations are tools of communication that are significant for our biological and socio-cultural existence (Arcavi, 2003). According to Rundgren and Yao (2014), visualisation in science education is a cognitive domain that has the role of making invisible ideas visible and illustrating abstract concepts to make them explicit. Thus, in the context of this study, the practical presentations by the IKCs on how crops are grown traditionally, particularly in terms of fertilising the soil and controlling pests, are regarded as visual representations that have the potential to mediate learning of the concept of organic crop farming in Grade 12 Agricultural Science classes. This resonates well with Mavhunga and Rollnick (2013) who assert that representations play a crucial role in teaching and learning as they serve as teaching aids that could help learners make sense of the science concepts being taught.

There are, however, counterarguments against the effectiveness of hands-on practical activities in science classrooms. For instance, Hodson (1990) argues that practical activities are often misunderstood and confused and do not always produce the anticipated outcomes. Teachers are cautioned that hands-on practical activities should not only be about hands-on activities but that learners should also use their minds to record scientific concepts which they can utilise to develop mind maps, and further develop concept maps (Maselwa & Ngcoza, 2003). This suggests that

practical activities should not be limited only to the manipulation of materials but should also cognitively challenge the learners to make sense of science concepts.

2.8 Teacher Professional Development

As demands for deeper and more complex student learning in the 21st century intensify, effective professional development is needed to assist teachers in learning and refining their pedagogies to teach effectively. PD is viewed as structural professional learning that results in transformed teacher knowledge and practices and improvements in student learning outcomes (Darling-Hammond et al., 2017). The goal is for teachers to gain and implement knowledge from these professional developments to provide learners with an enduring and relevant understanding of scientific concepts (Nhase, 2019; Shinana et al., 2021). To realise this, Eun (2008) suggests that workshops are central to professional development, as they afford opportunities for teachers to interact actively with others and share their experiences, knowledge, skills, problems and possible solutions.

In this study, teachers' professional development was hoped to be achieved by engaging the participating Agricultural Science teachers through a series of workshop discussions, learning from curriculum documents as well as from the presentations by the IKCs. The workshops aimed to expose the participating teachers to the use of relevant local IK as a tool for mediating the learning of scientific concepts in their science classes. In support of this intervention, Shabani (2016) postulates that CPD for teachers should include a comprehensive range of focused training where professional learning will take place.

It was hoped that through the planned workshops, the PCK of the four Agricultural Science teachers (Mavhunga & Rollnick, 2013; Shulman, 1986) would be improved in terms of IK integration into Agricultural Science classes. Development opportunities could also be created during the workshop discussions where the teachers would get an opportunity to plan collectively exemplar lessons using knowledge acquired from the expert community members' presentations. This means that workshop discussions might have created effective learning spaces for teachers to interact with each other, as recommended by Eun (2008) to promote collaborations among these professional teachers. This would allow the Agricultural Science teachers to reflect on their

teaching approaches and learn from each other how to select and use local IK that best fits classroom science. These are known as culturally responsive teaching strategies (Mhakure & Otulaja, 2017). Since elders are the custodians of cultural heritage and wisdom, they have a significant role to play in making teaching and learning culturally responsive (Kakambi, 2021).

2.9 Indigenous Elders

Generally, parents or community elders at the school level are often viewed as sources of funds for schools' daily operations as well as main agents in the disciplinary process of learners (Kakambi, 2021). However, community elders also have a critical role to play in the integration of IK into science education. In other words, the call to integrate IK into science education cannot be realised in the absence of indigenous elders as they are the custodians of IK, the MKOs (Vygotsky, 1978). That is, indigenous elders can play a significant role in the empowerment of science teachers on how to integrate IK into their science lessons. For instance, it would not have been possible to conduct this study if it was not for the spirit of Ubuntu of the IKCs, who voluntarily agreed to share their cultural heritage and wisdom on growing crops traditionally. This is the true meaning of "I am because we are" (Oviawe, 2016).

To King and Schielmannn (2004), this is an instance of an intergenerational learning programme, which calls for the active involvement of indigenous elders and speaks of indigenous language in education. This concept resonates well with Klein's (2011) study that affirms that elderly people could be the resources of every teacher in schools if they were actively involved in school activities. The IKCs were so delighted to be allowed to share their knowledge with us. Seemingly, IKCs also wanted to transmit their treasured knowledge and skills to young people (teachers in the context of this study) to ensure its continuation (Mateus & Ngcoza, 2019). This study has revealed that schools can either invite elderly people to schools or visit them wherever they are located (Mavuru, 2022).

In addition to providing opportunities to mediate learning of organic crop farming, traditional crop farming practices also offer opportunities for the integration of cross-curricular themes such as environmental sustainability. Environmental sustainability calls for the use of natural resources without depleting them. This is in line with Dei (2000) and Bowers (2007) who postulate that IK

holds a significant possibility for maintaining social and ecological sustainability. It could therefore be argued that to realise sustainable development the voice of IKCs is critical to contribute knowledge on indigenous ways of living with nature (O' Donoghue & Russo, 2014). In this study, IKCs shared their knowledge of environmental sustainability in terms of using organic fertilisers, for example, compost among others and organic pesticides thereof.

2.10 The Role of Home Language in Science Classes

Language plays a crucial role in the communication and development of scientific ideas in science (Gibbons, 2003). Vygotsky (1978) argues that language is the most significant cultural tool with which knowledge can be constructed. That is, effective teaching and learning require language, whether written or shared orally, during lesson discussions (Oyoo, 2017). Indigenous language is also the most crucial aspect of IKS as it embeds and transmits culture and history as part of the communication (Govender & Mutendera, 2020). Put differently, wisdom and knowledge are shared through indigenous languages either through songs, dances or *storytelling* (Lavallee, 2009). Adding weight to the latter, Settee (2007) also points out that *storytelling* is a fundamental mode of disseminating IK.

In the Namibian context, where English is used as a second language, its role is strongly felt by the indigenous learners as they struggle to develop the scientific language and learn the language of teaching and learning instructions (Msimanga & Lelliott, 2014). In light of this, Wellington and Osborne (2001) warn that poor English proficiency among Namibian learners has a detrimental effect on their education and may lead to poor academic performance. To ease this challenge, translanguaging and codeswitching tend to be used as solutions (Denuga, 2015). Supporting this view, Probyn (2009) reveals that code-switching is a common feature in most South African classrooms to achieve teaching and learning objectives. Similarly, in their studies, Charamba (2020) and Mutanho (2021) found that translanguaging created an environment conducive to learning, boosted learning and improved learners 'understanding.

In this regard, Ntsaone (2005) calls for the urgent promotion and protection of indigenous African languages because the lack of indigenous (home) languages in schools makes it difficult for learners to comprehend and make sense of science. Simply put, the use of home language in

science classes tends to empower learners as they can express their thoughts fluently and eloquently (Nieto, 2004; Ntsaone, 2005). Home language should therefore be regarded as a cultural resource instead of a barrier that can make science relevant and meaningful to the learners.

During the workshop presentation in this study, the IKCs used the Oshiwambo language which was well understood by all participants and led to increased participation of the participants. The discussions were then translated into English to ensure that both languages were learned. Essentially, the use of the home language helps to boost the indigenous learners 'self-esteem and participation (Ashofor et al., 2016; Mavuru & Ramnarian, 2019).

2.11 Theoretical and Analytical Frameworks

The theoretical framework for this study is drawn from Vygotsky's (1978) SCT (learning theory) and Shulman's (1986, 1987) theory of PCK (teaching theory). Within Shulman's (1986) PCK, I drew on the seminal work of Mavhunga and Rollnick's (2013) five topic-specific pedagogical content knowledge (TSPCK) components as my analytical framework. I now discuss these below.

2.11.1 Theoretical framework: Socio-cultural theory

Vygotsky's (1978) SCT is a learning theory that describes learning as a social process through which people interact with each other and construct meaning through their social experiences. That means learning takes place best during social interactions. Concurring, McRobbie and Tobin (1997) claim that the social and personal dimensions are indeed essential for learning to occur. In the classroom environment, for instance, learners should interact with their fellow learners and their teachers to make meaning that is relevant to what they want to learn. It should be noted that learners construct their meaning through interactions that exist between their peers and teachers in the classroom. In other words, Vygotsky (1978) emphasises that learning takes place through collaborative social interactions with peers or MKOs (parents, teachers or learners).

Although the social-cultural theory is a learning theory focusing on how children construct knowledge and understanding, Eun (2008) suggests that learning and development should not be restricted to children only as learning and development are essential for both children and adults,

such as teachers in the context of this study. Agreeing, Shabani (2016) posits that learning in school is also applicable to teachers, to assist them to grow in their workplaces. Therefore, this study intended to promote teacher learning through social interaction with each other and the IKCs, the MKOs (Vygotsky, 1978).

This study allowed interactions between the three Agricultural Science teachers, my critical friend and me (learners), and the IKCs (the MKOs). This indicates that this study was informed by the SCT in terms of interaction and learning that took place between IKCs as MKOs and teachers as learners in a socio-cultural setup. The SCT has many concepts. However, in this study, I focused only on three concepts, namely, *mediation of learning, social interactions*, and the *ZPD* as key constructs.

I drew on the three concepts as lenses to determine how teachers learn through social interactions amongst themselves and with the IKCs as well as how learning takes place during such a social-cultural context (Mavuru & Ramnarain, 2020). I now discuss each of these concepts which formed my analytical framework.

(a) Mediation of learning

Vygotsky (1978) describes mediation as a link between teachers and learners that directly affects learners' understanding of knowledge and skills in science. Mediation of learning involves the use of cultural tools such as language and other tools to achieve the learning goal (Vygotsky, 1978). Furthermore, Vygotsky suggests that mediation is essential in studying social processes since learning originates in social mediation. Moreover, Vygotsky (1978) argues that the social processes of mediation of learning are based on the understanding of the human intelligence of society and its culture. Agreeing, Lemke (2001) avers that the mediation of learning of science must be regarded as human actions which are positioned in the larger community and culture, extending outside the classroom.

Building on Vygotsky's seminal work, Kozulin (2004) points out that mediation encompasses the interaction between the teacher, subject content, and learners for the acquisition of knowledge. Vygotsky (1978) believes that human activities take place in cultural, social, institutional and historical contexts that are mediated by a system of symbols, language or cultural artefacts amongst

other mediatory tools. To Vygotsky (1978) language is the most important tool with which knowledge can be constructed. In concurrence, Everett (2013) asserted that language is a vital cultural tool through which learning and thinking are shaped. In other words, without language, it would be impossible to socialise and interact. Notably, mediation tools such as language serve the purpose of conveying abstract concepts to the concrete level. Thus, language is a vital feature and tool of any formal school learning system.

In the context of this study, the concept of mediation came into play during the practical presentation on traditional ways of growing crops by the local IKCs – the MKOs. During the presentation, the IKCs elaborated on how to grow crops traditionally to less knowledgeable teachers in the field of IK. The presentation created an opportunity to use cultural knowledge from the presentation and relate it to scientific concepts. This resonates with Snively and Corsiglia (2001), who state that science is embedded in our culture, thus it should be incorporated into the classes like other sciences.

During the presentation, the IKCs (MKOs) used the Oshiwambo language to mediate learning. By using Oshiwambo, their home language, the IKCs were confident and finished their presentation without any struggle with vocabulary. This also allowed teachers to communicate and participate more freely since they were also Oshiwambo speakers. This coheres with Mavuru and Ramnarain (2019) who claim that the integration of the home language helps to increase the indigenous learners' self-esteem which ultimately increases school engagement in the learning environment. Teachers (learners in the context of this study) are still capable and willing to communicate in their local language (Oshiwambo). Hence, teachers should sensibly consider the language they use to convey science concepts and main ideas to learners during instructional interaction. Figure 2.5 below shows a diagrammatical representation of the Vygotskian mediation triad linking.

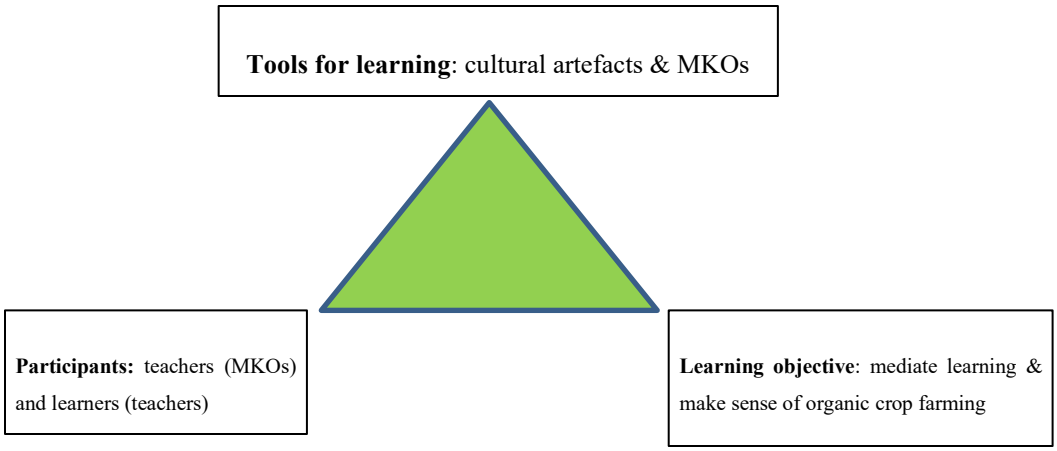


Figure 2.5: Mediation triad linking (adapted from Vygotsky, 1978, p. 54)

In this study, two MKOs presented organic ways of growing crops in their mother tongue (Oshiwambo) to mediate learning. The MKOs also used cultural artefacts to facilitate the presentation. Differently put, the use of the mother tongue and other cultural artefacts were used as mediatory tools as asserted by Lantolf and Thorne (2006). Social interactions took place during the mediation of learning.

(b) Social interactions

To Vygotsky (1978), learning takes place through social interactions with peers or knowledgeable others (MKOs) such as parents, teachers or learners. Tam (2015, p. 35) asserts that "the more we participate in collaborative activities, the more we learn from others, which in turn, maximises our productivity and potential to the fullest". This suggests that it is through collaborative interactions with more knowledgeable persons that meaningful learning takes place. In this study the IKCs, teachers (regarded as learners in this study) and I interacted during the presentation with the IKCs. I assumed that when the IKCs (MKOs) presented how crops were traditionally grown they were likely to contribute to the learning experience of the participating teachers on how to integrate IK when mediating the learning of organic crop farming and possibly shift them from their current teaching strategies to a more culturally responsive approach (Wyatt et al., 2017).

Furthermore, social interactions during the workshop presentations played a significant role as I could observe how the participating teachers were freely participating or interacting with each other and with the MKOs by asking questions and making comments on the presentation. This resonates well with Vygotsky's (1978) assertion that learners learn better from their peers as they feel more comfortable with each other. As such, social interactions might lead to an increased ZPD of the participating teachers. In this study, social interactions between the members of the Professional Learning Community (Chauraya & Brodie, 2018), the three Agricultural Science teachers, provided the answer to research question two:

RQ 2: What learning opportunities are created (or not) for Grade 12 Agricultural Science teachers to interact, participate and learn during the presentations on organic crop farming made by the expert community members?

(c) Zone of proximal development

Vygotsky (1978) described the concept of ZPD as the distance between the actual development level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers. He further states that "what a child can do in collaboration with others today, tomorrow he will do it alone". Moreover, Vygotsky (1978) posits that people who work in groups have large ZPDs compared to individuals. In concurrence, Shabani et al. (2010) assert that individuals learn best when working together with others during collaboration, and it is through such collaborative endeavours with more skilled persons that learners learn and internalise new concepts, psychological tools and skills. Shabani (2016) broadens the concept of ZPD from a school setting to teachers. In the same vein, Stott (2016) argues that it is not only the learners who benefit from the ZPD but all participants, including adults. The ZPD of teachers can be defined as a learning space between the current level of teaching knowledge and pedagogical knowledge of teaching at the next (potential) level, with support from others (Eun, 2008). In this study, the potential of teachers might have developed during the development of the lesson plan and science concepts that emerged from the IKCs presentation of how food is grown traditionally (see Appendix O & Figure 5.12 respectively). It is hoped that the participating teachers' ZPD shifted after they participated in the presentations by the IKCs and through joint conversations on how crops can be

grown organically. The model (Figure 2.6) below (adapted from Shabani et al., 2010, p. 242) shows how the ZPD of teachers is affected by influential factors.

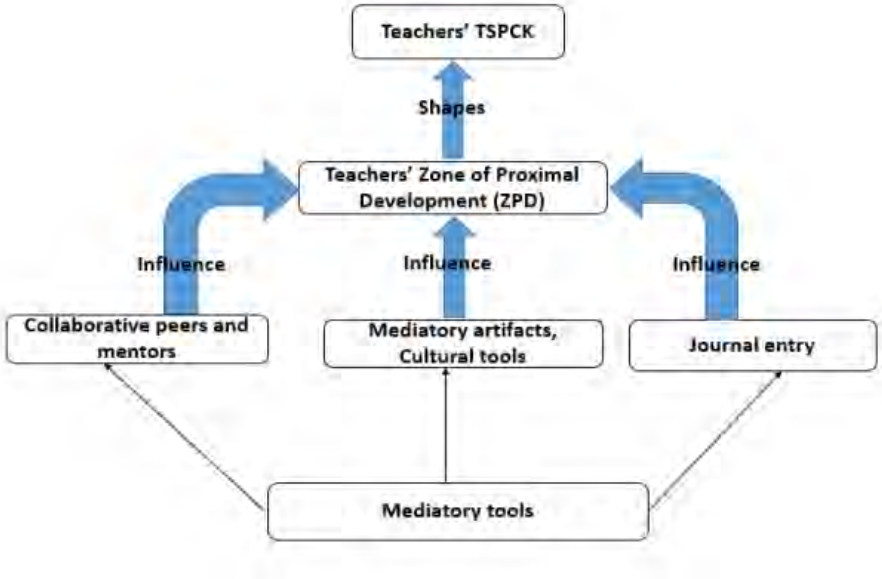


Figure 2.6: Factors influencing teachers' ZPD (from Shabani et al., 2010, p. 242)

This model illustrates how mediatory tools such as mentors, artefacts and journal entries influenced the teachers' ZPD in this study which in turn shaped their pedagogical approach to specific topics. The cultural tools used by the IKCs during the presentation on how crops were traditionally grown acted as mediatory artefacts that mediated learning. It was hoped that these tools could influence the teachers' ZPD, as they asked questions about the presentation. Through the guidance of the mentors (IKCs), learners were expected to progress to a higher level of understanding of the concept of organic crop farming. Shabani et al.'s (2010) model of influential factors in teachers' ZPD has helped me to see the link between Vygotsky's (1978) SCT and Mavhunga and Rollnick's (2013) TSPCK as analytical theories or frameworks in my study. I used these theories to establish how the Grade 12 Agricultural Science teachers learned from the IKCs (mentors) and each other (colleagues or peers) during the intervention on how to integrate indigenous knowledge into the teaching of organic crop farming.

2.11.2 Analytical Framework: Topic-specific pedagogical content knowledge

To augment Vygotsky's SCT, I also used Shulman's PCK as my analytical framework. Shulman (1986, p. 8) defined PCK as 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 of learners, and presented for instruction". Shulman (1986) proposes three categories of content knowledge for teachers: subject matter knowledge (SMK), PCK, and curricular knowledge. In light of this, Shulman suggests that teachers should know the subject matter and possess the knowledge to recognise and address the misconceptions learners may have about a topic. He further states that teachers should also employ the best strategies that make a topic more comprehensible and interesting to the learners. Moreover, Shulman (1987) elaborates on PCK as the knowledge that includes "an understanding of what makes learning a specific topic easy or difficult" (p. 9). This postulates that the teacher should know the appropriate teaching strategies and support materials required to mediate the learning of a particular topic effectively.

Shulman (1986) further identified seven categories of teachers' knowledge, namely: (i) content knowledge; (ii) general pedagogical knowledge; (iii) curriculum knowledge; (iv) PCK; (v) knowledge of learners and their characteristics;(vi) knowledge of educational contexts and (vii) knowledge of educational ends, purpose, and values. For teachers to develop PCK they should know the SMK. In this regard, Mothwa (2011) argues that PCK focuses on the knowledge of what teaching strategy would be most appropriate to ensure that learners comprehend a certain topic.

Drawing on Shulman's seminal work, Shing et al. (2015) define PCK as the integration of pedagogy and content which covers the 'what' and 'how' of teaching. In other words, to teach effectively, teachers should be skillful enough to merge the content knowledge, instructional strategies and student knowledge (Shing et al., 2015). Thus, I chose to use Shulman's (1987) PCK as it focuses on how teachers can transform their SMK to make it understandable to the learners.

However, Shulman's theory has been critiqued by some scholars. For instance, Bromme, (1995), argues that defining PCK as an instructional strategy gives the impression that the influences of other mediating factors of teaching and learning are not acknowledged. Similarly, Kind (2009)

also contends that Shulman's (1986) PCK is not yet an explicit tool to be used by teachers and is not yet backed up by theoretical evidence to support its existence. Agreeing, Loughran et al. (2016) claim that PCK is well understood but still under-theorised, lacking empirical grounding (Backman & Barker, 2020). Kind (2009) further argues that PCK is regarded to be difficult to measure because it is tacit and not easy to document. She was, however, quick to point out that PCK was a useful construct in education to uplift teaching to a professional status (Kind, 2009).

Within the PCK I used Mavhunga and Rollnick's (2013) TSPCK as my analytical framework. To Mavhunga and Rollnick (2013), PCK differs from topic to topic. In other words, different teaching strategies are required to teach different topics. In this study, I focused on PCK within the topic of organic crop farming in Grade 12 Agricultural Science. Thus, I adopted Mavhunga and Rollnick's (2013) Topic-Specific Pedagogical Knowledge (TSPCK) analytical framework to make sense of the teachers' PCK on mediating the topic of organic crop farming. To Mavhunga and Rollnick (2013), TSPCK comprises five components namely, learner prior knowledge, curricular saliency, what is difficult to understand, representations and conceptual teaching strategies (see Figure 2.7 below).

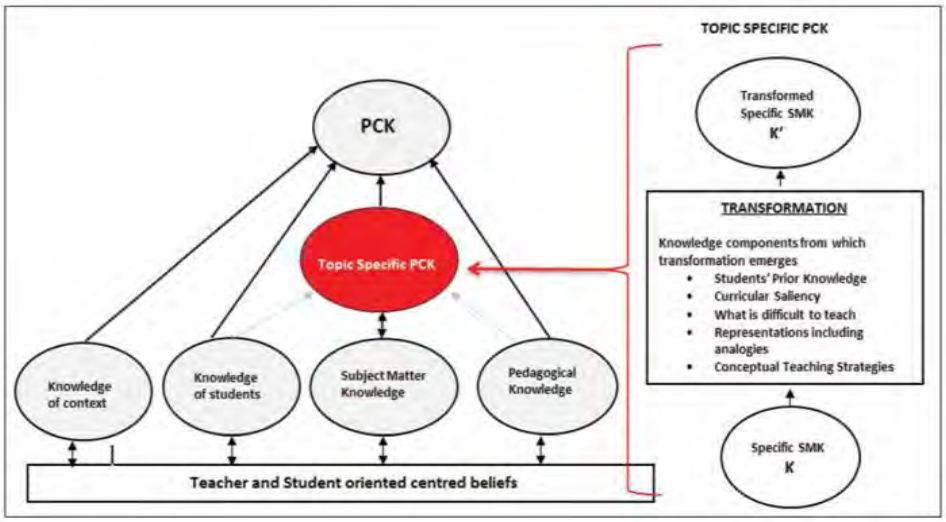


Figure 2.7: A model showing the five components of Topic-Specific PCK (adapted from Mavhunga & Rollnick, 2013, p. 115)

Mavhunga and Rollnick (2013) further contend that the five knowledge components are knowledge categories that are influenced by the beliefs of the science teachers and play an important role in teachers's pedagogies.

(i) Learners' prior knowledge

According to Mavhunga and Rollnick (2013) this component refers to the ability of the teacher to elicit learners' prior knowledge. Teachers are required to have skills and knowledge to understand and handle misconceptions learners might have on a specific topic (Mavhunga & Rollnick, 2013). This includes what learners were taught in previous grades as well as learners' everyday home knowledge. In this study, qualitative data were captured from the semi-structured interviews on how Grade 12 Agricultural Science teachers elicited and made use of their learners' prior knowledge. Moreover, this component was deployed to analyse the teachers' perspectives, understanding, and pedagogical insights into the integration of IK into science classes.

(ii) Curriculum saliency

According to Mavhunga and Rollnick (2013), curriculum saliency entails the identification of a specific topic and highlights the most important concepts around that topic which learners need to understand. Ideally, before a new topic is presented to the learners, the prerequisite concept should be learned or elicited (Magwentshu, 2020; Shinana, 2019).

(iii) What is difficult to teach?

This component focuses on how teachers deal with the concepts that learners find difficult to comprehend (Mavhunga & Rollnick, 2013). Essentially, this component aims to determine teachers' knowledge about learners' learning difficulties in a specific topic as well as the identification of misconceptions. In the case of this study, integrating IK into science concepts embedded in organic crop farming had been a challenge for many Agricultural Science teachers, as revealed in this study. This component was therefore drawn on to critically analyse the teachers ' responses given during the semi-structured interviews.

(iv) Representations and conceptual teaching strategies

According to Mavhunga and Rollnick (2013), representations refer to different ways of presenting the subject content to make it meaningful to the learners. Furthermore, Mavhunga and Rollnick (2013) describe representations as mediatory tools which can be in the form of models, simulations, or actual artefacts, which can be used to enhance learners' comprehension of science concepts. Mavhunga and Rollnick (2013) further posit that conceptual teaching strategies refer to the teaching methods and styles that the teacher can employ to enhance learners' conceptual understanding. With these knowledge bases, teachers can choose teaching and learning aids to mediate the learning of abstract science concepts in a manner that enhances a deep understanding of science concepts. Representations can enable learners to easily attach the meaning of the content being taught (Shinana, 2019).

In this study the five knowledge components were used as lenses to analyse the data gathered during semi-structured interviews, workshop discussions, presentations and reflections as well as the co-development of an exemplar lesson on the topic of organic crop farming integrating IK. I chose to use these components because I believed that they would enable me to comprehend how teachers elicited learners' prior knowledge related to the topic of organic farming and how they made abstract concepts meaningful to the learners; I also believed they would enable me to observe the teaching material and methods they use to teach organic crop farming.

The concept of PCK has evolved over the years owing to several opposing views regarding PCK. Thus, to come to a common understanding of PCK, a group of researchers gathered in 2012 in Colorado Springs, USA, and designed a consensus model which was referred to as the Teacher Professional Knowledge (Consensus PCK Model) (Gess-Newsome, 2015, p. 31). This is shown in Figure 2.8 below.

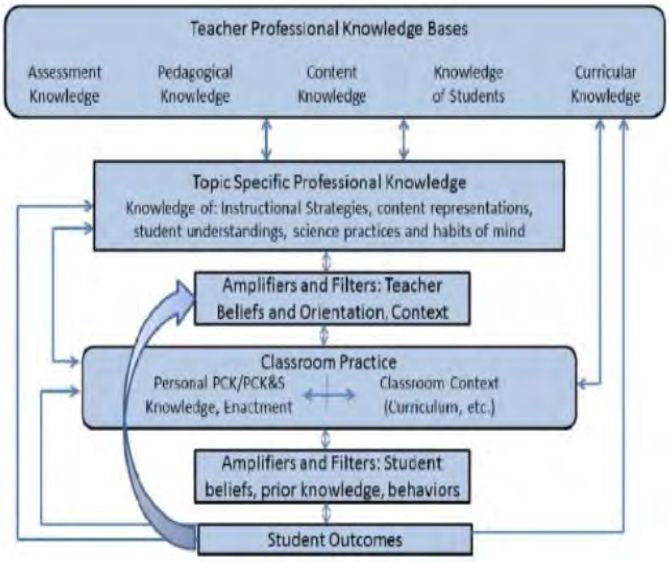


Figure 2.8: Consensus Model of PCK from PCK Summit 2012 (Gess-Newsome, 2015, p. 31)

In this model, PCK is defined as knowledge and skills used by teachers when planning to teach a specific topic in a classroom context (Gess-Newsome, 2015), in this case, organic crop farming. However, this model has also been critiqued for having insufficient detail about PCK. Subsequently, the model has been further refined and improved to reflect the multi-dimensional nature of PCK (Carlson & Daehler, 2019). The new Refined Consensus Model) identifies three distinct realms of PCK, namely collective, personal and enacted PCK as shown in Figure 2.9.

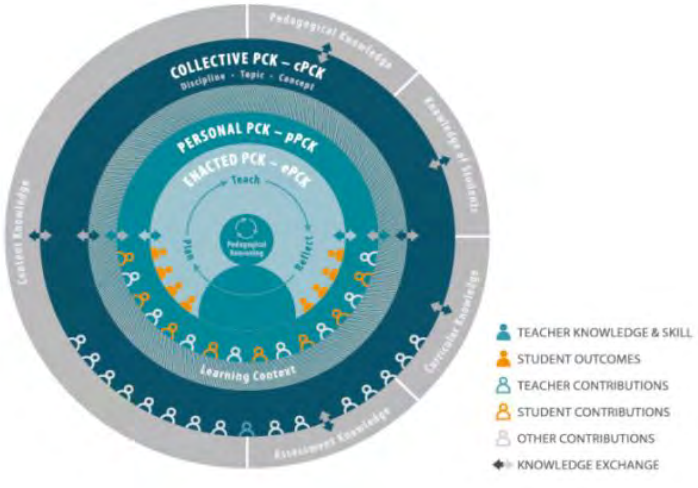


Figure 2.9: Refined Consensus Model of PCK (Carlson & Daehler, 2019, p. 83)

I now discuss these concepts below.

- Collective PCK is specialised knowledge that is held by many teachers in the field. This knowledge is usually public and not private. In the context of this study, it is the collective knowledge possessed by the four Agricultural Science teachers and I. This knowledge is usually acquired from institutions of higher learning such as universities and training colleges.
- Personal PCK is the knowledge that teachers acquire during their teaching careers. In this case, this is the knowledge that had been acquired by the Agricultural Science teachers and I over the years of teaching Agricultural Science at the secondary school level.
- Enacted PCK is the knowledge that teachers gain when they teach in classes. In the context of this study, this knowledge was realised during the co-development of the exemplar lesson plan that integrated the IK of growing crops.

I opted to use Vygotsky's (1978) SCT learning theory and augmented it with Shulman's (1987) PCK because they complement each other. For instance, the SCT emphasises the importance of culture, language and social interactions during the mediation of learning. In the case of this study, the three tenets were fostered during the practical demonstrations by the IKCs on the traditional ways of growing crops that is, methods of fertilising the soil and controlling crop pests. On the other hand, PCK focuses on pedagogies or teaching strategies to make SMK understandable to learners to enable a shift in their ZPDs. In essence, teaching involves language and social interactions between the teachers (MKOs) and the learners which are constructs of the SCT. Indeed, this shows that the two theories complement one another.

2.12 Chapter Summary

In this chapter, I discussed literature relevant to the integration of IK into science teaching. I reviewed the literature on the concept of organic crop farming in terms of pest control and fertilising the soil respectively. Indigenous knowledge (IK) and its importance were also highlighted. I also discussed challenges relating to IK integration in science teaching. The chapter ended with a discussion of theoretical and analytical frameworks. In the next chapter I discuss the research methodology employed in this study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The main goal of this study was to explore the use of the indigenous technology of organic crop farming to mediate learning in Grade 12 Agricultural Science lessons in Namibia. To achieve this goal, I established a methodology with an appropriate research design. Thus, in this chapter, I present and discuss the research methodology, that is, the research paradigms and research design that guided this study. The chapter also discusses issues of validity and trustworthiness and the ethical considerations taken in this study. The chapter concludes with a chapter summary.

3.2 Research Paradigms

According to Creswell (2016), a research paradigm is a lens through which a researcher discerns worldviews. Agreeing, Maree (2016) posits that research paradigms are lenses through which a researcher perceives the world. To Bertram and Christiansen (2015, p. 22) "a research paradigm represents a particular world view that defines, for the researchers who hold the view that is acceptable to researcher and how this should be done". This study is underpinned by two paradigms, namely the interpretivist and Indigenous paradigms. Notably, within the indigenous paradigm, I then focused on the Ubuntu perspective. I now discuss each of these below.

3.2.1 Interpretivist paradigm

Bertram and Christiansen (2020) posit that the interpretivist paradigm seeks to understand human agency, behaviour, attitudes, beliefs and perceptions. In the same vein, Thomas (2013) asserts that there is a world out there that is differently constructed by each of us and carries different meanings for everyone. Thomas (2013) further avers that interpretivists are interested in people and the way they interrelate, what they think, and how they form ideas about the world. Concurring, Cohen et al. (2018) posit that the interpretivist paradigm aims to understand the subjective world of human

experience. It is, therefore, imperative for a researcher to comprehend another person's world and this can be done by immersing oneself in that particular situation.

This paradigm, therefore, was deemed appropriate to my study as it could be used as a lens to ascertain the Agricultural Science teachers' perspectives, experiences, and pedagogical insights on the use of indigenous technology in their classes. In addition, it could be used to find out how the workshop presentation had influenced the teachers' perspectives on the integration of IK into science lessons. However, the interpretivist paradigm has been criticized because it mainly focuses on descriptions at the expense of explanations. To address this limitation, I therefore complemented it with the indigenous research paradigm (Chilisa, 2012).

3.2.2 Indigenous research paradigm

The indigenous research paradigm is viewed by many scholars as an emerging approach to research that is grounded in indigenous peoples' ontologies, epistemologies and axiologies (Chilisa, 2012; Le Grange et al., 2020; Seehawer, 2021). The indigenous research paradigm comes from the fundamental belief that knowledge is relational (Chilisa, 2012). That is, it enables research to be carried out in respectful and ethical ways which are beneficial to the research. Essentially, the indigenous paradigm enables researchers to reveal knowledge that was previously ignored which enables the researcher to close the knowledge gap that has resulted from colonisation and the suppression of indigenous knowledge (Chilisa, 2012). Moreover, the indigenous paradigm aims to decolonize indigenous dominant research methodologies by clearly defining research from the indigenous perspectives (Mutanho, 2021; Seehawer, 2018b).

However, it is imperative to note that indigenous people are not a homogenous group of people with a universal culture and worldview (Mutanho, 2021). For this reason, I drew from the Ubuntu perspective which is the epistemological foundation for many Africans (Seehawer, 2021). Ubuntu is a "philosophy that is a collective effort characterized by the spirit of togetherness which sees human needs, interests, and dignity as a fundamental importance and concern" (Higgs, 2008, p. 453). Essentially, the Ubuntu worldview expresses an ontology that addresses relations among people and promotes love and harmony among peoples and communities (Chilisa, 2012). Simply put, Ubuntu is a spirit of togetherness (Seehawer, 2018) that is mainly concerned about the welfare of the whole community as opposed to individual needs and interests. This indicates that Ubuntu

is central to the indigenous paradigm and thus could be used in this study as the relational lens that informed our conduct as we collaboratively engaged in the co-construction of knowledge (Chilisa, 2012).

Essentially, I chose to use the Ubuntu perspective because it focuses on indigenous African cultures and seeks explanations and solutions to alleviate problems faced by Africans (Mkabela 2015). This cohered well with the aim of my study, which sought to explore an alternative teaching approach (IK integration into science) to allow indigenous learners to access school science. Simply put, when I invited the IKCs to share their local knowledge on how crops are traditionally grown, this accorded the Agricultural Science teachers and I an opportunity to interact with them to gain insights into the science concepts embedded in the traditional ways of growing crops.

Further, Kakambi (2021) asserts that the Ubuntu paradigm is contrary to individualism as it holds the view that much can be achieved through collaboration. Thus, the willingness of the IKCs to freely share their knowledge on how crops are traditionally grown is central to their Ubuntu. This clearly shows that Ubuntu is concerned about the welfare of the whole community as opposed to individual needs and interests as I noted earlier. It was based on this comprehension that I chose to draw insights from Ubuntu and research with my informants as opposed to researching them as reiterated by Ngcoza and Southwood (2019). Put differently, Ubuntu allows mutual respect between the researcher and the participants because, in the Ubuntu paradigm, knowledge is generated and validated through discussions with the concerned community. On the one hand, Mangena (2015) stresses that there is no problem in appreciating and using the Ubuntu approach in African research, however, the problem emerges when one thinks that research approaches such as Ubuntu cannot stand in non-Western cultures without the blessing of Western thinkers. Thus, it is worth noting that Ubuntu is not entirely a unique concept and as such, there might be other similar concepts in other contexts.

Thus, in the context of this study, using an interpretive paradigm combined with the lens of Ubuntu allowed me to explore, observe and comprehend teachers' perspectives and understandings of IK embedded in the indigenous technology of organic crop farming during the presentation made by the IKCs. Essentially, the role played by the IKCs in this study of sharing their knowledge free of

charge and the smooth collaboration between the IKCs and the participating teachers are central to Ubuntu.

3.3 Research Design

Cohen et al. (2018) describe a research design as a plan or strategy used by the researcher to answer research questions based on empirical evidence. Similarly, Bertram and Christiansen (2020) also explain a research design as a plan showing exactly how the researcher systematically collects and analyses the data required to answer the research questions. Within the interpretive and indigenous research paradigm, I adopted a case study research design, as discussed in the section below.

3.3.1 Case study research design

A case study is a detailed phenomenon under close consideration, focused on practice, intervention and interpretation, aiming to improve the situation under study (Cohen et al., 2018). To Bertram and Christiansen (2015), a case study is "a systematic and in-depth study of one particular case in its context" (p. 42). Essentially, a case study allows a researcher to examine a particular issue in detail rather than superficially. This coheres with Thomas (2013), who elaborates that a case study involves an in-depth study to get a detailed understanding of a situation.

In the context of this study, a case study was thus deemed appropriate as I sought to obtain in-depth insight into how to integrate IK into organic crop farming. Therefore, my case in this study was the four Grade 12 Agricultural Science teachers, who worked together as co-learners in a learning community (Ngcoza & Southwood, 2019) to explore ways of integrating IK into their Agricultural Science classes. My unit of analysis, therefore, was based on the social interactions, participation and learning experiences during the workshop presentation made by the two IKCs. The reason for this research approach was to study how the presentation on the indigenous technology of organic crop farming enabled or constrained the teachers' perceptions of IK integration into science and their understanding of the concept of organic crop farming.

As with Hashondili's (2020) and Nyamakuti's (2021) studies, my study was also informed by Chikamori et al.'s (2019) Transformation Model of Education for Sustainable Development (TMESD) framework. This model resonates well with IK instructional designs such as lesson

planning and the involvement of community members as the key custodians of IK. Essentially, this model elaborates the processes involved in how IK could best be integrated and enacted in Agricultural Science classes. According to Chikamori et al. (2019), the TMESD framework is composed of three learning processes: (i) *knowing the present*, (ii) *past-present relationship* (focusing on dependence of the present on the past), and (iii) *future-present*. These scholars refer to the process of studying the past-present relationship as *retroduction* and future-present relationship as *retrodiction* (see Figure 3.1 below).

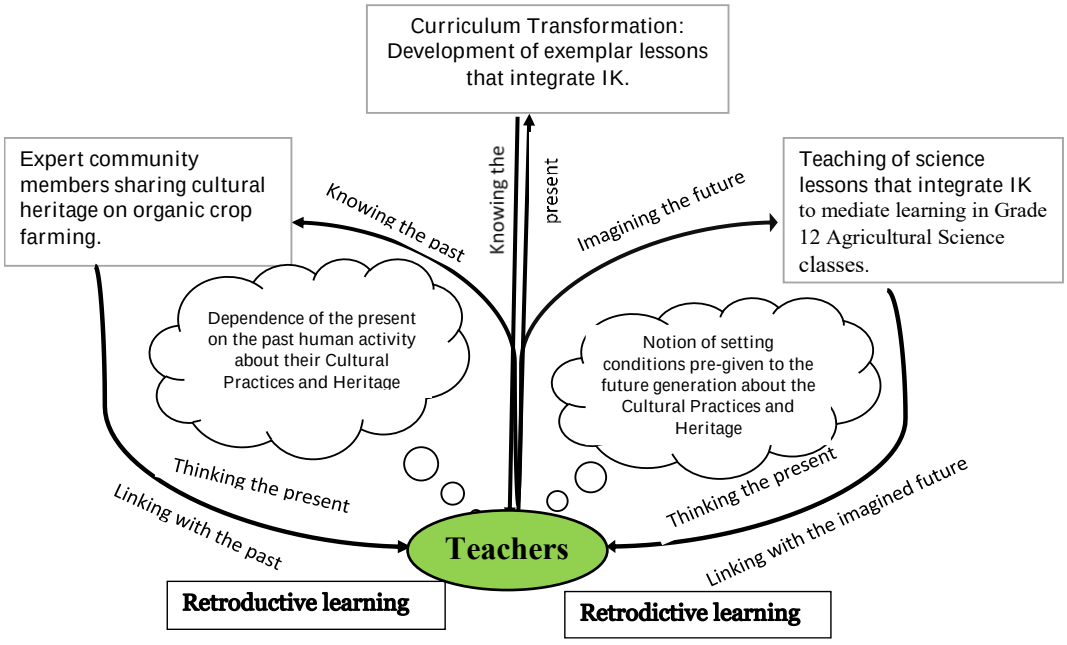


Figure 3.1: Shows the learning process regarding the integration of IK in science lessons (adapted from Chikamori et al., 2019, p. 9)

Drawing from Mavhunga and Rollnick (2013), the specific topic in this study was organic crop farming. The first sub-process (knowing the present) was achieved using semi-structured interviews. The data collected were used to find out the perspectives, experiences, and pedagogical insights of Agricultural Science teachers on organic crop farming and how they integrated IK or not when mediating learning of organic crop farming in their classrooms. In the second sub-process (past-present relationship), the teachers were engaged in an intervention workshop in which the IKCs presented and shared their IK of growing crops. This allowed the Agricultural Science teachers to link the scientific concepts embedded in the cultural ways of growing crops with the scientific concepts of organic crop farming. Lastly, the third sub-process (future-present) was

achieved through reflections and co-development of exemplar lessons that integrated IK on organic crop farming (future).

The Chikamori et al. (2019) TMESD framework was deemed appropriate for this study since it clearly outlines the processes involved in the design and integration of IK into science lessons. Furthermore, this model also afforded the IKCs as the custodians of cultural heritage a platform to share their traditional knowledge of growing crops (past) to make the learning of organic crop farming accessible and meaningful to the learners (future).

3.3.2 Research goal and research questions

The goal of a study always outlines what a researcher aims to accomplish. Therefore, to achieve the goal of this study, I formulated questions that were directed at achieving the goal of the study. Below, I present the goals of the study and the research questions which guided this study.

3.3.2.1 Research goal

The main goal of this study was to explore the use of the indigenous technology of organic crop farming to mediate learning in Grade 12 Agricultural Science classes**.**

3.3.2.2 Research questions

1. What are Grade 12 Agricultural Science teachers' perspectives, experiences and pedagogical insights regarding the integration of IK into their classrooms?
2. What learning opportunities are created (or not) for Grade 12 Agricultural Science teachers to interact, participate and learn during the presentation on organic crop farming made by the IKCs?
3. How can the IK on organic crop farming presented by the IKCs be used to co-develop exemplar lessons?

3.4 Research Site

This research study was conducted at two different peri-urban government senior secondary schools in the Oshana region in northern Namibia. The schools accommodate learners from grades 10–12 who are mainly from the same socio-cultural backgrounds (Mavuru & Ramnarian, 2017) at the time of this study. That is, about 99% of learners who attended these schools come from Black townships and speak the same language – Oshiwambo. Notably, Agricultural Science is offered as an optional subject and is taught in English which is used as the medium of instruction. Consequently, learners struggle to communicate in English as it is a second language to them. This is due to the Namibian Basic Education and Culture policy that made English mandatory as a language of instruction in all government schools (MoE, 2015).

3.5 Sampling of Research Participants

Convenient and purposive sampling was used in this study (Bertram & Christiansen, 2020). The two schools were convenient for me because they were close to the school where I was teaching. In addition, I already knew the participating teachers as we used to set the regional and circuit-based examinations together. I thus hoped that this would make it easier to interact with my research participants.

Drawing on the work of Bertram and Christiansen (2020), the four Grade 12 Agricultural Science teachers were purposively selected to participate in this study. For Bertram and Christiansen (2020), participants are chosen for a specific purpose that suits the needs of the study. In this study, I chose to work with the four Agricultural Science teachers because they were experienced and familiar with the Agricultural Science content and the various teaching approaches in Agricultural Science, including the practical work component. In addition, I selected these teachers from different schools as I wanted us to establish a Professional Community of Practice (PCL) to improve our practices (Lave & Wenger, 1991; Wenger, 1998).

The two IKCs were also sampled purposively as they were deemed suitable to be part of this study. That is, they had vast knowledge and experience in growing organic/traditional crops, as they had been practising organic crop farming as their traditional way of producing food in the rural areas where they grew up and lived. In addition, they were willing to share their cultural heritage of

growing crops which showed their Ubuntu spirit. This placed them in a more knowledgeable position regarding IK as espoused by Vygotsky (1978). Furthermore, the IKCs' homes were only about 10 kilometres away from the schools where I was conducting my study. This was quite convenient in terms of fuel costs for teachers to drive to and from the IKCs' houses.

Moreover, all four participants (including me) and the IKCs were all Oshiwambo speakers, which provided a good opportunity for us to explore the local alternative means to mediate learning of organic crop farming. This portrays the power of language as a cultural tool for communication (Hewson et al., 2009; Mavuru & Ramnarain, 2017; Nhase, 2019; Vygotsky, 1978).

Notably, the critical friend was also purposively chosen; even though she specialised in Biology, she was very passionate about agriculture and IK. As such, she willingly accepted to participate in my study as a co-researcher and critical friend as she wanted to deepen her knowledge about IK and agriculture in general.

The sample size for this study was small but adequate in terms of the data collected. That is, this was a case study, thus the main aim of the study was not to generalize the research findings to a larger population such as to all Grade 12 teachers in the Oshana region and beyond. However, the study aimed at determining and understanding the Grade 12 Agricultural Science teachers' perspectives, experiences and pedagogical insights on the integration of IK into their science teaching. Moreover, we intended to co-develop an exemplar lesson that integrated the IK of growing crops in terms of fertilising the soil and controlling crop pests.

The Namibian map below shows the research site where this study was conducted.

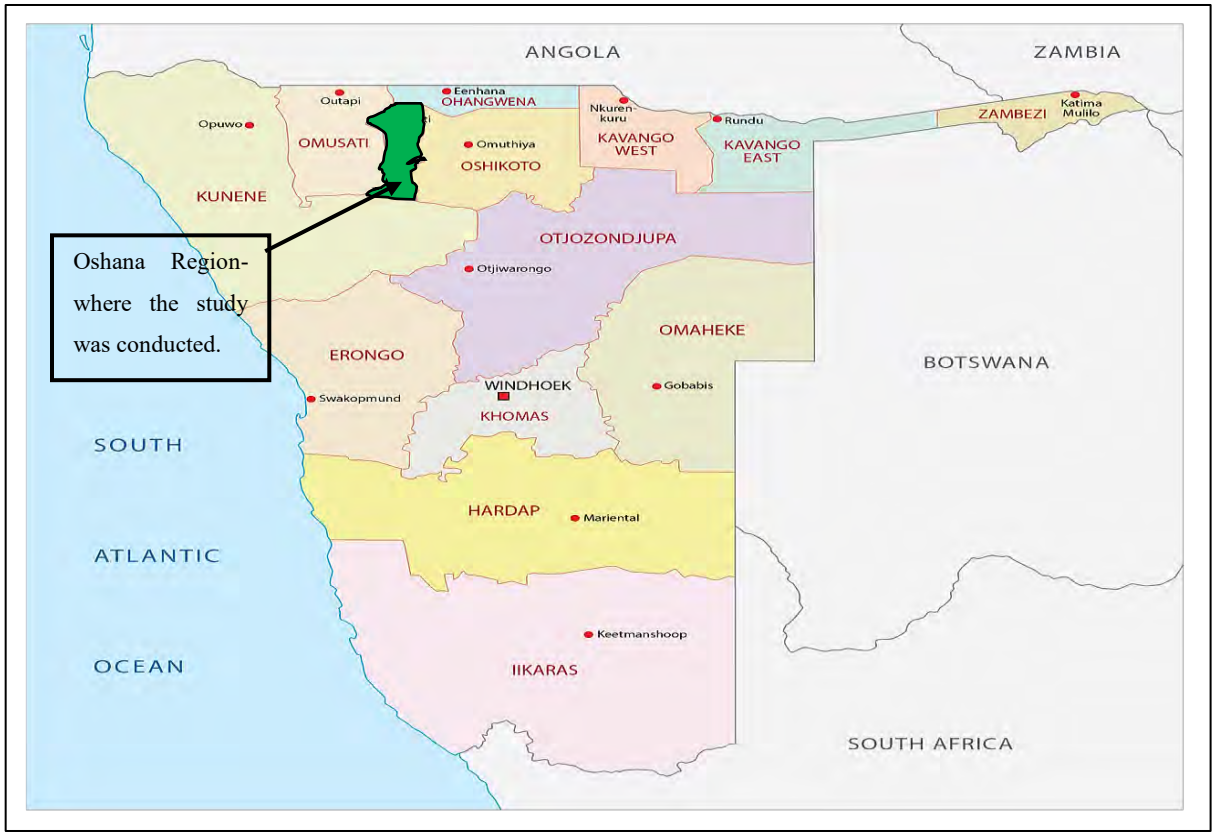


Figure 3.2: Shows the Namibian map with different regions (Adapted from WorldAtlas.com)

3.5.1 Participants profiles

In this study, I worked with four Agricultural Science teachers from two different schools in the same circuit who voluntarily agreed to take part in this study. I also worked with two IKCs (female and male) based on the criteria that they were the custodians of the IK. I now discuss the participants' profiles.

3.5.1.1 Teachers' profiles

All four of the Grade 12 Agricultural Science teachers participated in the semi-structured interviews. Concerning the use of pseudonyms, the teachers were given codes such as T1, T2, T3, and T4 respectively. Table 3.1 below shows the teachers' profiles.

Table 3.1: Shows the teachers' profiles

Name/Code	Gender	Age	Qualification	Teaching Experience	Ethnicity
T1M	Male	48	Post Grad. Diploma	19	Kwambi
T2F	Female	44	BEd Honours	15	Kwanyama
T3F	Female	27	BEd Honours	7	Kolonkandhi
T4F	Female	33	BEd Honours	8	Kwanyama

In terms of qualifications, only one teacher (T4) did not have a qualification to teach Agricultural Science as he specialised in Biology and Geography. The other three were fully qualified to teach Agricultural Science in Grade 12. The participants were aged between 27–48 years. They had between 7–19 years' experience. Ethnically, the cohort was quite diverse, representing three ethnic groups (Kwanyama, Kwambi and Kolonkadhi) from the Oshana region of Namibia. Notably, Oshikwanyama and Oshindonga were the languages used by the IKCs during their presentations. As such, there was no need for translation as the languages used were understood by all four teachers, my critical friend and me. Notably, my critical friend employed a back-translation method to ensure the accuracy of our translations in this thesis.

3.5.1.2 Indigenous knowledge custodians' profiles

Table 3.2: IKCs' profiles

Name	Gender	Age	Education	Occupation	Ethnicity
Tatekulu Dominjau	Male	76	Std 4	Crop Farmer and Retired Contractor	Oshindonga
Meekulu Paulina	Female	78	Std 7	Retired Hotel Matron	Kwanyama

Table 3.2 above shows the profile information of the two IKCs who presented and demonstrated how the soil is fertilised and crop pests are controlled traditionally. The IKCs were initially allocated codes; for instance, FIKC represented the female IKC and male IKC represents the male IKC. However, the two IKCs decided to use their real names of Paulina and Dominjau respectively in the thesis and in all resulting publications, citing that they were not thieves for their names to be hidden and that they wanted readers to know the original holders of IK unveiled in this study. This revelation is also congruent with Mutanho's (2021) study conducted in South Africa.

They also gave me permission for their photographs to appear in the thesis if need be. Therefore, the use of codes or pseudonyms was not applicable in this chapter. The IKCs' disclosure openly opposed the anonymisation of research informants as reiterated by Mutanho (2021). Simply put, although anonymity of research informants is a standard ethical measure in Western academia (Keane, 2016), in other cultural settings, such as in Africa, disconnecting knowledge from the knower can be disrespectful and has contributed to the perception of indigenous peoples' knowledge being stolen by Western researchers (Smith, 1999).

The IKCs who presented in this study were of the opposite sex (male and female). Notably, the female IKC was chosen based on the view that women are the keepers of knowledge on food production and community sustainability as espoused by Settee (2007). Put differently, I employed a culturally gender-responsive approach as advocated by Haimene (2023). Moreover, I used the words meekulu and tatekulu respectively, to show respect to the elders as per our Oshiwambo culture. Notably, the two IKCs were ethnically from the Aawambo tribe which is the largest ethnic group in Namibia. However, they spoke two different dialects, namely Oshikwanyama and Oshindonga, since the Aawambo ethnic group is made up of eight dialects. These dialects are related; hence, their presentations were done in the Oshikwanyama and Oshindonga language respectively. The ages of the IKCs ranged from 76–78 and academically their formal education varied. For instance, tatekulu Dominjau had passed standard 4 and meekulu Paulina had passed standard 7. Impressively, she could understand a few English words from the teachers' discussions/interactions, although she indicated that during their colonial schooling days, they were taught in Afrikaans and not English.

3.6 Data-Gathering Methods

Data-gathering methods are approaches used in research to collect data and well-defined pre-planned steps to be followed in the research process (Virkkunen & Newnham, 2013). In this study, I used multiple data-gathering methods to answer my research questions, namely semi-structured interviews (audio-taped), workshop discussions, participatory observation (video-taped) and journal reflections to collect data to answer three research questions. I video-recorded the interactions with the written permission of the IKCs and the teachers. As stated earlier, my critical friend was a biology teacher who was very passionate about agriculture and IK and she was part of this study from the beginning to the end. Notably, all the comments and suggestions she made were valued and appreciated.

I used a variety of data-gathering methods because I wanted to gain a broader understanding of my research study and reduce the risk of systematic bias or limitations of a specific method (Mills, 2011). This resonates with Cohen et al. (2018) who argue that the aim of using a variety of data-generating techniques is to enhance triangulation, which ensures trustworthiness, validity and reliability.

Since this study was conducted after COVID-19 restrictions were lifted, the study took place via normal face-to-face interactions. However, social distancing was still observed as we wanted to curb the further spread of COVID-19 and control the spread of other infectious diseases. I now discuss each method below.

3.6.1 Semi-structured interviews

Cohen et al. (2018) define semi-structured interviews as a conversation between the researcher and the respondent. These scholars further assert that interviews provide the researcher with richer and more reliable data about the phenomenon under investigation. In addition, O'Leary (2014) argues that semi-structured interviews use a flexible structure in which the interviewers can start with a defined questioning plan but can shift to follow the natural flow of the conversation. That is, the fact that the interviews are not structured allows the researcher to ask follow-up questions based on the interviewees to push for further clarifications. In this study, a semi-structured interview schedule was used as a guiding tool to obtain data for my research question one (see Appendix I).

I conducted individual interviews with the four Agricultural Science teachers who were audio recorded with their permission. Each interview session took about 10–20 minutes and was conducted in English. The interviews were later transcribed verbatim to make sure that all data from each participant was captured. I chose to use semi-structured interviews as I hoped that they would assist me in ascertaining teachers' understandings and pedagogical insights regarding mediating learning of organic crop farming (see Appendix J) from the teachers' collated semi-structured interview responses.

3.6.2 Workshop presentation and discussions

The workshop presentations were critical to my study. Sedlacek and Sedova (2017) postulate that workshops help to enhance teachers' learning processes, thus teachers should be involved in such activities that help them to advance their professional development. In concurrence, Eun (2008) asserts that workshops help teachers to improve their teaching strategies. As in Neporo's (2022) study, workshops were conducted in three phases.

Phase one

During the first workshop, I conducted orientation visits to lay the foundation of my study. That means that the orientations were not intended to generate data to answer any of my research questions but served as my baseline data. During this phase, I introduced myself and explained to the participating teachers and my critical friend the rationale of the study, their roles in the study, and how we were going to carry out the research study. I did this to build relationships and trust with the participants. We also collectively set out the programme of the research study events convenient for all of us. Participants were allowed to ask questions, and thereafter, they willingly signed their consent letters.

Moreover, I also paid courtesy visits to the two IKCs' houses to explain to them the purpose of the study and their roles therein. Simply put, I visited them to build trust and relationships as this is pertinent in our culture when working with elderly community members. They welcomed me with open arms citing that it made them happy to note that teachers valued the cultural norms and values as it was critical to the survival of local culture in society. In particular, meekulu Paulina highlighted that she was so delighted to learn that I was researching the traditional ways of growing

crops, citing that I took a crucial step as most modern foods are not healthy. Therefore, she noted that it was imperative for us to sustain our traditional/cultural ways of producing food to prevent various modern ailments. Interestingly, I visited the IKCs' houses at various times, and in all instances, they both closed our orientation/familiarisation meetings with prayer.

Phase two

Phase two exclusively involved workshop discussions. Vygotsky (1978) asserts that workshop discussions are important for learning through social interactions. They were thus critical to this study as they created a learning platform where informants were allowed to engage and participate in the activities (Sedlacek & Sedova, 2017). In this phase, the Agricultural Science teachers, my critical friend and I visited one of the IKC's houses where the presentation took place. The teachers introduced themselves to the IKCs and the IKCs did the same. We were welcomed with a prayer before the presentation. Of note, the IKCs preferred to co-present, reasoning that "*Omunwe umwe ihaulitoola ona*" (two minds are better than one) – they wanted to help each other so they did not leave out important information in case they forgot to mention something – they might not remember everything if they presented in isolation. This coheres well with Vygotsky (1978), who asserts that people can achieve more through collaboration. In this phase, I was a participant-observer during the presentation on organic/traditional ways of growing crops by the IKCs as I was a participant, and at the same time, I observed the interactions and engagement of teachers among themselves and with the IKCs. During the presentation, I informed the participating teachers to take notes of everything they were observing in their journals and participatory observation schedule. I also told them to feel free to ask the IKCs as many questions as possible. With their permission (IKCs' and the teachers'), the presentation and all interactions that took place were video recorded by my critical friend.

Data collected during this phase was used to answer my research question two. In other words, phase 2 focused on how the presentation by the IKCs created opportunities (or not) for teachers to interact and learn from the IKCs and among themselves. Notably, this workshop presentation was opened and closed with a prayer by each of the IKCs respectively, citing that *"without God, we are nothing and cannot achieve anything"*. For me, this gesture signalled the power of Ubuntu,

and it was impressively appreciated by my informants and me. After the presentation, we reflected on the IKCs' presentation. The next phase is the four teachers' reflections.

Phase three

After the presentation made by the IKCs, I organised a reflective session with the four teachers who were involved in this study. Four teachers were involved in this study, however, only three teachers attended the presentation made by the IKCs. The fourth teacher could not attend due to the ill-health of one of her close family members. However, she was later briefed by other participants during the group reflections about the IKCs' presentation that was done the next day.

As with Shinana's (2019) and Neporo's (2022) studies, in the last workshop, we listed all the science concepts that emerged from the IKCs' presentation and created a concept map (see Figure 5.12**)** for the emerged scientific concepts. This was done to establish if there were scientific concepts embedded in traditional ways of growing crops. Thereafter, we collectively adopted the knowledge we learned from the presentation and co-developed the exemplar lesson that integrated IK that would be used when mediating learning of organic crop farming (see Appendix O).

Essentially, the workshop discussions were deemed most appropriate for this study as they created an environment for social interactions which is considered a vital place for learning from a constructivist view (Vygotsky, 1978). This is also echoed by Sedlacek and Sedova (2017) who posit that participation in social interaction is a way to enhance learning. Therefore, these workshop activities were informed by Vygotsky's (1978) SCT and the TSPCK model (Mavhunga & Rollnick, 2013). Data generated in this phase was used to answer my research question three.

3.6.3 Participatory observation

Participatory observation is defined by Gay et al. (2012) as a setting where the observer becomes a part of and a participant in the situation being observed. That means the researcher takes part in the activity they set out to observe and in doing so they also gather first-hand experience and data on the activities, people, and physical aspects of the setting. Thus, in this study, I was a participant-observer as I carefully observed how the Agricultural Science teachers interacted, participated, and learned (or not) during the presentations made by the IKCs. Participatory observation assisted me

to get a feel for participants' actions (Cohen et al., 2018). In addition, participatory observation allowed me to establish new information that the informants were not willing or free to discuss during the interview sessions. Moreover, Sedlacek and Sedova (2017) aver that participation in social interactions in the form of workshops is one way of enhancing learning. This coheres well with Vygotsky's (1978) SCT and the TSPCK model (Mavhunga & Rollnick, 2013) adopted as the analytical framework in this study. My critical friend helped me to video-record the presentation by the IKCs with their permission. The gathered data was used to answer my research question 2.

3.6.4 Journal reflections

McMillan and Schumacher (2014) explain that journals are personal accounts of how a person has experienced a learning opportunity. The objective of reflective practice is to ensure a more precise and meaningful understanding of a situation and to provide effective applicable actions for strengthening performance (Creswell, 2016). Thus, Eun (2008) points out that writing reflections in teacher development leads to self-analysis and personal reflections. In the context of this study, journal entries were made from phase one of the study to allow teachers to internalise the learning process which would help them externalize their learning during their lesson presentations (Vygotsky, 1978). Essentially, I hoped that the teachers' reflections would assist me to ascertain the effectiveness of the workshop activities and establish any shift in the ZPD of the teachers after the presentations as proposed by Vygotsky (1978). Data generated was analysed using constructs from Vygotsky's (1978) SCT and helped me to answer my third research question.

Table 3.3: Shows a summary of the data-gathering methods used in this study

Method	**Purpose: to establish**	**Target research question**
Semi-structured interviews	Teachers' experiences, understanding and pedagogical insights on the use of IK in their classes.	1
Workshop discussions	How teachers interacted, participated and learned (or not) during the presentation by the expert community members.	2

Participatory observation	The learning opportunities were created (or not) for teachers to interact, participate and learn during the presentation on how to grow crops traditionally by the IKCs. Scientific concepts emerged from the expert community members' presentations.	2
Journal reflections	How can the IK on organic crop farming presented by the IKCs be used to co-develop exemplar lessons?	3

3.7 Validity and Trustworthiness

Validity is a crucial key to effective research (Cohen et al., 2018). These scholars further stress that if a piece of research is invalid then it is worthless. Bertram and Christiansen (2020) assert that the researcher should ensure that the research findings reflect the participants' reality and not the impression of the researcher. Furthermore, the researcher needs to make sure that the data-gathering tools employed are systematic, credible and transparent (Bertram & Christiansen, 2020). Thus, in this study, I used multiple data generation techniques (Maree, 2016) to enhance the validity and reliability of the data. Furthermore, the transcribed data from interviews was given back to the interviewees for member checking (Cohen et al., 2018). In addition, video records filmed during the presentations by the IKCs were watched in the presence of all participants to collectively reflect and discuss what emerged from the presentations. I also pilot-tested the interview questions with three fellow master's scholars before issuing them to the participants to make sure the questions would give the relevant data. Their review helped me to select the instruments I used. For instance, I changed from structured interviews to semi-structured interviews, as through peer discussions I came to understand that semi-structured interviews would allow me to ask follow-up questions to get clearer responses from the participants.

3.8 Ethical Considerations

Ethics is an important aspect of every research. According to Bertram and Christiansen (2015, p. 65), "ethics has to do with behaviour that is considered right or wrong". To Chilisa (2012), ethics involves values, a code of conduct during research and protection of the participants from physical, mental or psychological harm. Bertram and Christiansen (2015) further point out that

there are three pertinent ethical principles that all research studies should follow. These principles are autonomy, non-maleficence and beneficence. I now discuss these principles below.

(a) Autonomy

This implies that a researcher needs to get the consent of all participants and that participants must participate voluntarily in the study. In addition, it means that participants are free to withdraw from the study at any time. However, Mutanho (2021) cautions that while granting the participants the right to withdraw is a fundamental ethical procedure it must not be done as a tick-box exercise to fulfil the requirements of Ethics Committees in universities. He further argues that it is pertinent to be culturally sensitive in applying ethics. Nonetheless, in this study, the participants were informed about their rights to withdraw from the study. However, it was carefully and respectfully communicated to the participants as in Oshiwambo culture telling someone to withdraw from the exercise anytime…is generally interpreted 'as rude behaviour, which is believed to mean that the researcher does not value the informant's participation but literally, only if they want to'.

(b) Non-maleficence

Non-maleficence means "the research should not harm the participants or any other people" (Bertram & Christiansen, 2015, p. 66). This research study caused no harm to any person and all participants were assured of the confidentiality of the information they supplied. Moreover, I made sure that their identities were protected by using pseudonyms and codes for teachers, except for the IKCs who demanded that they wanted their real names appearing in my research, claiming that "*they are not thieves for their identities to be hidden*". Similarly, the expert community member (ECM) in Mutanho's (2021) study also questioned why her name would be left out yet she was the contributor of knowledge. The IKCs further granted me the permission to share their knowledge and skills with anyone as they wanted to educate the nation and the world at large about the value and power of our IK systems. It was for these reasons that the IKCs names were included in this study. It is worth noting that my study was conducted in Namibia in an Ubuntu based society where the emphasis is on mutual co-existence. Ubuntu is described by Tutu (1999) as the African philosophy which emphasises treating each other with love and compassion.

(c) Beneficence

This means the research study should be beneficial to the research participants or society at large. In the context of this study, I hoped that this study might be of great benefit to the Agricultural Science teachers as they were exposed to how best they could integrate IK into the topic of organic crop farming by using the exemplar lessons. More so, I hoped that this might ultimately benefit the learners in terms of improved performance. Furthermore, I hoped that the involvement of the IKCs might have shown them their value in society as the custodians of cultural heritage and the role they can play in the education of their children. Essentially, I hoped that the findings of this study might be used by curriculum developers to bridge the yawning gap between curriculum formulation and implementation in terms of integrating IK and WS in Agricultural Science.

3.9 Chapter Summary

In this chapter, I discussed the research methodology underpinning this study, the paradigms, and the research design employed in this study. Further, I discussed the research site, the sampling of research participants, and their profiles. Issues of positionality and reflexivity were also discussed. In addition, data-gathering methods, research processes, and data analysis were discussed. Lastly, validity, trustworthiness, and ethical considerations were also elaborated on. In the next chapter, I present, analyse, and discuss data generated from the semi-structured interviews.

CHAPTER FOUR: DATA ANALYSIS OF SEMI-STRUCTURED INTERVIEWS

4.1 Introduction

The goal of this study was to explore the use of the indigenous technology of organic crop farming to support Grade 12 Agricultural Science teachers to mediate learning in their classes. The study was motivated by the need to make school science more accessible and relevant to learners' local experiences.

In this chapter, I present, analyse and discuss the qualitative data generated from the semi-structured interviews. This was aimed at addressing research question one:

> *What are Grade 12 Agricultural Science teachers' perspectives and experiences of, and pedagogical insights into the integration of IK in their classrooms?*

4.2. Data from Semi-Structured Interviews

As explained earlier in Section 3.6.1, four teachers were individually interviewed during the semi-structured interviews which were audio-recorded with their permission. The interviews were then transcribed verbatim to make sure that information was not distorted **(**see Appendix J**)**. Teachers were given codes that were used throughout the thesis. The codes are T1 to T4 (see Table 5.1 below), representing participant teachers 1 to 4 respectively. The gender of each participant teacher - F for females and M for males - was indicated at the end of the code, while the code for semi-structured interviews is SSI. Eventually, participants were coded as teacher 1 female semi-structured interview (T1FSSI); teacher 2 female semi-structured interview (T2FSSI); teacher 3 female semi-structured interview (T3FSSI) and teacher 4 male semi-structured interview (T4MSSI). This enabled easy presentation, interpretation and discussion of the data obtained from the SSIs. While the participants' responses are given word-to-word, some may have been grammatically modified for clarity of thought.

4.3 Development of Sub-themes and Themes

Data generated from the SSIs were categorised based on the questions informants responded to and the sub-themes that were developed. Thereafter, common sub-themes were merged into themes (see Appendix K). The teacher informants' experiences, understandings and pedagogical insights into the local knowledge were not the same. Consequently, three themes were developed and data from the SSIs are presented under those themes. The themes are: Teachers' views and experiences of teaching Agricultural Science; Teachers' understanding of the term IK; and Teachers' perspectives on the integration of IK.

Table 4.1: Themes and sub-themes that emerged from semi-structured interviews

Research Question 1: *What are Grade 12 Agricultural Science teachers' perspectives, experiences and pedagogical insights on the integration of IK in their lessons?*		
Themes	**Sub-themes**	**Literature/ Theory**
1. Teachers' views and experiences on teaching Agricultural Science	-Value of local/home knowledge in science (agriculture) -Teachers' views on practical activities -Misconceptions about organic crop farming -Language usage	Asheela et al. (2021); Hashondili (2020); Asheela et al (2021); Mavhunga and Rollnick (2013); Mhakure and Otulaja (2017); Millar (2010); Mukwambo et al (2014); Mutanho (2016); Nikodemus (2017); Roschelle (1995); Sedlacek and Sedova (2017), Shinana et al. (2021); Vygotsky (1978)
2. Teachers' understanding of the concept of indigenous knowledge	- Comprehension of the term IK	Kibirige and Van Rooyen (2006); Magwentshu (2020); Mkabela (2015); Nyika (2017); Seehawer (2018)

3. Teachers' perspectives on the integration of indigenous knowledge into Agricultural Science lessons to mediate organic crop farming	-Teaching strategies or styles - IK as prior knowledge - Significance of culture and home language in teaching science - Perceived challenges on the integration of IK into science teaching	Abah et al. (2015); Aikenhead and Jegede (1999); Kibrige and Van Rooyen (2006); Le Grange (2007); Mavhunga and Rollnick (2013); Mavuru and Ramnarain (2017); Mukwambo et al. (2014); Seehawer (2018); Shulman (1986), Tylor (1999); Vygotsky (1978)

In this section, I present and discuss the themes that emerged from the data collected from the semi-structured interviews concerning the themes and the literature and theory.

4.3.1 Teachers 'views and experiences on teaching Agricultural Science

Understanding teachers' perceptions or views about Agricultural Science as a subject served as a point of departure in my mission to comprehend how the teachers mediated learning in their lessons. The teachers' responses acknowledged that school agriculture was rooted in their traditional agricultural practices. However local agricultural practices were not included in the textbooks used at school. The teachers believed that the exclusion of local agricultural practices from school tended to be one of the contributing factors to learners' poor performance. For instance, T1FSSI and T2FSSI revealed:

> *Agriculture is an interesting subject that is close to our traditional ways of living, however, many learners do not really pass it with good symbols, may be due to textbooks used which do not really include local agricultural practices or examples (T1FSSI).*
>
> *Agriculture taught in school does not really refer to agriculture practised at home, but agriculture is practised in this region (T2FSSI).*
>
> *Is like there are two agricultures now, the one learners practice home and the one they learn at school (T2FSSI).*

These responses indicate that learners' existing and everyday knowledge seems to be ignored as prior knowledge. These findings have affinity with Ogunniyi (2007), Mukwambo (2013) as well as Simpson's (2014) assertions that most African children learn science in alienating contexts that largely neglect their everyday experiences (Gwekwerere, 2016). Simply put, these teachers seem

to claim that learners are taught without any reference to their everyday lived experiences as textbooks seem not to include local agricultural examples and practices. These findings are also in line with Govender (2014) who believes that indigenous learners in most African classrooms learn science in an abstract context.

Several scholars, such as Mhakure and Otulaja (2017), Mutanho (2016), Nikodemus (2017), and Shinana (2019), similarly argue that learners' cultural heritage has the potential to make the learning of science relevant and improve their understanding of science. Indeed, it cannot be ignored as the beginning of each stage of the learning process is the learners' existing knowledge (Kuhlane, 2011). Thus, this study aimed to explore the alternative strategies of including local examples or practices in science lessons from the IKCs to assist the teachers in contextualising the science concepts that appear to be presented in textbooks in unfamiliar or abstract contexts.

Moreover, teachers' responses from the semi-structured interviews acknowledge that Agricultural Science was a practical subject in nature. For instance, T3F and T4M commented:

> *Agriculture is a practical subject; that is why is categorised as a vocational subject in the National Curriculum. However, I can say that it is taught more theoretical than practical (T3FSSI).*
>
> *Agricultural Science has to do more with practicals as a subject; however, I see the opposite happening (T4MSSI).*

The above excerpts seem to reveal that Agricultural Science is mostly delivered through a theoretical mode of teaching. In this regard, T3 further commented that "*practical work wastes or consumes a lot of teaching time … as classes are overcrowded"* (T3FSSI). From this excerpt, it could be surmised that T3's response acknowledged that they do not conduct hands-on practical activities in their lessons. Yet, it has been established that practical activities in learning and teaching science significantly facilitate learners' knowledge and understanding of science by making abstract concepts explicit to learners (Asheela et al., 2021; Shinana et al., 2021). Similarly, Millar (2010) and Shinana et al. (2021) believe that practical activities harness the linkage of theory and practice of science concepts.

T4 further highlighted the lack of materials, such as fertilisers and pesticides, as the greatest hindrance or constraint to conducting hands-on practical activities in schools. To address this challenge, science teachers are encouraged to improvise teaching and learning materials that are easily accessible and low-cost from their local environments (Asheela et al., 2021; Ministry of Education, Arts, and Culture (MEAC), 2016)). This assertion resonates well with the rationale of this study which focused on exploring indigenous ways of growing crops to help teachers integrate it in their science lessons. It was hoped that the indigenous ways of fertilising the soil and controlling pests centred on cheap and locally available materials could offer opportunities for Agricultural Science teachers to conduct hands-on practical activities at little or no cost. Materials used are sustainably obtained from the immediate environment as suggested by Asheela et al. (2021).

Moreover, when I interviewed the teachers involved in this study to share their experiences on teaching the topic of organic crop farming T1 and T4 reflected:

> *My experience is that organic crop farming is a new topic in Grade 12. I can say it is not that easy to both teachers and learners as it was not taught in previous grades and learners know nothing about it (T1FSSI).*

> *Organic crop farming is a new topic in Grade 12, so basically it is not taught in previous grades so this topic is a bit challenging to some learners to understand…and most of them do not really perform well in this topic (T4MSSI).*

From the two excerpts above, it can be seen that the lack of prior knowledge was hindering learners' understanding of the concept of organic crop farming. My analysis of their responses is that these teachers seemed to feel that there were gaps in the subject matter content, and this seemed to make learning about organic crop farming difficult. For instance, T1 further stated: *"I don't think I have seen local examples in those textbooks to help learners understand this new topic, but agriculture is practised in this area"*. These excerpts seem to highlight two sources of prior knowledge: previous grade subject content knowledge (Mavhunga & Rollnick, 2013) and everyday knowledge (Kuhlane, 2011). These researchers further claim that knowing the source of learners' prior knowledge will assist teachers in eliciting relevant prior knowledge and experiences (Mavhunga & Rollnick, 2013).

These teachers seem to have sound PCK in the sense that they are able to identify what makes learning a specific topic difficult (Shulman, 1987). For instance, T1, T2 also commented: "*Learners find organic crop farming difficult to understand as their textbooks do not really link it to the local ways of growing crops"* (T2FSSI). She added: *"Is like there are two agricultures now, the one practised at home and the one they learn at school"* (T2FSSI). These excerpts clearly show that T2 is aware that local or home knowledge is a critical source of prior knowledge that has the potential to enhance the teaching and learning of organic crop farming. These findings reverberate Kibrige and Van Rooyen's (2006) assertion that teachers normally make their teaching tasks more difficult by not commencing where the learners are and building on what they know. Similarly, this teacher's line of reasoning is in line with Aikenhead and Jegede's (1999) contention that if IK was not integrated into science, learners would find it difficult to move between the micro-culture of family and the school, and this would have a detrimental effect on their performance. By extension, T2's revelations cohere with Kuhlane's (2011) and Roschelle's (1995) notion that new knowledge begins with the selection of ideas from everyday experience. This is following Mavuru and Ramnarian's (2017) and Vygotsky's (1978) assertions that when learners' prior knowledge is acknowledged and their socio-cultural backgrounds are considered, new knowledge could be constructed. Building on Vygotsky's (1978) seminal work, Mavuru and Ramnarain (2020) argue that science teachers must take into consideration their learners' socio-cultural backgrounds to enhance science learning.

Moreover, teachers involved in this study were asked to share some of the challenges they encountered when mediating learning of organic crop farming. T1 said:

> *I cannot say challenges are not there; they are there, for example … some learners keep answering in tests that organic crop farming uses inorganic fertilisers such as compost … while the majority of learners just say compost is manure (TIFSSI).*

From this excerpt, it could be concluded that T1 identifies learners' learning difficulties and misconceptions during her lessons (Mavhunga and Rollnick, 2013). According to Mavhunga and Rollnick (2013), poor conceptual understanding could be a result of the teachers' poor conceptual teaching strategies. In my view, this form of confusion could also be attributed to conflicts between scientific and everyday language (Le Grange, 2007) as some words in English do not have the

same meaning in the indigenous language. This is indeed true of the Oshiwambo language. For instance, both compost and manure are referred to as *uushosho*, which is not necessarily the case as *uushosho* is mostly perceived as animal manure in Oshiwambo as it is the type of fertiliser commonly used by Ovawambo people in growing their crops, while compost is mainly sourced from plant materials. Thus, teachers are encouraged to use teaching strategies that can assist learners in grasping the science concepts they are learning to avoid misconceptions and memorisation.

Expanding on this view, T1 further highlighted that to clear the misconceptions, she once let learners in groups of five to six carry out a hands-on practical activity on making a compost heap. According to T1, learners were actively collaborating in their groups and asking each other and their teacher questions such as *"Why do we need to add wood ash in the compost heap?" "Why should we irrigate and cover the compost heap with a plastic…?"* From this observation, it could be deduced that the group activity proved that learning does indeed take place through social interactions with peers (learners) and the MKO (teacher) (Vygotsky, 1978). Considering this evidence, it could be argued that this teacher embraces the significance of practical activities as a teaching strategy to clear learners' misconceptions about organic crop farming. It could also be argued that this teacher had sound PCK (Shulman, 1987) in the sense that she knows what conceptual teaching strategy (Mavhunga & Rollnick, 2013) to use to enhance learners' conceptual understanding of compost.

Another challenge encountered in mediating learning of organic crop farming was highlighted by T2 who reflected: "*Obviously challenges are there … some learners struggle to understand and express themselves in English"* (T2FSSI). English as a second language seems to be a serious challenge to some learners. From my own classroom experience I can also attest that most indigenous learners really struggle to comprehend English as a medium of instruction and scientific language as English is a second language to them. For instance, one day, one of my learners during the agriculture lesson confidently stated:

> *Maara Mrs ngeno okwali hatulongwa o Agriculture moshiwambo ngeno ohatupiti aike nee A ile eeB, shaashi ondamona kutya mboli iinima ei hatulihonga ihapu oyafa aike ei hatuningi komaumbo maara shaashi oyanyolwa nohailongwa moshiingilisa they sound so foreign and difficult to understand.*

He further asked: *"But Mrs ... Why do we have to be taught in English which is a foreign language?"* (But Mrs … do you know that if we were taught agriculture in Oshiwambo we could only score As and Bs, because I have noticed that most of the things that we are taught are just similar to what we practise at home, but because the contents are written and taught in English, they sound too foreign and difficult to understand).

This revelation corroborates Wellington and Osborne's (2001) point that poor English proficiency among Namibian learners has a detrimental effect on their education and may lead to poor academic performance. To ease this challenge, T2 further expanded her response by stating that she encouraged her learners to express their answers in their vernacular (Oshiwambo) and she and other learners try to translate their answers into English for assessment purposes. She further highlighted that she observed that this tended to increase learners' conceptual understanding as well as participation in the class unlike when only English was used. Like T2, T1 also revealed that she tried to use a little bit of Oshiwambo to help learners understand the content better. It could be argued from these findings that these teachers (T1 and T2) deployed code-switching or translanguaging (Denuga, 2015) as solutions. Code-switching can be described as the change by a speaker from one language to another or the use of more than one language to contextualise communication (Masimanga & Lelliott, 2014). Expanding this view, Charamba (2020) argues that translanguaging creates an environment conducive to learning, boosts learning and improves learners' understanding. Differently put, the use of home language in science classes tends to empower indigenous learners as they can express their thoughts fluently and eloquently (Nieto, 2004; Ntsaone, 2005). Adding weight to this argument, Nhase (2019) in her study conducted in South Africa, also found that Foundation Phase teachers were able to promote scientific inquiry using isiXhosa. Similarly, Probyn (2009) affirms that code switching was a feature of many South African classrooms where teachers and learners shared a common home language to achieve various cognitive and affective teaching and learning goals.

4.3.2 Teachers 'understanding of the concept of indigenous knowledge.

All four teachers who participated in this study portrayed an understanding of what the term IK meant. For instance, TI, T2 and T3 defined IK as follows:

It is local knowledge within a community …. traditional knowledge and ways of doing things culturally, the values and norms within our families that is passed from one generation and transferred to the next generation (T1FSSI).
I think indigenous knowledge is a legacy of local knowledge that was developed by our ancestors of a particular culture which is then inherited from our fore parents and then passed from one generation to another (T2FSSI).

Knowledge and experiences from the past that is passed on to the next generation (T3FSSI).

From these excerpts, it can be argued that these teachers had some understanding of what IK was. This is evidenced by the fact that their definitions resonate with the definitions of scholars such as Kibrige and Van Rooyen (2006), Nyika (2017) and Seehawer (2018). These scholars posit that IK is a legacy of knowledge and skills unique to a particular indigenous culture that has been developed locally for the people and by the people of that locality and has been passed from parents to their children. These findings also corroborate Mkabela's (2015) view that IK is unique to a particular geographic area and possessed by people in a given cultural framework. Knowledge is passed orally from one generation to another and is not easily shared with members of another community (Kibrige & Van Rooyen, 2006) as it is based on different community contexts. T4 elaborated with some examples:

Indigenous knowledge refers to the cultural ways of doing things that we inherited from our parents…. which is specific to a certain culture for example Ovawambo people have inherited a culture of cultivating mahangu fields and keeping livestock … singing of traditional songs and dances (eenghama), storytelling …. and rituals practised at birth, weddings, or death (T4MSSI).

This response seems to be congruent with Abah et al. (2015) who describe IK as practical and contextual knowledge that cannot be detached from an individual or community as it includes the major community processes such as agriculture and traditional medicine that people depend on for survival. This finding is also in line with Mosimege and Onwu (2004) who define IK as all-inclusive knowledge that covers technologies and practices that have been and still are used by indigenous people for their existence, survival and environmental adaptations.

In expanding his understanding, T4 further reflected that IK also included singing of traditional songs and dancing, storytelling done at *oshoto* and rituals practised at birth, weddings or death ceremonies. This finding resonates well with Magwentshu (2020), Nyika (2017) and Seehawer

(2018), who postulate that IK manifests through the community elders through cultural songs, the local language, games, cultural beliefs and norms, rituals and ceremonies. This finding also highlights that wisdom and knowledge in Oshiwambo are shared either through songs and dances or *storytelling* as explained by Lavallee (2009). Concurring, Liveve (2022) describes how stories and songs in Oshiwambo play a vital role in teaching young people about Oshiwambo values and discipline. Simply put, IK is embedded in daily social interactions (Vygotsky, 1978).

This research revealed that all four teachers participating in this study seemed to understand the concept of IK. They viewed IK as local or cultural knowledge that was unique to a particular culture that was passed from one generation to another (Kibrige & Van Rooyen, 2006; Simpson, 2014). These teachers also used similar terms to define IK such as 'local community', a 'certain culture' and 'passed on from one generation to another.'

4.3.3 Teachers' perspectives on the integration of IK into Agricultural Science lessons.

The data gathered from the semi-structured interviews revealed that three out of four Agricultural Science teachers had positive sentiments towards integrating IK into their science lessons. For instance, T1 and T2 commented:

> *I try to integrate IK in my class but in a limited way because I was not trained from the institutions or any workshop how to use IK (T1FSSI).*

> *Yes, I do integrate it a little bit for example, I normally used to send learners to go and ask their parents at home about the cultural ways they use to grow crops and then I use their findings to define and explain organic crop farming (T2FSSI).*

From these excerpts, it could be deduced that despite the challenges alluded to, the teachers seemed to embrace the integration of IK into their teaching. T1 also said:

> *I have seen that when I mix IK in my teaching, especially when I use Oshiwambo, it really helps learners to understand better, participate well and also perform well in parts where I have used IK to explain concepts (T1FSSI).*

This finding resonates with Kibrige and Van Rooyen's (2006) view that when IK is integrated in teaching science it enhances participation because learners can feel the connection between what

they are learning and what they do at home. This claim also concurs with Govender (2014) who stresses that the integration of IK into science lessons results in increased learner motivation, participation and achievement. Similarly, in his study conducted in Namibia, Nikodemus (2017) found that learners' understanding and participation improved when teachers integrated IK during their lessons. The use of IK thus has the potential to enable a broader understanding of science concepts during teaching and learning (Erinosho, 2013). It allows for cultural border crossing from home or community to school (Aikenhead & Jegede, 1999). Hence, there is a need for teachers to be cultural knowledge brokers as suggested by Sleeter (2001).

In the above excerpt, T1 also highlighted that when she used Oshiwambo (the home language) to explain concepts it really helped learners to understand better, participate well and perform well. This finding is congruent with Mavuru and Ramnarian's (2019) assertion that through home language, learners can construct knowledge and make sense of science. In fact, it can make science accessible and relevant to learners (Vygotsky, 1978) as explained earlier in Section 4.3.1. Hence, it can be suggested that indigenous language is a legitimate cultural resource for science teachers to mediate difficult science concepts as it improves learners' conceptual understanding (Charamba, 2020; Masimanga & Lelliott, 2014; Ngcoza, 2019). However, it should be done in such a way that learners' acquisition of the correct scientific concepts is not compromised.

In the same vein, T2 explained: "*I normally send learners to go ask their parents at home about the cultural ways they use to grow crops and then use their findings to define and explain organic crop farming" (T2FSSI).* This speaks to culture as a prerequisite for learning science. It focuses on the elicitation of learners' prior everyday knowledge (Kuhlane, 2011; Mavhunga & Rollnick, 2013; Roschelle, 1995). This line of thought aligns with Kibrige and Van Rooyen's (2006) belief that learners enjoy linking old and new knowledge learned at home and school respectively which Aikenhead and Jegede (1999) call border crossing. This notion also corroborates the Ministry of Education, Arts, and Culture's (MEAC, 2016) argument that teachers should use learners' existing IK and culture to create new knowledge. In the same vein, T1 commented:

> *Uumh … in addition, sometimes I give learners a homework where they have to go and ask their parents the cultural things … they use to fertilise the soil and control pests … and tell them to bring to school some samples of what they have found out from their parents (T1FSSI).*

T1's strategy of asking her learners to bring locally available and low-cost resources from their immediate environment to use them as a visual representation to mediate learning of organic crop farming explicitly resonates well with Mavhunga and Rollnick (2013) who assert that representation plays a critical role in teaching and learning as they serve as teaching aids that could help learners to make sense of the science concepts being taught. In contrast to T1, T2, and TF, T4 asserted:

> *Unfortunately, I don't integrate IK in my lesson because it is not in the syllabus and textbooks, and it is also not accepted in assessments. So, I do not want to waste time teaching about something that will not be accepted in the exam (T4MSSI).*

The argument here is that the curriculum seems to be silent about IK integration. This illustrates that there is an urgent need for textbooks to be designed in a way that is inclusive of valuable cultural elements as postulated by Liveve (2022). Moreover, T4 also pointed out:

> *I was also not trained on how to use it. Uumh … I think growing up in town might also have contributed to this as I lack most of the cultural knowledge as I did not really grew up in an environment that could make it possible for me to learn IK. However, I am willing to learn about it because there is a saying that goes: A society without a culture is heading nowhere (T4MSSI).*

This response concurs with Seehawer (2018) who revealed that teachers' training institutions do not prepare teachers for the integration of IK. Taking the argument further, Kibrige and Van Rooyen (2006) posit that teachers can only recognise the value of IK in the science classroom if they are taught or trained how to integrate it into science lessons. Teacher training institutions should embark on teaching IK to student teachers so that they will be able to teach IK in schools as proposed by Neporo (2022). These findings highlight the importance of Continuing Professional Development and most significantly point to the need for this interventionist study.

4.4 Chapter Summary

In this chapter, I presented, analysed, and discussed the qualitative data gathered from the semi-structured interviews. This aimed at answering the first research question of my study. The findings revealed that teachers seemed to have positive sentiments towards the integration of IK into Agricultural Science. However, it emerged that the participating teachers had not received any

tertiary education training on the integration of IK and lacked the pedagogical skills to integrate IK into their teaching. Herein lies the importance of my interventionist study. In the next chapter I present, analyse and discuss data generated from the workshop presentations by the expert community members through participatory observation and teachers' reflections.

CHAPTER FIVE: WORKSHOP DISCUSSIONS AND PARTICIPATORY OBSERVATIONS

5.1 Introduction

The goal of this study was to explore the use of the indigenous technology of organic crop farming to mediate learning in Grade 12 Agricultural Science classes. In this chapter, I thus present, analyse and discuss data generated from workshop discussions and participatory observations during the presentations by the two IKCs and the four teachers' reflections. Data generated from these data-gathering techniques was aimed at answering my second research question:

> *What learning opportunities are created or (not) for Grade 12 Agricultural Science teachers to interact, participate and learn during the presentations by the IKCs?*

While school science can be accessed through textbooks, IK is not documented. Instead, it exists in the heads of the IKCs or elders who are the custodians of cultural heritage. Consequently, teachers cannot access such knowledge unless they find ways of engaging with community coffers of knowledge (Mutanho, 2021). It is for this reason that the invitation of the two IKCs to share their cultural knowledge, wisdom, and expertise on traditional ways of growing crops – in terms of fertilising the soil and controlling pests – was central to this study. Indeed, this is in line with the call by the Ministry of Education Arts and Culture (MEAC, 2016), that in the community there are people with expertise in cultural traditions who can be approached to support teaching for the benefit of the learners (Mavuru, 2022).

The chapter commences with the profiles of the two IKCs who were invited to present and demonstrate the cultural ways of fertilising the soil and controlling pests. Most significantly, the data sets gathered from the IKCs' presentations were subsequently used to co-develop an exemplar lesson plan on organic crop farming that integrated IK (see Appendix O).

5.2 Indigenous Knowledge Custodians' Presentations

As explained earlier in Section 3.6.2, four teachers were involved in this study. However, only three teachers attended the presentations made by the IKCs. The fourth teacher could not attend due to the ill-health of one of her close family members. Of note, during this session my critical friend assumed two roles; video recording the interactions and translating the local languages, that is, Oshikwanyama and Oshindonga into English. This is described as translanguaging in Msimanga and Lelliot's (2014) terms.

Notwithstanding these language nuances, IKCs who were the custodians of the cultural heritage as alluded to earlier were regarded as the MKOs as espoused by Vygotsky (1978). During their presentations, they used their indigenous languages which enabled them to express themselves freely and confidently. This concurs with Gibbons (2003), who asserts that language is an essential mediatory cultural tool that can be used as a vehicle via which IK can be transferred and preserved (Chilisa, 2012). In the same vein, Liveve (2022) avers that language alone communicates much traditional wisdom and knowledge. Further, Oshikwanyama and Oshindonga were essential mediation cultural tools that were used by the IKCs to stimulate social interactions and active participation among the Agricultural Science teachers (Sedlacek & Sedova, 2017). Interestingly, learners (teachers in the context of this study) were still capable and willing to communicate in their vernacular language of Oshiwambo (Li & Tomasello, 2021).

As elaborated earlier in Section 3.6.2**,** the IKCs opted to co-present, citing that "*omunwe umwe ihauli toola ona"* (one finger cannot pick a louse from the head). Simply put, they wanted to assist each other so they did not leave out important information. The co-presentation took place at the male IKC's home as per their agreement. However, the practical demonstration on how compost is prepared and how crop pests are culturally controlled took place at the female IKC's house as per tatekulu Dominjau's suggestion, citing that meekulu Paulina is more knowledgeable about soil fertilisation aspects than him, as women are mostly the ones who take the lead in the process of growing crops. Interestingly, meekulu Paulina proved to be more knowledgeable than tatekulu Dominjau, as she richly presented most of the IK practices compared to tatekulu Dominjau. This resonates with Settee's (2007) assertion that **"**women's knowledge is fundamental to the well-

being of the community, as it is women who are keepers of knowledge around food production, community sustainability, and family life" (p. 235).

Moreover, it is worth noting that the IKCs largely used *storytelling* as a prominent feature of their presentation to recount past experiences and highlight pertinent aspects of IK. Indeed, *storytelling* among other cultural expressions such as language, drama and so forth has been used among indigenous people such as the Ovawambo since time immemorial to pass cultural/IK onto the next generations (Kibirige & Van Rooyen, 2006). According to Settee (2007), *storytelling* is an important mode of communicating IK and it plays a pivotal role in research and deep surfacing the 'truth' about indigenous people. In other words, *storytelling* is central to the preservation of IK which this study aimed to address.

In the next section, I present the summary of the presentations made by the two IKCs. As with Nhase (2019), I also transcribed the videos into a *story* format.

The presentation commenced with tatekulu Dominjau welcoming us to his house with a prayer citing: "*Mukehe shoka tatuningi natukale nokuithana Nambongo etukwatele komeho, oshoka ngele katumuna nena katuna sho tatu vulu okupondola"* (In whatever we do we must always invite God for his presence and guidance, as without him all our attempts will be in vain). Thereafter, meekulu Paulina also introduced herself to us. We were then allowed to introduce ourselves one by one which really made us feel at home.

Meekulu Paulina then proceeded to say: "*Otu li tuudite ounambano oku mona ovalongifikola veuya oku pekaapeka ouyelele kufye ovakulupe kombinga yanghene oikunomwa hailongekidwa pamufyuululwakalo"* (We are so proud and delighted to see teachers coming to search for information from us – the old people about how crops are grown traditionally). Tatekulu Dominjau nodded his head and said:

> *Ondahala yoo kuholola mbano ngeyi kutya etokolo ndjoka mwakutha aalongi aasimanekwa olyasimana nolyomuule, oshoka inatumona nale aalongisikola tayeya komikunda yakonge uuyelele u nasha nelongo lyuunona wetu. Onkene ondahala lela kumutsa omukumo mutsikile ngaaka oshoka omuthigululwakalo ogwo ethina lyuunongo auhe neliko lyoshigwana shetu. Ondahala yoo kuyelitha mbano kutya omiyelo domagumbo getu odheeguluka ethimbo kehe uuna mwapumbwa omauyelele kutse oshoka natse otwahala uunongo gwetu wopamuthigululwakalo ulongwe moosikola pamwe nuunongo gwokoEulopa opo aana yetu kaahepe monakuiwa* (I also would like to emphasise that the

> decision you have taken is critically important as we have never seen in our lifetime teachers coming to villages -to old people in search of school-related information to benefit our children. Therefore, I really want to encourage you to continue doing that because culture is the root of all expertise, our pride and wealth of our society. I further wish to openly state that our doors are always open for you should you need more cultural-based information, as we also want our indigenous knowledge to be taught in schools together with European knowledge so that our children will be able to survive better in the future).

The IKCs' expressions from these excerpts highlight the uniqueness of the research study that aimed to bring science from the classroom to the community and the community to the classroom as advocated by Hashondili (2020). In addition, tatekulu Dominjau's latter expression appears to be congruent with Nuntsu's (2020) study findings that revealed that for African children to become complete people with a balanced life, they must learn local knowledge together with Western knowledge. Expanding on this view, Seehawer and Breidlid (2021) assert that if learners are allowed to compare different forms of knowledge and apply it according to what fits best in the given context, it would provide them with a large repository of strategies for sustainable livelihoods rather than just drawing on so-called Western knowledge.

After the IKCs' opening remarks, I then thanked them on behalf of the research team as follows:

> *Tatekulu na meekulu otwe mu pandula unene eshi mwetutambulako nawa lela, naunene eshi mwadimina tuuye tu tekemo mounongo weni noinamutupula nande oyo ofuto yasha, kalunga natwikile nokumuyambeka. Ondahala yoo ndiyelife ngaha kutya onye ookatokote kounongo wopamufyuululwakalo. Nomolwaasho, pamhito ei onye ovahongi vetu nafye otuli ovanafikola veni shaashi omuna ounongo uhapu mutudule ngee tashiya poipambele yopamufyuululwakalo ngaashi oikunomwa nosho tuu* (Tatekulu na meekulu we appreciate you a million times for a warm welcome and most importantly for agreeing for us to come and drink from your cup of knowledge- at no cost. May God richly bless you! I would also like to let you know that you are the experts- the custodians of indigenous knowledge. Therefore, at this juncture, you are our teachers and we are your learners because you are more knowledgeable than us in cultural aspects).

This excerpt indicates that the IKCs shared their knowledge with the Agricultural Science teachers free of charge. In my view, this is the true meaning of Ubuntu – "I am because we are" – as the IKCs seemed to be more concerned about the welfare of the community members as opposed to individual needs and interests (Kakambi, 2021). In addition, it could be argued that the IKCs also wanted to implant their valuable knowledge and skills in young people (teachers in the context of this study) to ensure that it is passed on from one generation to another as reiterated by Mateus

and Ngcoza (2019) to ensure cultural revitalisation (Cocks et al., 2012). Moreover, this excerpt indicates that knowledge is not only found in the physical classroom or with teachers only but also in the community and knowledgeable persons, the IKCs in this case, and the MKOs in Vygotsky's (1978) terms.

Both IKCs smiled and clapped hands. Meekulu Paulina stood up and said: "*Iyaloo tangi unene ketumbaleko olo jevrou otuudite uunambano lela okuhonga ovalongifikola nena. Oha tukatameka nee nonghene edu halilongekidwa opo lidule kumena nawa loo litupe oipalwifa yawanena"* (Thank you so much for that acknowledgement, we are indeed humbled and honoured by your words. We are now going to start with the presentation on how the soil is prepared to give us a bumper harvest).

- **Soil preparation**

Prior to her presentation, meekulu Paulina urged us to listen attentively and ask questions where needed for us to be able to get in-depth clear information. She then introduced her presentation by asking us to identify cultural tools around her: "*Oilongifo omuishi omadina ayo ei*?" (Do you know the names of these tools?) This is referred to as the elicitation of prior knowledge to engage the learners as espoused by several scholars (Kuhlane, 2011; Mavhunga & Rollnick, 2013; Roschelle, 1995). T2 replied: "*Yes, this is a hoe*" and T3 added: "*This one looks like a rake*". Meekulu Paulina smiled and said: "*Iyaloo omuli mondjila lela, eli etemo lakashimbwela eli lali halilongifwa monale, eli olanakanena, eshi olukoolo*" (Well done, this one is a traditional hoe that was used in olden days, this is a modernized traditional hoe-commonly used today, and the rake-like one is called olukoolo). T4 was quick to ask: "*Meekulu what is olukoolo used for? I have never seen it before*". Meekulu Paulina replied: "*Ohashilongifwa okukoola oihati mepya konima yokuteya" ohandikemuulikila nghene hashilongifwa"* (It is used to collect crop leftovers in the field after harvest).

Figure 5.1: Shows a traditional hoe, modernized traditional hoe and olukoolo respectively that were identified by the participants.

Meekulu Paulina continued with the presentation and said: "*Monale kakwali kuna oipululo okwali ashike hatu limi neenyala nomatemo*" (In the past there were no ploughs and we used to cultivate by hand using hoes). She further explained:

> *Shaa nee twamane okuteya ohaatutetemo nee oihati- ei inaitekauka ohatuimange nee ndee hatu itulike komiti ikaninge oikulya yoimuna pokwenye. Omanga ei yatekauka ohatu ikoolamo nee nolukoolo fyee hatuningi nee omafita fyee hatu axwikepo nee* (Once we are done harvesting, we cut out the dry mahangu and sorghum stalks and place them on trees to be used as animal feeds (hay) during the dry season. The remaining crop residues are then collected with olukoolo and form omafita which we then burn).

T4 further asked: "*Meekulu omafita oshike?*" (What is omafita?) Meekulu explained: "*Omafita eenduba ashike doihati*" (they are simply groups of mahangu crop remains/dry stalks).

Figure 5.2: Shows Meekulu Paulina and her granddaughter demonstrating how *okukoola* is done and form *omafita.*

Out of curiosity, T2 asked: "*Why are omafita burnt down*?" Meekulu replied, "*Omafita ohaa xwikwapo opo aninge omutoko - omutoko uushosho muwa kiimeno - ashike inaupumbiwa uhapu shoosho uwete oihati ihapu haitetwamo ininge oikulya yoimuna*" (Omafita are burnt to form ash- which is a good soil fertiliser. However, ash is not needed in large amounts, thus most of the dry stalks are cut and stored for later use as animal feeds during the dry season). T3 commented saying that these dry stalks are just hay – in class, we teach that it is a supplementary feed given to animals during the dry seasons. "*You are right*, *I actually thought hay only refers to dry grass, imagine!"* (T2). In addition, T2 recounted her experiences and explained: "*I can vividly remember that whenever I used to visit my grandmother at the village, she used to tell us to dump ash formed from firewood used for cooking- in the field. I did not know the reason behind it*". Meekulu smiled and said: "*Ehee, omutoko uushosho muwa koimeno nokomiti doyiimati ngee taditulako eengala, woo natango oha u denge mo yoo oshimongwa medu*" (Yes, wood ash is a good fertiliser for crops. It is also good for fruit trees during the flowering stage, and it also decreases acidity in the soil).

In addition, I elaborated that wood ash contains high contents of potassium, phosphorus and calcium among other nutrients. "*Interesting*", T2 remarked! "*So, literally ash is good for fruit trees during the flowering stage because it is rich in potassium which encourages flowering and fruiting?"* Agreeing, I further elaborated that wood ash can reduce the acidity in the soil as

meekulu stated, simply because it contains calcium which neutralizes the acidic soil or increases the soil's pH. T3 further added: "*This means wood ash has a liming effect, just like agricultural lime we teach in class*". T4 remarked: *"You have phrased it well, in simpler terms wood ash is just traditional or organic lime … this is quite interesting indeed".*

The teachers' discussions surfaced new scientific perspectives and understanding of the indigenous technology of organic crop farming. Taking the argument further, tatekulu Dominjau amplified meekulu Paulina's point:

> *Okufika iihenguti mbyoka ya thigala mepya, omukalo lela omwaanawa gwoku wedha uuhoho mevi. Shino ondeshi dhidhilika uule wethimbo oshoka ndakala nokukuna oomweenge nokandina nande esiku ndatulilemo uuhoho mevi, ihe aluhe konima ngele ndamana okuteya oomweenge ohandi fike owala pehala mboka pwali oomweenge etandi tekelepo. Omathindi ohaatameke nduno taatwiyuka etaaningi ishewe oomweenge oompe* (Burning crop remains in the field is indeed a good method of fertilising the soil. I have practised this for many years I have been growing sugar canes, but there was never a single day I added fertiliser to the soil, but I only burn the remaining stumps after I am done with harvesting, then I just keep irrigating the areas with remaining stumps. After a few weeks those stumps start to sprout new leaves and stems then grow into new sugar cane plants again).

This excerpt resonates well with several scholars. For instance, Corbeels et al. (2000) aver that traditionally, farmers burnt some crop residues as they believed that ash acts as a fertiliser and increases crop yields. Similarly, Edje et al. (1988) underscore that ash is rich in nutrients such as phosphorus, calcium and potassium. These scholars further assert that ash also increases soil pH and improves soil structure which leads to intensified crop yields. Moreover, it is also believed that burning reduces the weed population (Wakui, 2009). Based on my personal experience, I can now vividly testify that the areas where we normally dump wood ash at home always have fast-growing *mahangu* (millet) with dark green leaves and stems that give us a bumper harvest every year. This is quite impressive, T4 further commented, citing:

> *Meekulu Paulina and tatekulu Dominjau are qualified traditional Agricultural Science teachers, citing that the traditional knowledge they shared clearly speaks to various scientific concepts such as soil fertility (plant nutrients), and soil structure as well as soil pH regulation amongst others. I am honestly impressed to learn that science has actually started from home - embedded within our cultural practices and did not start at school as perceived, thank you so much for opening our minds.*

Both tatekulu Dominjau and meekulu Paulina smiled and clapped hands. Meekulu Paulina replied and said:

> *Ehafo linene kufye okuuda kutya otamulihongomo shihapu moshinyangadalwa eshi notwahafa yoo kushiiva kutya ounongo wetu uhapu owelifa naau hamulongo meefikola, ondiwete paife ounongo ou otaukapupaleka enongeko leni* (We are so delighted to learn that you are learning a lot from this presentation, and we are over the moon to learn that much of our cultural knowledge is more or less the same as what you teach at school. We trust this information will help make your teaching to be more meaningful and relevant to your learners).

T2 responded and said: "*You are right meekulu, this information will help us greatly to enhance our science teaching because this type of knowledge is either appearing in textbooks in an abstract manner or just not there at all*". Meekulu continued and said:

> *Iyaa kakele nee komutoko, momapya etu ohatutulamo yoo oushosho wiimuna ngaashi oikombo, eengobe neendoongi, haututilwamo lwopoo Kotooba opo manga odula yotete inailoka. Ou oo wakala omukalo wafimana wokuweda uushosho medu moshitunda shetu, notwakala hatulikola oilya ya matutu lela. Ashike konima yoshikukuta shakula shaliko mo1992, oimuna ihapu oyafilepo shililifa novanhu vahapu ovekelihanga nee vehena vali oimuna yokuvapa oushosho, osho shaetifa nee omapya mahapu atutuke- hano ihaadi vali oilya ihapu ngaashi nale eshi kwali haatulamo oushosho woimuna* (Well, apart from ash, we also use animal manure - from goats, cattle, and donkeys to fertilise our fields. This has been the common and effective method of fertilising our fields and we really used to get bumper harvests. However, after we experienced a severe drought in 1992, most of our animals (cattle and goats) died from drought. Consequently, most people do no longer get enough animal manure to fertilise their fields and this resulted in poor infertile soils which rarely produce enough food for the local subsistence farmers as before).

Meekulu further explained:

> *Ohatulongifa yoo oipete yeengongo,-ngee ovanhu vakolo, fyee ohatulongifa yoo olungu olo hatu fudike medu oshoyo oimbodi ei haikombwa muumbo ohayeekelwa mepya yoo tailiminwamo nee medu* (We also use organic waste/remains such as marula fruits peels that are obtained after women have removed marula juice and we also use olungu (threshed mahangu remains) which we bury in the soil as well as other plant wastes collected from the house such as dry leaves, grass etc which we dump in the field, and plough them into the soil).

In this regard, T2 asked: "*Meekulu how and why do you bury olungu?"* Meekulu replied and said:

> *Konima ngee twamane okuxwa, ohatu fe nee omalambo ndee hatutulamo olungu ndee konima hatufufileko- opo lidule kwoola loo linyanyaulwepo kedu shaa odula yatemuna. Ngeenge nee*

> *twamono kutya olalikapo nawa kedu ohatu lifemo nee ndee hatu li tutile mepya peenhele apa pehena oushosho nawa- olungu uushosho muwa lela* (After we are done with threshing mahangu, we dig various pits in the field and bury olungu there to allow it to decompose. After the first summer rains we then dig it out and apply it at different areas in the field which seems to be infertile. It is indeed a good form of fertiliser that help us to get a good harvest).

The above excerpts are in harmony with Wakui's (2009) assertion that materials for enriching soil are produced by composting locally available materials such as dead twigs, fallen leaves, weeds, household waste and animal waste among others by putting them in pits and covering them with topsoil to decompose. T4 interjected and said: "*Colleagues, these pits I think they are just the same as the compost pits we teach in class and what is formed here after olungu is decomposed is simply compost we teach*". All participants agreed to this.

In addition, T2 pointed out that she did not know if compost could be made culturally at home, citing that she thought it was a foreign concept. Concurring, T3 reflected:

> *Wow, traditional knowledge is so rich hey, so our elders even know that organic waste needs to be buried to quicken decomposition, and also that rain (moisture) is needed for decomposition to take place, but learners do fail these things at school, poor kids. It is crystal evident that there is a lot of science in our everyday knowledge and this knowledge really need to be documented so it can be taught in schools.*

"I concur with you 100%!", T4, a male participant expressed. He further suggested:

> *We really need to start integrating this knowledge in our teaching to make science easy to understand and meaningful to the learners so they will be able to think outside of the box. It is a pity most science teachers are still not aware of the wisdom in our indigenous knowledge.*

In agreement, T3, commented with a smile, saying:

> *It is true, I have realised that there is a lot of science in our cultural practices that could be beneficial to our learners. I feel we are really fortunate to be exposed to this hidden reality through this research study, thumps up to the researcher.*

Meekulu Paulina replied with a smile too saying: "*Ondiwete kutya ounongo wetu nao meefikola mboli omo uli, owapumbwa ashike kuetwa poluheela"* (I can see from your discussions that our cultural knowledge is also part of your school textbooks, it only needs to be made explicit for both teachers and learners). She continued and said:

> *Otuna lela ounongo uhapu tweufyuulula koomeekululululwa ovo navo veufyuululile kooinakulu oo paife wa pumbwa nee kunyanyangidwa opo udule kukaleshwa komapupi taeya opo uhakane shaashi ngee owakana oshiwana otashikahepa. Omukulu wonale okwati: Oshiwana shihena omufyuululwakalo oshafa olweendo latumba li hena oku la finda. Tashiti ounongo wetu wopamufyuululwakalo oo onghalamwenyo yetu, emona letu lakula notuna okulikalekapo, osheshi omufyuululwakalo osho exukamwoongo loushitwe* (Yes, we really have a lot of rich cultural knowledge we inherited from our forefathers which now needs to be documented and preserved for the future generations to come. There is an African proverb which says: 'A society without culture is like a journey that is heading nowhere' – This means our culture is life, wealth and above all our utmost identity that we need to respect and uphold as it is the backbone of the natural environment which we depend on for life).

This excerpt clearly demonstrates that indigenous elders are the custodians or community coffers of IK or cultural heritage (Mutanho, 2021). In addition, the IKCs expressed the importance of continuity of their culture through documentation (Govender & Mutendera, 2020). This view is also in harmony with Cocks et al.'s (2012) suggestion that there is a need for cultural revitalisation.

Moreover**,** it could be deduced from the above excerpt that IK plays a pertinent role in maintaining biodiversity and ecological sustainability (Bowers, 2007). It could then be argued that to realise the sustainability of the environment and culture, the voices of IKCs are critical in contributing knowledge about indigenous ways of living with nature (O'Donoghue & Russo, 2004). Notably, the participants showed interest during the presentations as they were actively interacting, asking questions and taking notes to serve as their future references.

Figure 5.3: Shows the participants interacting and taking notes during the presentation (seated at tatekulu Dominjau's *okalupale kokeenduda* – a place next to his bedroom where he normally attends to his valuable guests)

From there, meekulu told us: "*Paife ohandikemuulikila nee nghene handikongo omafo nokualongekida adule kueta uushosho medu, opo awede oushosho ou haudi momikalo odo ndatumbula pombada*" (Now, I am going to show you how I collect dry leaves and prepare them to become fertiliser, to supplement the amount of fertiliser I get from the above-mentioned natural ways of fertilising the soil).

Figure 5.4: Meekulu Paulina demonstrating how she collects dry leaves.

Meekulu Paulina then took a leaf rake, two basins and large empty sugar plastic bags and said: "*Iyaa, ohandi kongo nee peenhele apa paongala omafo mahapu ame handihalaka nee nokahalaka ngaha, ame haitula nee meeshako noshiyaxa"* (Well, I normally look for the areas with a lot of dry leaves like here and I rake them like this then I put the leaves in the big sacks using the basin). Thereafter, she invited us to come and assist her in collecting the leaves. The male participant was the first to volunteer as he was fascinated by meekulu's innovation.

Figure 5.5: Shows the male Agricultural Science teacher assisting meekulu Paulina to collect dry leaves from an African Ebony tree.

Meekulu further explained that*:*

> *Omafo ohaakala mahapu lela keshe odula eshi omiti tadiyaumuka, uuwa nee washo, omiti edi deemwandi nomifyaati otudina dihapu lela momidingonoko detu- tashiti omafo kaena fiku akale ehepo, ohandi pandula une kalunga eshi etupa omiti ditupe oushosho oshali shoovene sheshito* (We get a lot of dry leaves from African Ebony and Mopane trees every winter as they lose their old leaves. We are quite blessed because we have a lot of these trees in our surrounding environment).

Expanding meekulu's point, I asserted that this means that natural fertiliser from leaves is an example of a sustainable agriculture practice as leaves are obtained every winter from deciduous trees at no cost. This is in line with Dei (2000), who posits that IK holds a significant possibility for social and ecological sustainability. In other words, community elders' indigenous ways of living with nature have the potential to contribute to the understanding of sustainable agriculture in Namibia and Africa at large (Glasson et al., 2010).

Further, T3 asked meekulu Paulina why she prefers to use leaves from African Ebony and Mopane trees instead of other common tree species in the surrounding environment such as Neem. Meekulu replied:

> *Petameko onda tamekele handi fudike omafo adja komiti dayooloka nokonima ondaka mona nee kutya omafo eemwandi, nomifyaati aapange oidjemo iwa. Ondakamona lela kutya hamafo aeshe mawa kedu, omiti dimwe ngaashi eeNeem nomingaalipi odina omafo malula nohaaaweda oshimongwa medu hoo ohaakukutike edu osho shili shanyika oshiponga koimeno* (When I first started with this experiment of burying tree leaves, I used leaves from various tree species. However, I later found out that Mopane and African Ebony leaves are the best as they keep the soil moist for longer, makes the soil darker and easier to cultivate).

T4 was quick to comment and said that meekulu meant that compost improves water holding capacity and soil structure, - the same benefits written in the textbooks. "*You are right*", T3 reflected:

> *This is a sign that our indigenous knowledge is hidden in English, all along I thought these were foreign concepts which do not exist in our language. We really need to start explaining most of the concepts in Oshiwambo to the best of our ability to enhance our learners' conceptual understanding.*

That is to say that not all tree leaves are good for the soil/crops, as some trees such as Neem and Eucalyptus have sour leaves and make the soil too acidic and dry, making the soil unsuitable for plant growth. From my own home experience, I can safely confirm that leaves from Neem and Eucalyptus trees are indeed very sour, and they are normally known for their medicinal properties; thus, they are commonly used in our local communities to treat cold and flu, fever, and cough among other ailments.

From there, meekulu told us: "*Paife ohatutwaleni nee omafo mepya mukatale nghene handi alongekida omafo opo aninge oushosho*" (We are now taking the leaves to the field to show you how I burry them in the soil). At this stage, meekulu informed us: "*Ohatufe nee omalambo peenhele dayooloka apa tuwete pehena oushosho opo eshi mbakumbaku teya alime yee tahalakanifa nee nawa nepya*" (They do make some tunnels or shallow pits where they place the leaves and cover with soil).

Figure 5.6: Shows some of the prepared tunnels or pits in the field where dry leaves are buried.

She then started to dig two more new tunnels, placed the leaves in the pits and covered them with soil. She asked the male participant to help her out. In my view, she specifically invited the male participant to assist her because in our culture, hard work such as digging is mostly associated with men as they are culturally believed to be more powerful and energetic than women. It seemed that meekulu Paulina employed the cultural gender-responsive approach as reiterated by Haimene (2023).

Figure 5.7: Shows meekulu Paulina demonstrating how she buries the leaves in her field with the assistance of the male participant.

While meekulu was busy burying the leaves with the help of the male Agricultural Science teacher, T2 asked her why she buried the leaves. To my surprise, meekulu responded by saying: "*Omafo ohatwaafudike opo anyanyaunwepo kedu diva*" (So that the leaves can be decomposed fast). I thought that leaves are buried so that they could not be blown away by the wind, but meekulu gave the scientifically based reason of decomposition. We were all astonished at the way she prepared the leaves to fertilise her field – it was creativity and innovation at its best, indeed, it was new to all of us.

She further explained that this is the method she currently uses to fertilise her field since she does not have livestock any more to provide her with animal manure – she cited that the compost has been giving her a remarkable harvest of about four full granaries per year. Considering this it could be argued that if local farmers are taught how to increase their production sustainably through organic crop farming, particularly by fertilising their fields with natural materials around them, it would result in increased production at a family level and food security. This view seems to be in affinity with Da Silva's (2012) suggestion that to address the problem of food insecurity in developing countries such as Africa, the world needs to shift to organic crop farming that is accessible to small-scale farmers to sustainably increase food production by harnessing traditional knowledge to sustain the natural ecosystems.

Figure 5.8: Illustrates the modernized granaries (omaanda) where meekulu Paulina stores mahangu grains she obtained from her field as a result of using dry leaves and other organic waste.

Meekulu explained to us that she now uses these modernized granaries (*omaanda*) because the traditional ones are now scarce to find, and the modernized ones are also more durable and keep the grain in good condition for a long time. I then asked meekulu Paulina if she learned this method of burying leaves to form fertiliser from her parents. In response, meekulu expounded:

> *Aaye, kovakulunhu vange ondelihongamo ashike okufudika olungu, kounongo oo oko nee ndatungila opo ndi tameke okufudika yoo omafo mokukendabala ashike eshi ndalulilwa kepya latutuka eshi oimuna ei kwali haipenge oushosho yafyapo koshikukuta. Tawedapo kutya onda mona nee kutya mboli uushosho womafo ouwa unene nokuli udule nowoimuna shaashi womafo ile woimeno ohaukwata omeya medu woo ohauningi yoo edu lipu nawa* (No, from my parents among other things, I have learned to bury olungu, I then built on that knowledge and started to bury dry leaves some years ago, as I was desperate to find a more reliable, natural method that I can use to fertilise my field which became infertile after my livestock (cattle and goats) that use to provide me with animal manure to fertilise my field have died from drought over the past years).

This explanation in the above excerpt corroborates Glasson et al. (2010) who in their study conducted in Malawi established that "sustainability practices such as burying of leaves from Msangu trees as a natural fertiliser were practised for generations long before colonization" (p. 135). Meekulu smiled and said*: "Iyaloo ondiwete lela kutya ounongo wetu otautu kumwe naau uli momambo eni, oshiima shiwa lela"* (I can see that our cultural knowledge is corresponding with what you teach at school, that is really good). Continuing, she further explained:

> *Eshi nee ndelihonga osheshi kutya oushosho womafo ihauxwike oimeno ngaashi wiimuna shaashi ondadidilika kutya wiimuna ouhole odula ihapu nongee kapena odula yawana ohauxwike oimeno. Tatwikile kutya paife oo ashike omukalo konyala halongifa mepya laye, nohaumupe eteyo liwa lela lidulife nokuli naashi kwali halongifa woimuna manga kwali inaifyapo koshikukuta. Tatwikileko kutya luhapu ohapulwa kovaendanandjila kutya mepya laye ohatulamo shike opo epya laye likale lilaula loo olina oilya yatalala nawa omanga omapya avakwao matoka oo omakukuta. Tayelifa kutya ohevalombwele kutya ohafudike ashike omafo omwandi noomusaati, olungu, omutoko, oipeta yeengongo noshoyo oimbodi yadja koimeno ei haikombwa meumbo. Tawedapo kutya ouyelele ou oheuyandje ui ngaashi uli nohevalombwele veuye kuye eveendifepo nghene haalongekida edu laye, shaashi okwakoneka kutya omapya mahapu paife okwatutuka molwo oushosho wiimuna oo waxupipala moshiwana shetu paife molwa oshikukuta osho sheidipayapo momido dapita* (Worth noting, is that from experience, compost does not burn crops even when there is no little rain, unlike animal manure, because I have noticed that animal manure prefers a lot of rain to work effectively. She further stated that this is the kind of fertiliser she currently uses in her field, and it really gives her a bumper harvest than when she used animal manure. She proudly pointed out that at times she meets people who ask her what she uses for her field to be more fertile compared to her neighbours' fields. Stating that she tells them the truth that she only uses Mopane and Ebony dry leaves, olungu,

> marula fruit peels, and other plant wastes she cleans from the house, including wood ash plus the crop remains in the field which she buries in the soil. She further asserted that she freely shares her knowledge/discoveries because she wants others to also start using the same method, since most fields in their communities have now become infertile due to animal manure scarcity as most animals died from drought over the years).

This excerpt demonstrates the true meaning of Ubuntu as meekulu Paulina was concerned about the welfare of the whole community as opposed to her individual needs (Kakambi, 2021). Moreover, meekulu Paulina elaborated:

> *Omukalo vali umwe nda kendabala ndee tau penge oidjemo iwa; oipeta yomai nomabanana. Oipeta ohandiikukutike ndee handii twile mumwe ndee tainingi oufila. Muufila ohandi tulamo nee omeva ndee taitutu nawa nawa, konima yefiku ame omeya ohandaadindiko nee ndee haitekele omiti dange doyiimati pomafina ado omiti dange doyiimati ndee ohadiimi nawa nohadikulu lela nawa* (Another method I have tried out and turned out successful-are the eggshells and banana peels. I collect these wastes from town then dry them. Once they are dry, I pound them into a powder form and put them in a container of water and leave them overnight there. The next day I filter out the liquid mix and apply it around the fruit trees stems. It really makes my fruit trees to grow well and bear many healthy fruits).

I then explained that banana peels are rich in potassium which is needed for the formation of flowers, fruits and seeds, while eggshells are rich in calcium which regulates the soil's pH and is needed for the formation of strong plant cell walls. Similarly, meekulu further explained that she believes in an Oshiwambo proverb that says "*Uhakendabala kufindi*" (If you don't try out things you will never achieve anything in life). Therefore, she expressed that she has also tried to submerge various dead/old plant materials such as dry leaves and animal waste such as chicken and cattle/goat manure in a drum of water that she kept stirring off and on for about two to three weeks until it mixed really well and started to produce a bad smell. She then filtered the concentrated liquid, diluted it with water and applied it to her fruit trees and vegetables as a liquid fertiliser. She further indicated that she came to learn that liquid fertiliser works much faster compared to solid fertilisers. This clearly shows that indigenous agricultural practices are perfected through observations, collection of data, experimentation and interpretation, as stated by Glasson et al. (2010).

Figure 5.9: Shows the orchard where Meekulu uses self -processed organic fertilisers.

Finally, meekulu said: "*Pwiikineni nee nawa! Oshiima shimwe shafimana mwapumbwa kushiiva osheshi kutya oomeekulu ovetulonga kutya eefukwa, eembudufukwa nomakunde ihaatulwa uushosho ngaashi oilya, shaashi omidi dado odina eenghono*" (Listen carefully, another important thing we have learned from our great parents is that legume crops do not need fertilisers because their roots have energy). T2 interjected and said: "*Ombili meekulu ondahala kupula, omidi dado dina eenghono ngaipi?"* (Excuse me meekulu, I want to ask what you mean by saying legumes roots have energy?) Meekulu replied:

> *Otashiti omidi dayo ohadi yandje eenghono kedu- hano oitungifi, shoosho hamumono kutya konyala eefukwa nomakunde ohaa kunwa ashike peenhele apa pehana nawa oushosho ngaashi momufitu ndee ohadikulu aike nawa. Oshitivali konyala ohadi kunwa peenhele dayooloka keshe odula, elalakano okwaandjakaneka oitungifi oyo hadiyandje kedu, shaashi ngee owakunu oilya poima pali pena oshifukwa ohapakala lela oilya* yiiwetikile (It means that their roots add nutrients into the soil, that is why you see that legumes are mostly grown in less fertile areas in the field for instance areas with sand soil but they just grow well and produce well).

This finding corroborates with Wakui (2009) who claims that leguminous crops are effective for soil enrichment as they supply nutrients to the soil.

I then asked meekulu why legumes are grown in different places in the field almost every year. Meekulu responded saying: *"Ohashiningwa opo kuandjakanekwe eenghono odo hadiyandjwa komidi mepya alishe"* (It is done to widely spread the energy (plant nutrients) their roots provide to the soil). T4 then said: "*Colleagues; I think meekulu here is describing the process of nitrogen fixation by legumes and crop rotation*". T3 said: "*Yaa is true, quite impressive indeed, meaning the energy provided to the soil by roots is nitrogen in Western science*". T4 further asserted that there is no doubt that meekulu is very knowledgeable about indigenous ways of growing crops, and she needed to start coming to schools so she could explain to the learners some of the science concepts embedded in IK to enhance their conceptual understanding. Meekulu smiled and said: "*Omuufanange ashike, ohandi ya lela kapena oudjuu opo*" (Just invite me I will gladly come). This resonates with Klein's (2011) study that affirms that elderly people could be resources for teachers in schools if they are actively engaged in school activities.

From there, meekulu said: "*Iyaa, paife ohandi ka popya nee kombinga yomikalo edi hadilongifwa ile dakala nokulongifwa okukondeka oupuka momapya*" (Well, now I am going to present the cultural methods used to control pests). Meekulu explained:

> *Monale inakukala naana lela kuna oupuka vahapu momidingonoko detu, mutu shaashi momapya omwakala hamumene oimbodi ihapu ina omadimba madjuu oo haataatayele uupuka kokule, ngaashi etwelakuku, naikwao yoo. Ohapeya noxo uupuka havakala kokule shaashi fyee ohatukunhu oimeno yetu yohavakana, pamwe ohashikala shidjuu kuupuka vakwatepo oshimeno shimwe shadingililwa kiimeno ikwao yayooloka pamwe* (We did not really experience the challenge of crop pests in our communities, perhaps because there are usually plants with strong smells that grow together with the cultivated crops which were known to deter pests, such as etwelakuku, amongst others. Additionally, we normally grow different crops in our fields every year, so that they might make it difficult for pests to attack crops).

This excerpt concurs with Wakui (2009) who found that traditional farmers grow different types of crops in the form of crop rotation and mixed planting (intercropping) to reduce pests and diseases. Moreover, according to Singh and Singh (2017), traditional farmers encourage the growth of herbal plants and natural enemies such as ladybugs, spiders, and small birds around crops to prevent insect damage. T2 said: "*Etwelakuku is just a natural enemy of pests such as marigolds, lavender etc, specified in textbooks, is just that names of local plants such as etwelakuku are not included in textbooks".*

Figure 5.10: Illustrates *etwelakuku* – a plant that naturally controls crop pests.

T2 further added that the growing of different crops in the field is just intercropping. T4 was quick to comment: "*Yaa, is true intercropping controls crop pests and diseases*". Meekulu further extended his presentation and told us: "*Etwelakuku oshimeno shanyika oshiponga lela, shaashi ohashilongifwa yoo okudipaya eemwe*" (*Etwelakuku* is a powerful plant – it is commonly used to control mosquitoes). Concurring, T3 confirmed that she knows that *etwelakuku* is used to control mosquitoes citing that they even call it an *African DOOM* at their home. She laughed and said she did not know that the reason why those plants always grow together with field crops is to control pests.

In addition, meekulu stated: "*Omukalo umwe ukulu haulongifwa okudipaa oupuka okukatula*" (Another traditional method used to control pests is *okukatula*). T3 asked meekulu: "*What is okukatula*?" Meekulu Paulina replied, saying: "*Okukatula okufamo omafinde oihati mepya hashiningw poJuli nooAguste lwaapo konima yokuteya*" (Okukatula means to dig out the stumps of mahangu and sorghum done around July and August). T4 said: "*Ohoo oko okukatula oko mboli?"* (Ahaa, so when people dig out crop stumps that is okukatula? I normally see people doing that in villages and I never knew what it is called and why it is done).

Figure 5.11: Illustrates meekulu Paulina demonstrating how okukatula is done and me practising it.

T4 further asked meekulu how *okukatula* helps to control pests. In response, meekulu elaborated that *"Oupuka ohaahondama momidi oimeno ndishi, okukatula ohakuningwa nee opo uupuka ile omai avo euye kombada voo taaxwikwa nee ketango"* (Crop pests normally hide themselves in underground in the roots, so removing the stumps exposes them and/or their eggs to the sun and get burnt, hence breaking their life cycles). All participants looked astonished to hear this explanation. I then added that this method seems to be similar to winter ploughing as it is also done to expose pests or their eggs to the sun among other things, thereby breaking their life cycles.

Lastly, meekulu Paulina expounded that since she likes to try out new things, she also uses Etosha pan salt, chilli and dishwasher liquid which she mixes in water and leaves the mixture overnight – she then strains the mixture and sprays on her fruit trees to kill pests. She further revealed that about 10 years back she learned from her Egyptian and Indian friends that Neem leaves are very good for controlling pests. Meekulu extended her explanation and revealed that she has also learned from her two foreign friends that Neem leaves are effective at treating many infections/ailments in both humans and animals. After carrying out some home experiments, she now uses a self-made liquid pesticide she makes from powdered Neem leaves, chilli and Sunlight dishwasher to control pests on her fruit tree leaves and it is effective. In addition, meekulu Paulina explained that she also now applies powdered Neem leaves together with wood ash on the top of her mahangu in storage containers to prevent them from being damaged by weevils while in

storage. Thus, the mahangu in storage remains undamaged compared to when she only used wood ash in the past.

Moreover, meekulu further revealed to us that even though it was not part of our research, she wanted to share with us that Neem powdered leaves or even fresh leaves are effective home remedies for treating coughs and flu, sore throats and general body fevers. She further added that she now also adds powdered Neem leaves to her chicken drinkers, and it really strengthens their immune system so that they hardly become sick anymore.

Continuing with the presentation, meekulu elaborated that the knowledge she acquired from her foreign friends prompted her to also try Eucalyptus powdered leaves since their leaves are sour just like Neem leaves – the attempt/experiment was successful, and she now mixes Eucalyptus powdered leaves with her seeds when planting to prevent soil pests. T2 asked meekulu Paulina why she uses dishwasher liquid in her organic pesticide mixture. In response, meekulu Paulina said that she thought of using the dishwasher liquid to make the mixture sticky so the mixture could stay on the leaves for some time to kill pests effectively – before she added the dishwasher the liquid mixture just ran off the leaves and was not effective at all.

The IKCs expressed that they were so delighted to be allowed to share their cultural knowledge with us, citing that the presentations had also assisted them in remembering most of their cultural heritage. They further stated that their hearts were now at peace knowing that even if they were to depart from this world one day, they would rest easy knowing that they had left their cultural funds of knowledge in good hands and that it would undoubtedly continue to flourish from the present generation to the next. Lastly, the IKCs once again assured us that their doors would remain open to us should we need any help from them. The workshop was then closed with a prayer by meekulu Paulina. This clearly shows that the IKCs were guided by the spirit of Ubuntu.

5.3 Data from Workshop Discussions and Participatory Observations

In this section, I present the episodes that I developed from the IKCs' presentations and participatory observations. The episodes were then linked to form sub-themes, and the common sub-themes were then combined to develop themes concerning the literature. Three themes emerged as shown in Table 5.1 below.

Table 5.1: Themes and sub-themes from workshop discussions and participatory observations

Themes	Sub-themes	Literature reviewed	Theory used
1. Teachers' conceptual understanding of organic crop farming	- Organic crop farming - Teachers' views about organic crop farming	Mavhunga & Rollnick (2013)	PCK (Shulman, 1987)
2. Teachers' interactions and participation	- Teachers posing questions and giving responses/comments - Participation in demonstrations - Teachers' discussions	Kuhlane (2011); Roschelle (1995); Mavhunga & Rollnick (2013); Sedlacek & Sedova (2017); Mavuru & Ramnarian (2020); Msimanga & Lelliott (2014)	SCT (Vygotsky,1978)
3. Learning affordances	- Learning created during presentations/demonstrations - Linking IK to school science	Mavhunga & Rollnick (2013); Roschelle (1995); Kuhlane (2011); Mavuru (2022); Wyatt & Chapman De Sousa (2017); Sleeter (2001)	SCT (Vygotsky, 1978); PCK (Shulman, 1987)

I now discuss each of these themes below.

5.3.1 Teachers' conceptual understanding of organic crop farming

Based on the observations I made during the IKCs' presentations on traditional ways of fertilising the soil and controlling crop pests, it appeared that the Agricultural Science teachers were allowed to enhance their comprehension of the concept of organic crop farming. This was evidenced by the teachers' comments in their reflections. For instance, T3 commented:

> *I always wanted to know how to control crop pests organically, as I always feared to use chemical pesticides on crops that we feed on. At least, from here, I will be able to teach learners the cultural/organic methods of controlling pests Hence, I really feel blessed for this great opportunity- that allowed me to learn more about organic ways of controlling pests.*

In addition, T2 commented:

> *I have really learned about many cultural agricultural practices from the workshop, citing that she did not know if there were plenty traditional or organic ways of fertilising the soil apart from using animal manure.*

T4 further added:

> *I was quite impressed to learn that there is a lot of science embedded in local agricultural practices, such as making natural compost, role of ash as a fertiliser and regulator of soil pH, and biological nitrogen fixation by legumes, processing of organic waste into powder or liquid fertiliser among other science concepts.*

From these excerpts, it can be deduced that the teachers' conceptual understanding of the concept of organic crop farming was improved. According to Mavhunga and Rollnick (2013), a good conceptual understanding of topics enables teachers to adopt the best teaching techniques that can assist learners in attaining curriculum competencies. More so, it can be surmised from the above excerpts that the teachers' SMK was also increased (Shulman, 1987).

5.3.2 Interactions and participation

Meekulu Paulina commenced her presentation by asking the teachers to identify the hand tools around her: "*Oilongifo omuishii ei? Ondahala mwiitumbule momalaka eni aa hamupopi keumbo opo tuhongafaneni yoo omalaka etu"* (Do you know the names for these tools? I want you to name them in your home languages, so we learn how you call them in your home language). From such an interaction, it could be surmised that meekulu Paulina was eliciting the teachers' prior knowledge (Kuhlane, 2011; Roschelle, 1995), which is also termed as everyday life knowledge from home and community by Mavhunga and Rollnick (2013). This, in my view, was critical, in the sense that it increased participation among the participants as espoused by Sedlacek and Sedova (2017). Notably, the question posed by the IKCs was partly answered correctly. For instance, T2 pointed out what looked like a traditional hoe and a modern hoe while T4 pointed out what looked like a rake. Meekulu Paulina then said: "*Oshilongifo eshi shafa oshihalaka ohashuufanwa oshikoolifo*" (This tool which you said looks like a rake is called *oshikoolifo*). All teachers were astonished to hear about the tool's name for the first time. This indicates that Agricultural Science teachers were learning from each other and the IKC during the social-cultural

set-up. This resonates with Vygotsky (1978), who emphasises that learning takes place through collaborative social interactions with peers or MKOs – the IKCs in the context of this study.

Moreover, it could also be deduced from the above excerpt that meekulu Paulina was aware of the importance of home language in teaching. This finding is in line with Mavuru and Ramnarian (2020) who posit that home language can be instrumental in the teaching of science concepts as it has the potential to allow learners (teachers in the context of this study) to think and express their thoughts explicitly and can also assist in the conceptual understanding of scientific concepts (Msimanga & Lelliot, 2014). Simply put, the use of a home language, Oshiwambo, during the IKCs' presentations enabled the participants to communicate and actively participate more freely since they were all Oshiwambo speakers. This finding resonates with Vygotsky (1978), that language was the most pertinent cultural tool that enabled knowledge construction between the novice teachers (participants) and the MKOs.

5.3.3 Learning affordances

The expert community members presented and demonstrated various cultural ways of growing crops particularly on fertilising the soil and controlling crop pests. Their presentations allowed the Agricultural Science teachers to link the presentations to their teaching practices. Notably, the teachers were able to come up with scientific concepts that emerged from the IKCs' presentations as shown in the concept map below.

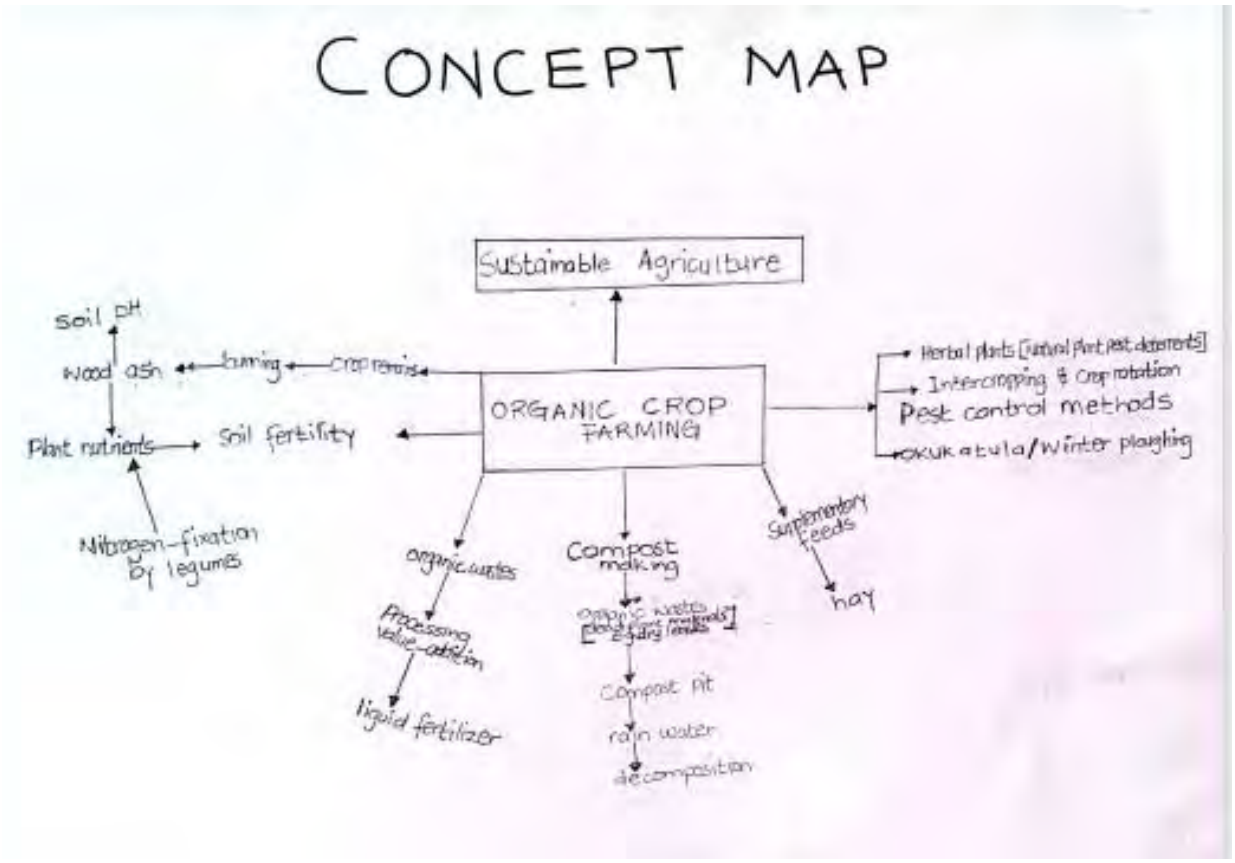


Figure 5.12: Shows a concept map

From the concept map, it was observed that the three Agricultural Science teachers could link the cultural practices of growing crops to various science concepts/topics illustrated in Figure 5.12. It is evident that these teachers were able to identify specific topics within the Agricultural Science syllabus. In my view, this speaks to curriculum saliency (Mavhunga & Rollnick, 2013) which focuses on the identification of a specific topic and highlights the most pertinent concepts of a topic that learners need to understand.

Furthermore, the IKCs actively involved the Agricultural Science teachers during their presentations. For instance, meekulu Paulina asked the teachers to identify the traditional hand tools used to prepare the soil. For instance, she said: "*Oilongifo omuishi omadina ayo ei…"* (Do you know the names of these tools…?), to which T2 and T4 responded. This excerpt indicates that learning took place through the elicitation of prior knowledge (Mavhunga & Rollnick, 2013; Roschelle, 1995) as they could link the IKCs' elaborations to their everyday prior knowledge

(Kuhlane, 2011). Moreover, meekulu Paulina also asked the male participant to assist her with the collection and burying of dry leaves. This collaboration resonates with Vygotsky's (1978) social-cultural theory which asserts that learning takes place through social interactions with peers or MKOs, the IKCs in the context of this study.

Notably, the participants took notes in their reflective journals as the IKCs were presenting. This also showed that learning was taking place. For example, T2, T3 and T4 reflected:

> *T4: I was quite impressed to learn that there is a lot of science embedded in local cultural practices/ IK, such as how to make natural compost, role of ash in soil pH, and biological nitrogen fixation by legumes, amongst other science concepts. I have also learned that it is imperative for us (teachers) to integrate IK in mediating the concept of organic crop farming as IK can make the topic more relevant to the learners.*
>
> *T2: I have learned about in-depth cultural agricultural- knowledge, I did not know if there were other more traditional ways of fertilising the soil apart from using animal manure as I thought compost is a foreign concept.*
>
> *T3: I have learned about organic ways of controlling crop pests using organic methods, at least I can now teach methods that learners can relate to.*

These reflections indicate that T4 seemed to have learned and realised the importance of acknowledging and using the knowledge systems learners bring to school as reiterated by Mavuru (2022). Simply put, this teacher realised that IK is a resource rather than an impediment in the teaching and learning process as espoused by Mavuru (2022). Interestingly, during the semi-structured interviews, this teacher openly revealed that he does not integrate IK into his lessons because he was not trained, there is no IK in textbooks, and it is also not included in assessments. It could then be argued that the IKCs' presentations seem to have enabled a shift from the traditional model of teaching to a more culturally responsive approach as it helped T4 to reconceptualise the way he teaches (Wyatt & Chapman De Sousa, 2017). Furthermore, T3 reflected that "*I have learned about organic ways of controlling crop pests using organic methods, at least I can now teach methods that learners can relate to".* It was evident that teachers seemed to be ready to mobilise cultural practices in their classes as they were now empowered through the IKCs' presentations.

In my view, the above reflections affirm that teachers can become cultural brokers if they are given the support they need, as after the presentation, they seemed to be ready to bridge learners' culture with that of the school to close the cultural gap that exists between the two worlds (Sleeter, 2001) This, in my view, would enable learners to develop a more robust scientific world view. By extension, it could also be argued that the teachers' PCK improved after they visualised the link between home science and classroom science, enabling border crossing as advocated by Aikenhead and Jegede (1999). Simply put, teachers showed an understanding of IK and the importance of integrating it into their classes, particularly in the mediation of organic crop farming. This clearly indicates a shift in both their SMK and PCK (Shulman, 1987) and ZPD in Vygotsky's (1978) terms.

5.4 Chapter Summary

In this chapter, I presented and analysed data from workshop discussions, participatory observations on the IKCs' presentations and data from teachers' reflections. Findings indicated that teachers found the indigenous technology of organic crop farming useful and appropriate to mediate lessons on crop production in Agricultural Science classes. Teachers' participation during the presentations was remarkably high and they actively interacted both with the IKCs and their mediatory artefacts. In the next chapter, I present the summary of the findings, recommendations and conclusion.

CHAPTER SIX: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

The main goal of this study was to explore the use of the indigenous technology of organic crop farming to mediate learning in Grade 12 Agricultural Science classes. To achieve this goal, the following research questions were addressed:

1. What are Grade 12 Agricultural Science teachers' perspectives, experiences and pedagogical insights regarding the integration of IK into their classrooms?
2. What learning opportunities are created (or not) for Grade 12 Agricultural Science teachers to interact, participate and learn during the presentations on organic crop farming made by the IKCs?
3. How can the indigenous technology on organic crop farming presented by the IKCs be used to co-develop exemplar lessons?

To answer these research questions, I employed a qualitative research design to generate data using semi-structured interviews, workshop discussions, participatory observations and teachers' journal reflections. Data sets were analysed using a deductive-inductive approach and a thematic approach to data analysis was employed to come up with sub-themes and themes. The findings from the data analysis were discussed in Chapters Four and Five using the participants' quotes and the relevant theory and literature.

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

6.2 Summary of the Findings

In this section, I present a summary of the findings of this study in relation to each research question. I begin with research question one as follows.

6.2.1 Research question 1

> *What are Grade 12 Agricultural Science teachers' perspectives, experiences and pedagogical insights regarding the integration of IK into their classrooms?*

This study's findings revealed that all four teachers who participated in this study seemed to understand the concept of IK. For instance, they used similar terms to define IK such as local community, certain culture and passed on from one generation to another. In essence, they viewed IK as a legacy of local or cultural knowledge that is unique to a particular culture and is passed from one generation to another (Kibrige & Van Rooyen, 2006).

Moreover, the research findings also revealed that these teachers seemed to embrace the integration of IK and demonstrated a degree of positivity towards the enactment of IK in their science lessons. For instance, T2 explained that "*I normally send learners to go ask their parents at home about the cultural ways they use to grow crops and then use their findings to define and explain organic crop farming".* This excerpt clearly indicates that T2 is aware that local or home knowledge is a critical source of prior knowledge that has the potential to enhance teaching and learning of organic crop farming. That is, she regarded IK as a guiding tool to link learners' home knowledge to what is taught at school to enhance learners' conceptual understanding, particularly on the topic of organic crop farming. This is termed as border crossing by Aikenhead and Jegede (1999). In support of this finding, these scholars pointed out that when IK is integrated it assists learners to learn school science by relating it to their home experiences to make sense of school science. Indeed, this finding is in line with the Ministry of Education Arts and Culture (MEAC, 2016) which underscores that teachers should use learners' existing IK and culture to create new knowledge.

In addition, T1 explained: "*I have seen that when I use IK in my teaching, especially when I use Oshiwambo to explain science concepts, it really helps learners to understand better, participate well and perform well in sections where I have used IK*". This finding coheres with Kibrige and Van Rooyen (2006) who postulate that when IK is integrated into teaching science it enhances participation because learners can feel the connection between what they are learning and what they do at home. Similarly, this finding also concurs with Govender (2014) who stresses that integration of IK into science lessons results in increased learner motivation, participation, and achievement. Moreover, T1 also highlighted that learners tend to understand science concepts much better when she uses the Oshiwambo (home/local) language in teaching science. This finding is congruent with Vygotsky's (1978) assertion that home language makes science accessible and relevant to learners. Thus, it can be argued that indigenous language is a legitimate resource for science teachers to mediate the learning of science concepts as it enhances conceptual understanding (Msimanga & Lelliott, 2014).

However, this study's findings revealed some challenges that hinder the integration of IK into schools. For instance, T1, T3 and T4 commented:

> *I try to integrate IK in my class but in a limited way because I was not trained from the institutions or any workshop how to use IK (T1FSSI).*
>
> *I don't integrate it that much because it is not included in the syllabus, so I find it difficult to explain to the learners because I also do not know most of the IK as I was never trained how to use it in my class (T3FSSI).*
>
> *The reason why I don't incorporate it in the lessons is because it is not in the textbooks and syllabus, and it also not accepted in assessments. … Furthermore, I was also not trained on how to use it. I think growing up in town might also have contributed to this as I lack most of the cultural knowledge (T4MSSI).*

The argument in point in these findings is that the curriculum and teachers' training institutions are silent about the integration of IK. These teachers' thoughts seemed to concur with Seehawer (2018) who reveals that teachers' training institutions do not prepare teachers on how to integrate IK which inhibits its integration. Adding more weight to the teachers' claims, Kibrige and Van Rooyen (2006) posit that teachers can only recognise the value of IK in the science classroom if they are taught or trained on how to integrate it into science lessons.

6.2.2 Research question 2

The research findings revealed that the practical presentations by the two IKCs enhanced active participation and interactions (Sedlacek & Sedova, 2017) among the teachers. The research findings further showed that interactions and participation were enabled by using cultural artefacts and home language (Oshiwambo in the context of this study). For instance, the IKC commenced her presentation by asking "*Do you know what these hand tools are?*" This illustrates that although the IKC had no formal teaching training, they used cultural tools to elicit teachers' prior knowledge as described by scholars such as Khulane (2011), Mavhunga and Rollnick (2013) and Roschelle (1995). In addition, the IKC invited the Agricultural Science teachers to assist her with collecting dry leaves. This indicates that the IKC attempted to engage the teachers during the practical presentation.

This resonates well with Vygotsky's (1978) SCT which underscores that learning takes place through collaborative social interaction with peers or MKOs. More so, increased social interactions and participation could also be attributed to the use of a home language during the presentation. This finding coheres with various scholars who aver that the use of home language allows learners (teachers in this case) to think and express their thoughts freely and explicitly (Mavuru & Ramnarian, 2020; Msimanga & Lelliot, 2014). This corroborates Vygotsky's (1978) assertion that language is the most significant cultural tool that enables the construction of knowledge between novice teachers and the MKOs. Furthermore, the IKCs were thrilled to share their knowledge with teachers, citing that the presentations also helped them to recall the cultural heritage they inherited from their forefathers. It could be argued, therefore, that the sharing of their cultural heritage by the IKCs in this study is a practical example of how IK can be passed from one generation to another as espoused by Kibirige and Van Rooyen (2006).

Moreover, the IKCs' presentations enabled the teachers to relate the presentations to their teaching practices. They were able to identify the science topics or concepts that were embedded in the cultural practices presented that they could use to mediate learning in their classes. For instance, T4 reflected:

> *I was quite impressed to learn that there is a lot of science embedded in our local cultural practices/IK, such as to make natural compost, role of ash in fertilising the soil and regulating soil pH, and nitrogen fixation by legumes, amongst other science concepts.*

This excerpt shows some of the science concepts that emerged from the presentations that teachers could use to contextualise the topic of organic crop farming. The above excerpt further demonstrates that there was a shift in learning because of the IKCs' presentations. These teachers realised and learned the significance of acknowledging and using the knowledge learners bring to school from home as reiterated by Mavuru (2022). In other words, they learned that IK is a resource rather than a constraint in teaching and learning science (Mavuru, 2022). Worth noting was that during the semi-structured interviews, T4 openly revealed that he does not integrate IK into his lessons as he was not trained, there is no IK in the textbooks, and it is also not included in assessments. However, after the IKCs presentation, T4 reflected that "*I have also learned that it is imperative for (us) teachers to integrate IK in mediating the concept of organic crop farming as IK can make the topic more relevant to the learners*".

From this excerpt, it could be argued that the IKCs' presentations empowered T4 to shift from the traditional model of teaching to a more culturally responsive approach – as it appeared to assist him in re-conceptualising the way he taught (Wyatt & Chapman De Sousa, 2017). To this end, T4's reflection seemed to affirm that if given the necessary support, he might become an effective cultural broker, as after the presentation, he appeared to be ready to bridge the gap between home and school that Aikenhead and Jegede (1999) refer to as border crossing. In essence, the teachers' PCK and subject matter content (Shulman, 1987) as well as their ZPD (Vygotsky, 1978) were augmented.

6.2.3 Research question 3

> *How can the indigenous technology on organic crop farming presented by the IKCs be used to co-develop exemplar lessons?*

The findings from the study revealed that during workshop discussions the four Agricultural Science teachers managed to co-design and develop an exemplar lesson plan. The exemplar lesson plan integrated IK of growing crops to mediate the concept of organic crop farming in sustainable agriculture (see Appendix O**)**. Essentially, the aim of the workshop on the co-development of the

lesson plan was for teachers to implement the knowledge they obtained from the IKCs' presentations to provide learners with an enduring and applicable understanding of scientific concepts (Nhase, 2019; Shinana et al., 2021).

Most significantly, the teachers not only co-developed the lesson plan but were also empowered to plan future IK-inclusive lessons using the exemplar lesson plan as a guide. This activity coheres with scholars in the CPD arena who advocate educational workshops and training to advance teachers' professional development (Eun, 2008; Ngcoza & Southwood, 2019) to enhance teachers' teaching practices. More so, this workshop was a way of establishing a community of practice (Mutanho, 2021) and a professional learning community (Chauraya & Brodie, 2018) to improve the four Agricultural Science teachers' SMK (Shulman, 1987) and TSPCK (Mavhunga & Rollnick, 2013).

6.3 Recommendations

Given the findings, the study recommends that the indigenous technology of organic crop farming be integrated into the teaching of Agricultural Science in schools, particularly in areas where crops are grown culturally. I believe that this could make Agricultural Science accessible and relevant to local learners (Asheela et al., 2021; Shinana et al., 2021).

For instance, the indigenous technology of growing crops in this study proved to be effective in mediating learning of organic crop farming as it featured a range of topics/concepts under organic crop farming. As such, the study recommends that teachers should collaborate with IKCs in their communities to learn about IK practices that could be integrated into their teaching practices. This has the potential to pave the way for the Africanisation of the science curriculum as advocated by Mukwambo et al. (2014). This might also serve in restoring and preserving the cultural heritage and dignity of indigenous people (Cocks et al., 2012; Smith, 1999).

Arguably, although the country cannot revert to the pre-colonial era, in the post-independence era, it is pertinent for policymakers to revisit IKS and incorporate these into the school curricula – this would enable teachers to build on what learners already know in pursuit of sustainable development. Learners come to school with a wealth of knowledge that teachers need to acknowledge and use as prior knowledge to enhance their conceptual understanding (Mavuru &

Ramnarain, 2020). Most significantly, they need to equip learners with the relevant knowledge and skills applicable to their different communities to boost agricultural productivity and ultimately ensure food security at both household and national levels (Muchenje et al., 2021).

Another recommendation is that curriculum developers, in collaboration with IKCs and science teachers, should amend the Agricultural Science syllabus to richly include relevant IK. This would serve as a guide to science teachers on how to integrate IK into their science lessons, as the exclusion of IK poses difficulties in making sense of abstract science concepts (Govender, 2014). In addition, curriculum developers should also encourage textbook publishers to publish textbooks that reflect the integration of IK and encourage schools to research and document IK predominant in their communities from which they can draw pools of knowledge during teaching (Muchenje, 2021). Moreover, teacher training institutions must modify their curriculum to include a pedagogy course module on IK (Mutanho, 2021) to equip student teachers with the essential PCK (Shulman, 1987) on IK integration into science teaching.

6.4 Areas for Further Research

Further research could focus on using the indigenous technology to process or add value to agricultural products. It would also be interesting to see a study on the same topic, where the community members demonstrate to learners how they grow crops traditionally and allow them to link IK to school science. More so, this research could be extended on the same topic where teachers could teach the co-developed exemplar lesson in their classes while they are being observed.

6.5 Limitations of the Study

In this research study, I worked with four Grade 12 Agricultural Science teachers and two Indigenous Knowledge Custodians (IKCs) in the Oshana region. In this study I did not experience many challenges, however, as stated ealier in Section 3.6.2, only three teacher participants attended the IKCs' presentations. The fourth teacher could not attend as she had to visit one of her close family members who was critically ill at the time. Notably, she was later briefed by other participants during the group reflections on the IKCs' presentations that were done the next day. As such, the sample was small; thus, the findings of the study cannot be generalised to represent

all Agricultural Science teachers in the region and beyond. Nevertheless, the study's findings provided valuable insights on how crops are traditionally grown and how such IK may be used to mediate learning of the concept of organic crop farming. Even though the use of home language (Oshiwambo) enhanced social interactions (Vygotsky, 1978) and active participation (Sedlacek & Sedova, 2017), I am cognisant of the fact that some information might have been distorted or possibly lost through the process of translating from the home language to English. To counteract this, member checking was done to ensure the validity of the data.

6.6 Personal Reflections

My research interest in IK started in 2020 when I was completing the BEd Honours programme in science education at Rhodes University. In my second and final year of this programme, we were introduced to the concept of IK as one of the key components of the science education elective by our lecturer and my thesis supervisor Prof Ken Ngcoza with the assistance of Dr Chris Mutanho. For instance, we started by being actively engaged in a group activity on cultural beliefs and practices on lightning. Interestingly enough, all the responses from Namibian classmates from various cultures (including Prof Ken from South Africa and Dr Chris from Zimbabwe who formed a group) had many commonalities. For example, "You don't use a mirror when there is lightning – otherwise, you will be struck by lightning".

I should indicate that I found science lessons on IK quite enjoyable and interesting as they were centred on my area of interest – traditional knowledge as I grew up in a cultural set-up. It was the science elective lessons on IK plus the first assignment we got on the integration of IK into science education that greatly exposed me to a lot of scholarly work on this topic that inspired and motivated me to do my master's in science education.

After registering for my master's degree, under Prof Ken's guidance I extensively read various scholarly works to be able to determine the research/knowledge gap that my research study could fill. I thus discovered that the integration of IK into agriculture education has been under-researched and there were only two research studies under the Rhodes research umbrella that had been conducted in this critical field. For instance, a study on animal production conducted by Siseho (2019) and a study on food preservation conducted by Hashondili (2020). I further

established that no research has ever been conducted on crop production which is a key area of agriculture. It was against this backdrop that I decided to do my research in Agricultural Science education to fill the knowledge gap. Notwithstanding, through reading studies conducted by several scholars, I came to realise that IK is one of the key ingredients needed for effective teaching and learning of science. Notably, I had been one of those teachers who rarely valued learners' cultural heritage of funds of knowledge in the classroom. Thumbs up to Prof Ken Ngcoza for exposing me to such a wealth of knowledge. I can now proudly state that I am one of the few living IK ambassadors in Namibia in Agricultural Science in particular. What makes me even more proud is that I am a woman and there are few women in this field. Consequently, I have been able to positively influence most of the educators in my circle, such that they are slowly starting to realise the importance of integrating IK into their science teaching.

My research journey was a challenging and at the same time rewarding experience. For instance, I struggled to find literature in line with my research study as few studies have been conducted on agricultural education, particularly on crop production. However, through extensive reading, I eventually completed my literature review chapter. Analysing my data was not "a walk in the park" either. However, after I attended two workshops on analysing qualitative data at the Rhodes University Centre for Postgraduate Studies and received support from my esteemed supervisor, Prof Ken, fellow master's scholars and esteemed PhD scholar Ester Shinana, I started to comprehend and internalise the process of analysing data. Simply put, we were a team with the Ubuntu spirit, and we all embraced our supervisor Prof Ken's most loved African proverb that goes: *"If you want to walk fast walk alone, but if you want to walk far walk together"* (Ratan Tata, n.d.).

The journey was also rewarding in various ways. For instance, from this study, the presentations made by the IKCs made me realise that the science we teach at school really starts at home or in the community. The IKCs' presentations made me regret the damage I had long caused to my learners by neglecting their cultural heritage and their everyday home experiences during lessons. Moreover, this study made me appreciate the power of home language in science as I observed how it increased participation and active engagement among the participating teachers (Sedlacek & Sedova, 2017) during the IKCs' presentations. For instance, I observed that the home language

(Oshiwambo) enabled the teachers to make sense of science concepts embedded in the cultural practices of growing crops (Mavuru & Ramanarian, 2019) as they freely expressed themselves as they engaged with the IKCs and among themselves.

Moreover, my computer and research skills were significantly enhanced. Unfortunately, prolonged use of the computer caused me a persistent right eye problem that swells when I spend more time on the computer, especially during the night. Consequently, I wrote this thesis during the day only and it was not easy at all as I am a full-time high school teacher. This greatly slowed my pace to complete my thesis within the planned time. Nevertheless, I thank the Almighty God for carrying me through this journey until the end.

6.7 Conclusion

This study sought to explore the indigenous technology of organic crop farming to mediate learning in Agricultural Science classes. The findings derived from the semi-structured interviews revealed that the participated teachers demonstrated a degree of positivity towards the integration of IK into their lessons. That is, they are aware that IK is a critical tool that links learners' home knowledge to school science, to enhance learners' conceptual understanding as espoused by Aikenhead and Jegede (1999). Indeed, this finding is in line with the Ministry of Education, Arts and Culture (MEAC, 2016) which underscores that teachers should use learners' existing IK and culture to construct new knowledge. However, it is easier said than done as all teachers conceded that they lacked PCK for integrating IK in their lessons as they were never trained at their training institutions on how to integrate IK in their science teaching.

To lessen this hindrance, this study tapped into the cultural heritage of IKCs who were positioned as the MKOs in Vygotskian terms. The IKCs' presentations allowed the participating teachers to interact, participate, and learn about IK that they can integrate in their lessons. More so, the presentations enabled the participants to realise that knowledge is not only found in physical classrooms or lies with teachers, but it also exists and is found in the community, where there are more knowledgeable persons – in this case, the IKCs who knew and had the skills to make various forms of organic fertilisers and pesticides.

This study, therefore, recommends that there is a need for professional development workshops to support teachers on how best they can integrate IK into their lessons. Most significantly, the study suggests that IKCs should be part of such professional workshops as they are the custodians of the cultural heritage.

Moreover, the study also established that the use of home language during the IKCs' presentations increased teachers' participation and social interactions (Sedlacek & Sedova, 2017; Vygotsky, 1978) as the language was accessible to all teachers. That is, language was a resource rather than being a barrier. This study's findings, therefore, illuminate a great need for teachers to consider their learners' home language where possible- in their science lessons, to help contextualise the abstract science concepts and to make science accessible, meaningful, and relevant to indigenous learners.

REFERENCES

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. https://doi/org/10.12691/education-3-6-1

Adamchak, R. (2021). Organic Farming. *Encyclopaedia Britannica*.

Adebayo, A.S., & Oladele, O. I. (2013d). Vegetable farmers' attitude towards organic agriculture practices in South Western Nigeria. *Food Agric Environment, 11*(2), 548-552.

Afonso-Nhelevilo, E.Z.F. (2013). Rethinking the history of inclusion of IKs in school curricula: Endeavoring to legitimate the subject. *International Journal of Science and Mathematics Education*, 23-42. https://doi.org/10.1007/s10763-012-9382-8

Aikenhead, G. (2006) Towars decolonizing the pan-Canadian science framework. Canadian *Journal of Science Mathematics and Technology Education*, *6*, 387-399

Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching, 36*(3), 269-287.

Altieri, M. A. (2009). Agroecology, small farms, and food sovereignty. *Mon Rev 61*(3), 102-113

Arcavi, A. (2003). The role of visual representations in the learning of mathematics. *Educational Studies in Mathematics*, *52*(3), 215-241.

Archer, L., Ransom, B., & Coley, M (2017). *Sustainable agriculture research and education program. Organic farming. What is sustainable agriculture?* University of California.

Asheela, E., Ngcoza, K. M., & Sewry, J. (2021). The use of easily accessible resources during hands-on practical activities in rural underresourced Namibian schools. In U. Ramnarain (Ed.). *School science practical work in Africa* (pp. 14-31). Routledge. https://doi.org/10.4324/9780429260650-2

Ashofor, A. H., Ekele, C.B., & Milcah, T.S. (2016). The importance of indigenous languages in teaching and learning: Implication for ECCE and PED students. Capital Journal of Education Studies, 4(1), 1-15.

Avery, A. (2007). Going organic. *Crops and Soils, 40*(1), 8-12.

Backman, E., & Baker, D. M. (2020). Re-thinking pedagogical content knowledge for physical education teacher's implications for physical education. *Physical Education and Sport Pedagogy*, *25*(5), 451-463. https://doi.org/10.1080/17408989.2020.1734554

Baquete, A. M., Grayson, D., & Mutimucuio, I. V. (2016). An exploration of Indigenous knowledge related to physics concepts held by senior citizens in Chókwé, Mozambique. *International Journal of Science Education*, *38*(1), 1-16. https://doi.org/10.1080/09500693.2015.1115137

Battiste, M., & Henderson, J. Y. (2000). *Protecting indigenous knowledge and heritage: A global challenge.* Purich.

Bazuin, S., Azadi, H., & Witlox, F. (2011). Application of GM crops in sub-Saharan Africa: Lessons learned from Green Revolution. *Biotechnol. Adv*., *29*, 908-912.

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

Bertram, C., & Christiansen, I. (2020). *Understanding research: An introduction to reading research* (2nd ed.). Van Schaik Publishers.

Biao, X.X., Ding, Z., & Yang, Y. (2003). Critical impact assessment of organic agriculture. *Journal of Agricultural Environmental Ethics, 16*, 297-311.

Bifuh-Ambe, E. (2020). Educational policy for postcolonial Africa. In *Oxford Research Encyclopedia of Education*.

Bowers, C. (2007). Introducing eco-justice and the revitalisation of the common issues into thinking about environment education. In D. Zandvliet & D. Fisher (Eds.), *Sustainable*

communities, sustainable environments: The contributions of science and technology education (pp. 47-60). Sense Publishers.

Brayboy, B. M. J., & Castagno, A. E. (2008). How might Native science inform ‘‘informal?

Bromme, R. (1995). What exactly is pedagogical content knowledge? Critical remarks regarding a fruitful research paradigm. *IPN Schriftenreihe, 147*, 205-216.

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.

Charamba, E. (2020). Pushing linguistic boundaries: translanguaging in a bilingual Science and Technology classroom. *Journal of Multilingual and Multicultural Development*. https://doi.org/10.1080/01434632.2020.1783544

Chauraya, M., & Brodie, K. (2018). Conversations in a professional learning community: an analysis of teacher learning opportunities in mathematics. *Pythagoras*, *39*(1), https://doi.org/10.4102/Pythagoras.v39i1.363

Cheikhyoussef, A., & Embashu, W. (2013). Ethnobotanical knowledge on indigenous fruits in Ohangwena and Oshikoto region in Northern Namibia. *Journal of Ethnobiology and Ethnomedicine*, *9*, 34. https://doi.org/101186/1746-4269-9-34

Chikamori, K., Tanimura, C., & Ueno, M. (2019). Transformational model of education for sustainable development as a learning process of socialization. *Journal of Critical Realism*, *18*(1), 1-17. https://doi.org/1080/14767430.2019.1667090

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

Cobern, W. W., & Loving, C. C. (2001). Defining "science" in a multicultural world: Implications for science education. *Science Education, 85*(1), 50-67.

Cocks, M. L., Alexander, J., & Dold, T. (2012). Inkcubeko nendalo: A bio-cultural diversity school's education project in South Africa and its implications for inclusive indigenous knowledge systems (IKS) sustainability. *Journal of Education for Sustainability Development*, *6*(2), 241-252.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Sage.

Corbeels, M., Shiferaw, A., & Haile, M. (2000). *Farmers' knowledge of soil fertility and local management strategies in Tigray, Ethiopia.* Russell Press.

Creswell, J. W. (2016). *First steps in research* (3rd ed.). Van Schaik Publishers.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute.

Da Silva, J. G. (2012). *Feeding the world sustainably*. FAO & United Nations.

Davidowitz, B., & Rollnick, M. (2011). What lies at the heart of a good undergraduate teaching? A case study in organic chemistry. *Chemistry of Education Research and Practice, 12*, 335-336.

De Bon, H., Brun-Diallo, L., & Sene, J-M. (2019). Rendements ET pratiques des cultures maraicheres en agriculture biologique au Senegal. *Cah Agric, 28*(2). https://doi.org/10.1051/cagri/2019001

Dei, G. J. S. (2000). Rethinking the role of indigenous knowledges in the academy. *International Journal of Inclusive Education, 4* (2), 111-132. https://doi.org/10.1080/136031100284849

Denuga, H. M. (2015). *An investigation into how Grade 7 Natural Science teachers mediate learning through code-switching from English to Silozi in the Zambezi region of Namibia: A case study* [Unpublished master's thesis]. Rhodes University.

Department of Basic Education. (2011). *Curriculum and Assessment Policy Statement.* Government Printer.

Dixon, G. (2012). Climate change – Impact on crop growth and food production, and plant pathogens. *Canadian Journal of Plant Pathology, 34*(3), 362-379. https://doi.org/10.1007/s11422-008-9125-x

Dziva, D., Mpofu, V., & Kusure, L. P. (2011). Teachers' conceptions of indigenous knowledge in science curriculum in the context of Mberengwa district, Zimbabwe. *African Journal of Educational and Technology, 1*(3), 88-102.

Escobar, M. E. O., & Hue, N. V. (2007). Current developments in organic farming. *Research Signpost, 37,* 661.

Edje, O. T., Semoka, J. M. R., & Haule, K. L. (1988). *Traditional forms of soil fertility maintenance.* National Soils and Fertilizer Use Research Programme, Tanzania.

EI Bilali, H. (2020). Organic food and farming in West Africa: A systematic review. *Sustainable Organic Agriculture Systems, 70*(2), 94-102.

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), 1137-1142. https://doi.org/10.20533/ijcdse.2042.6364.2013.0160

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

Everett, D. (2013). *Language: The cultural tool*. Profile Books LTD.

Food and Agriculture Organization and United Nations. (2018). *The future of food and agriculture: Alternative pathways to 2050. Summary version.* http://www.fao.org/3/CA1553EN/ca1553en.pdf

Furtak, K., & Galaxka, A. (2019). Effect of organic farming on soil microbiological parameters *Polish Journal of Soil Science, 52*(2), 259-267.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2012). *Educational research: Competencies for analysis and application* (10th Ed.). Pearson Education International.

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK: results of the thinking from the PCK summit. In A. Hume, R. Copper & A. Borowski (Eds.), *Repositioning pedagogical content knowledge in teacher's knowledge for teaching science* (p. 79). Springer.

Gibbons, P. (2003). Mediating language learning: teacher interactions with ESL students in a content-based classroom. *TESOL Quarterly*, *37*(2), 246- 273. http://www.jstor.org/stable/3588504?origin=JSTOR-pdf

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

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

Gonzalez, E., & Meira, P. (2019). Environmental education under siege: Climate radicality. *The Journal of Environmental Education, 50*, 86-402.

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

Govender, N., & Mutendera, G. (2020). Teachers' and custodians' views and dilemmas arising thereof regarding the integration of indigenous knowledge in the primary school. *International Journal of Indigenous Peoples*. https://doi.org/10.1177/1177180120970935

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

Haimene, J. S. (2023). *Exploring and expanding teachers' gender and culturally responsive practices when mediating the learning of Chemistry in rural schools in Namibia* [Unpublished PhD thesis]. Rhodes University.

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

Hashondili, S. (2020). *Exploring working with Grade 6 Elementary Agricultural Science teaches in understanding and developing model lessons that integrate local knowledge on food preservation* [Unpublished master's thesis]. Rhodes University.

Hewson, M. G., Javu, M. T., & Holtman, L. B. (2009). The indigenous knowledge of African traditional health practitioners and the South African science curriculum. *African Journal of Research in Mathematics, Science and Technology Education*, *13*(1), 5-18.

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.

Hodson, D. (1990). A critical look at practical work in school science. *School Science Revie*w, *71*, 33-40. https://doi.org/10.1080/03057269308560022

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

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

Horsthemke, K., & Schäfer, M. (2007). Does 'African mathematics' facilitate access to mathematics*?* Towards an ongoing critical analysis of ethno mathematics in a South African context. *Pythagoras, 65*, 2-9. https://doi.org/10.4102/Pythagoras.v0i65.85

Howden, D. (2008). Organic agriculture can address food security in Africa. *Independent.* http://www.independent.co.uk/news/world/africa/organic-farming-could-feed-africa-968641.html

Kakambi, W. M. (2021). *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.

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., & 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.

Kind, V. (2009). Pedagogical content knowledge in science education: Perspectives and potentials for progress. *Studies in Science Education, 45*, 169-204.

King, L., & Schielmannn, S. (2004). *The challenge of indigenous education: Practice and perspectives.* UNESCO.

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

Kozulin, A. (2004). *Vygotsky's educational theory in cultural context*. Cambridge.

Kreisler, A., & Semali, L. (2001). Towards indigenous literacy: Science teachers learn to use indigenous knowledge resources. *Pacific Curriculum Network, 10*(2), 9-13.

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.

Lantolf, J. P., & Thorne, S. L. (2006). *Sociocultural theory and the genesis of second language development*. Oxford University Press.

Lavallee, L.F. (2009). Practical application of an indigenous research framework and two qualitative indigenous research methods: sharing circles and Anishnabe symbol based-reflection. *International Journal of Qualitative Methods,8*(1), 21-40. https://doi:10.11.77/160940690900800103

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press. https://doi.org./10.1017/CBO9780511815355

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), 579-591.

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

Lemke, J. L. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching, 38*(3), 296-316.

Li, L., & Tomasello, M. (2021). On the moral functions of language. *Social Cognition*, *39*(1), 99-116.

Liu, Y., Duan, M., & Yu, Z. (2013). Agricultural landscapes and biodiversity in China. *Agricultural Ecosystems Environment, 166,* 46-54.

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

Loughran, J., Keast, S., & Cooper, R. (2016). Pedagogical reasoning in teacher education. In J. Loughran & M. L. Hamilton (Eds.), *International handbook of teacher education* (vol. 1, pp. 387-421). Springer.

Magwentshu, T. (2020). *Exploring an intervention on how to integrate local or indigenous knowledge on the features of the moon in Grade 4 classes* [Unpublished master's thesis]. Rhodes University.

Mangena, F. (2015). Restorative justice's deep roots in Africa. *South Africa Journal of Philosophy, 34*(1), 1-12.

Manna, M. C., Ghosh, P.K., & Acharya, C. L. (2003). Sustainable crop production through management of soil organic carbon in semiarid and tropical India. *J Sustain Agric, 21*(3), 85-114.

Maree, K. (2016). *First steps in research* (4th ed.). Van Schaik Publishers.

Maselwa, M. R., & Ngcoza, K, M. (2003). 'Hands-on', 'minds-on' and 'words-on' practical activities. In electrostatics: Towards conceptual understanding. In D. Fisher & T. Marsh (Eds.), *Making science, mathematics and technology education accessible to all.* Proceedings of the Third International Conference on Science, Mathematics and Technology Education (pp. 649-659). Key Centre for School Science and Mathematics.

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 Systems*, *18*(1), 64- 77. https://hdl.handle,net/10520/EJC-17399bc320

Matsika, C. (2012) *Traditional African Education: Its significance to current education practices with special reference to Zimbabwe*. Mambo Press.

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).

Mavuru, L. (2022). Reimagining indigenous knowledge in a multicultural science classroom. *International Journal of Inclusive Education.* https://doi.org/10.1080/13603116.2022.2127498

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

Mavuru, L., & Ramnarain, U. D. (2019). Language affordances and pedagogical challenges in multilingual grade 9 natural sciences classrooms in South Africa. *International Journal of Science Education,* 1-21.

Mavuru, L., & Ramnarain, U. D. (2020). Learners' socio-cultural backgrounds and science teaching and learning: A case study of township schools in South Africa. *Cultural Studies of Science Education, 15*, 1067-1095.

Mawere, M. (2015). Indigenous knowledge and public education in sub-Saharan Africa. *Africa Spectrum, 50*, 2, 57-71. https://doi.org./10.1177/000203971505000203

McKinley, E. (2005). Locating the global: Culture, language and science education for indigenous students. *International Journal of Science Education, 27*(2), 227-241.

McMillan, J., & Schumacher, S. (2014). *Research in education: Evidence-based inquiry* (7th ed.). Pearson.

McRobbie, C., & Tobin, K. (1997). A social constructivist on learning environments. *International Journal of Science Education, 19*(2), 193-208.

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*. Sense Publishers.

Millar, R. (2010). Practical work. In J. Dillon (Ed.), *Good practices in science teaching: What research has to say* (2nd ed.) (pp. 108-134). Open University Press.

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

Ministry of Education. (2020). *Namibia Senior Secondary Certificate (NSSC) agricultural science syllabus, advanced subsidiary level*. NIED.

Ministry of Education, Arts and Culture. (2015). *National Curriculum for Basic Education*. NIED.

Ministry of Education, Arts and Culture. (2016). *National Curriculum for Basic Education.* NIED.

Ministry of Education, Arts and Culture. (2016–2023). *Report on the examinations NSSCO.* DNEA.

Mkabela, Q.N. (2015). Ubuntu as a foundation for researching African indigenous psychology. *Indilinga: African Journal of Indigenous Knowledge System*, *14*(2), 284-291.

Moser, S. (2008). Personality: A new positionality? *Area, 40,* 383- 392. https://doi.org./10.1111/j.1475-4762.2008.00815

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

Mothwa, M. M. (2011). *Teachers' experiences of incorporating indigenous knowledge in the Life Science classroom* [Unpublished master's thesis]. University Johannesburg.

Msimanga, A., & Lelliott, A. (2014). Talking science in multilingual contexts in South Africa: Possibilities and challenges for engagement in learners home languages in high school classrooms. *International Journal of Science Education*, *36*(7), 1159- 1183. https://doi.org/10.1080/09500693.2013.851427

Muchenje, F., Goronga, P., & Gora, R. (2021). Teachers' views on the utility of indigenous knowledge systems in the teaching of agriculture in selected schools in Zvimba District, Zimbabwe. *Journal for Studies in Humanities and Social Science, 1*(2).

Mukwambo, M., Ngcoza, 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.

Murphy, K., Garland-Campbell, K. A., & Lyon, S. (2007). Evidence of varietal adaptation to organic farming systems. *Field Crops Research, 102*(3), 172-177. https://doi.org/10.1016/j.fcr.2007.03.011

Mutanho, C. (2016). *Understanding how the incorporation of indigenous knowledge (IK) enables or constrains the teaching and learning of alcoholic fermentation* [Unpublished master's thesis]. Rhodes University.

Mutanho, C. (2021). *Exploring indigenizing the University science curriculum through bottom-up decolonization: Affordances and hindrances* [Unpublished doctoral thesis]. Rhodes University.

Mwape, P. (2022). *Practical training: Organic farming.* Farming Ideas Africa.

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. https://doi.org/10.1080/10288457.2014.956407

Neporo, J. (2022). *Mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry* [Unpublished master's thesis]. Rhodes University.

New Zealand. Ministry of Education. (1993). *Science in the New Zealand curriculum*. Learning Media.

Ngcoza, K. M. (2019). Education for sustainable development at problem-posing nexus of re-appropriated heritage practices and science curriculum, *South African Journal of Environmental Education*, *35*(1), 1-9.

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).

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 doctoral thesis]. Rhodes University.

Nieto, S. (2004*). Affirming diversity*. Longman.

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.

Ntsaone, O. (2005) African indigenous knowledge – An academic and socio-cultural exploration of indigenisation. *Indilinga- African Journal of Indigenous Knowledge Systems, 4*(1), 89-100.

Nuntsu, S. (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.

Nyamakuti, M, N. (2021). *Exploring the effect of the indigenous technology of oil extraction on Grade 10 Biology learners' perspectives and sense making of enzymes* [Unpublished master's thesis]. Rhodes University.

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

O' Donoghue, R., & Russo, V. (2004). Emerging patterns of abstraction in environmental education: A review of materials, methods and professional development perspectives. *Environmental Education Research, 10*(3), 331-351.

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

Ogawa, M. (1995). Science education in a multi-science perspective. *Science Education, 79*(5), 583-593. https://doi.org/10.1002/sce.3730790507

Ogunniyi, M. B. (2004). The challenge of preparing and equipping science teachers in higher education to integrate scientific and indigenous knowledge systems for learners: the practice of higher education. *South African Journal of Higher Education*, *18*(3), 289-304.

Ogunniyi, M. B. (2007). 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. (2018). *Human capital formation and economic growth in Nigeria: A time bound testing approach*. https://doi.org/10.30918/AERJ.62.17.046

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 and Japanese educators to enact an indigenised science curriculum. *South African Journal of Higher Education, 22*(1), 175-190.

Oviawe, J. O. (2016). How to rediscover the Ubuntu paradigm in education. *International Review of Education*, *62*, 1-10.

Oyoo, S. O. (2017). Learner outcomes in science in South Africa: role of the nature of learner difficulties with the language for learning and teaching science. *Research in Science Education*, *47*(4), 783-804.

Ozmen, H. (2004). Some student misconceptions in Chemistry: A literature review of chemical bonding. *Journal of Science Education and Technology, 13*(2), 147-159.

Palm, C. A., Gachengo, C.N., Delve, R. J., Cadisch, G., & Giller, K. E. (2001). Organic inputs for soil fertility management in tropical agroecosystems: Application of an organic resource database. *Agric Ecosyst Environ, 83*(1), 27-42.

Probyn, M. (2009). Smuggling the vernacular into the classroom: Conflicts and tensions in classroom codeswitching in township/rural school in South Africa: International *Journal of Bilingual Education and Bilingualism, 12*(2), 123-136. https://doi.org/10.1080/13670050802153137

Proietti, P., Calisti, R., Gigliotti, G., Nasini, L., Regni, L., & Marchini, A. (2016). Composting optimization: integrating cost analysis with the physical-chemical properties of materials to be composted. *J Clean Prod, 137,* 1086-1099,

Quigley, C. (2009). Globalisation and Science Education: The implications for indigenous knowledge systems. *International Education Studies, 2*(1), 76-88

Rahman, S. (2021). Perceptions of smallerholder farmers towards organic farming in South Africa. *Agriculture, 11*(11). https://doi.org/10.3390/agriculture11111157

Ramesh, P., Sigh, M., & Rao, A. S. (2005). Organic farming: Its relevance to the Indian context. *Current Science, 88*(4).

Reganold, J. P., & Wachter, J. M. **(**2016**).** Organic agriculture in the twenty-first century. *Nature Plants, 2*, 15221. https://doi.org/10.1038/nplants.2015.221

Rosales, J. R., & Sulaiman, F. (2016). Students' personal interest towards project-based learning. *People: International Journal of Social Sciences*, *2*(1). https://doi.org/10.20319/pijss.2016.s21.214227

Roschelle, J. (1995). *Learning in interactive environments prior knowledge and new experiences*. http://www.exploratorium.edu/ifi/resources/museumeducation/priorknowledge.html

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.

Sandoval-Rivera, J. C. A., & Mendoza- Zuany, R. G. (2021). The milpa goes to school: Teacher training in climate change adaptation from situated learning perspective. *Mary Ann Liebert, 14*(1). https://doi.org/10.1089/scc.2020.0062

Santhoshkumar, M., Reddy, G. C., & Sangwan, P. S. (2017). A review on organic farming – sustainable agriculture development. *Int J. Pure App. Biosci, 5*(4), 1277-1282.

Scarpat, D., & Simeone, M. (2013). Euro-Mediterranean integration and competitiveness of the agro-food sector: an empirical analysis in Campania region. *New Medit, 12*(3), 56-64.

Schröttner, B. T. (2010). The effects of globalisation phenomena on educational concept. *USChina Education Review, 8*(7), 50-61.

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. K. (2018). South African teachers' strategies for integrating indigenous and western knowledges in their classes: Practical lessons in decolonisation. *Educational Research for Social Change*, *7*(1), 91-110.

Seehawer, M. K. (2018b). Decolonizing research in a sub-Saharan African context: Exploring Ubuntu as a foundation for research methodology, ethics and agenda. *International Journal of Social Research Methodology, 21*(4), 453-466.

Seehawer, M. K. (2021). *Exploring how South African science teachers can integrate students' indigenous knowledge in their regular teaching: Approaching bottom-up decolonization through participatory action research* [Unpublished doctoral thesis]. Oslo Metropolitan University.

Seehawer, M. K., & Breidlid, A. (2021). Dialogue between epistemologies as quality education. Integrating knowledges in sub-Saharan African classrooms to foster sustainability learning and contextually relevant education. *Social Sciences & Humanities Open, 4*(1), 100200. https://doi.org/10.1016/j.ssaho.2021.100200

Semali, L. M., & Kincheloe, J. L. (Eds.) (1999). *What is indigenous knowledge? Voices from the academy*. Falmer Press.

Sen, S. (2007). Globalisation and development. *Globalisation and Economic Crisis*, *41*.

Settee, P. (2007). *Indigenous knowledge systems, our time has come*. University of Saskatchewan.

Shabani, K. (2016). Application of Vygotsky's sociocultural approach for teachers' professional development. *Cogent Education, 3*, 2-10.

Shabani, K., Khatib, M., & Ebadi, S. (2010). Vygotsky's zone of proximal development: instructional implications and teacher's professional development. *English Language Teaching, 3*(4), 237-248.

Shinana, E. (2019). *Mobilising the indigenous practice of making Oshikundu using an inquiry based approach to support Grade 8 Life science teachers in mediating learning enzymes* [Unpublished master's thesis]. Rhodes University.

Shinana, E., Ngcoza, K. M., & Mavhunga, E. (2021). Development of teachers' PCK for scientific inquiry-based teaching approach in Namibia's rural schools. *African Journal of Research in Mathematics, Science and Technology Education*, 1-12.

Shing, C., Saat, R., & Loke, S. (2015). The knowledge of teaching – pedagogical content knowledge (PCK). *The Malaysian Online Journal of Educational Science, 3*(3), 40- 55.

Shizha, E. (2013). Reclaiming our indigenous voices: The problem with postcolonial SubSaharan African school curriculum. *Journal of Indigenous Social Development, 2*(1). http://scholarspace.manoa.hawaii.edu/ handle/10125/29811

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

Shulman, L. S. (1986). *Those who understand: Knowledge growth in teaching*. Stanford University.

Shulman, L. S. (1987). Knowledge and teaching: Foundation of the new reform. *Harvard Education Review, 57*, 1-22.

Simpson, L. B. (2014). Land as pedagogy: Nishnaabeg intelligence and rebellious transformation. *Decolonization: Indigeneity*, *3*(3), 1-25.

Singh, R., & R., Singh, G. S. (2017). Traditional Agriculture: A climate-smart approach for sustainable food production. *Energ, Ecol. Environ., 2*(5), 296-316. https://doi.org/10.1007/s40974-017-0074-7

Siseho, R. S. (2019). *Exploring opportunities for integrating indigenous knowledge and practices into animal husbandry in Grade 10 Agricultural Science lessons* [Unpublished master's thesis]. Rhodes University.

Sleeter, C. (2001). Preparing teachers for culturally diverse schools: Research and the overwhelming presence of whiteness. *Journal of Teacher Education, 52*, 94-106. https://doi.org/10.1177/0022487101052002002

Smith, L. T. (1999). *Decolonising methodologies: Research and indigenous people*. Zed Books.

Snively, G., & Corsiglia, J. (2001). Discovering indigenous science: Implications for science education. *Science Education, 85,* 6-34. Space. *International Journal of Science Education, 32*(1), 125-141.

Srivastava, P., Singh, R., Tripathi, S., & Raghubanshi, A. S. (2016). An urgent need for sustainable thinking in agriculture: an Indian scenario. *Ecol Ind, 67,* 611-622.

Stein, M., Larrabee, T. G., & Barman, C. R. (2008). A study of common beliefs and misconceptions in physical science. *Journal of Elementary Science Education, 20*(2), 1-11. https://doi.org/10.1007/bf03173666

Stolze, M., Piorr, A., Haring, A. M. & Dabbert, S. (2000). Environmental impacts of organic farming in Europe. *Organic Farming in Europe: Economics and Policy, 6.*

Stott, D. (2016). Making sense of the ZPD: An organizing framework for Mathematics education research. *African Journal of Research in Mathematics, Science and Technology Education, 20*, 25-34. https://doi.org/10.1080/10288457.2016.1148950

Svotwa, E., Baipai, R., & Jiyane, J. (2009). Organic farming in the small holder farming sector of Zimbabwe. *Journal of Organic Systems, 4* (1).

Suryavanshi, S. R. (2020). *Principles of organic farming*. Department of Agronomy.

Tam, A. C. F. (2015). The role of a professional learning community in teacher change: A perspective from beliefs and practices. *Teachers and Teaching*, *21*(1), 22-43. https://doi.org/10.1080/13540602.2014.

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). https://doi.org/10.1080/10288457.2016.1147800

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.

Thomas, G. (2013). *How to do your research project: A guide to students in education and applied Social Sciences*. Sage.

Tobin, K., Rennie, B., & Frazer, L. (1990). The learning environment as a focus in a study of higher-level cognitive learning. *International Journal of Science Education,* 531-548. https://doi.org/10.1080/0950069900120506

Tonbuloglu, B., Aslan, D., & Aydin, H. (2016). Teachers' awareness of multicultural education and diversity in school settings. *Eurasian Journal of Educational Research, 16*(64), 1-28.

Trewavas, A. (2001). Urban myths of organic farming. *Nature, 410*, 409-410.

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development.* https://sdgs.un.org/2030agenda

United Nations. (2008). *Organic agriculture and food security in Africa*. New York and Geneva.

Usama, M., & Siddiqui, M. J. A. (2016). Organic farming – an approach to sustainable development. *Organic Farming, 3*(2).

Vincentnathan, L. (2012). Food rights, food frugality, and climate change. *Food and Foodways, 20*(1), 76-92.

Virkkunen, J., & Newnham, D. S. (2013). *Preparing a change laboratory intervention*. Sense Publishers.

Vos, R. (2014). *The use of context in science education*. Utrecht University.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological process.* Harvard University Press.

Wakui, Y. (2009). *Organic farming technology in Japan.* www.provinos.nl/images/compost_and_Bokashi_CN.pdf

Walker, P. (2004). Decolonising conflict resolution. *American Indian Quarterly, 28*(3&4), 527-549.

Webb, P. (2013). Xhosa indigenous knowledge: Stakeholder awarenesss, value and choice. *International Journal of Science and Mathematics Education*, *11*(1), 89-110.

Weiland, I. (2015). An exploration of Hispanic mother's culturally sustaining experiences at an informal service centre. *Journal of Research in Science Teaching*, *52*(1), 84-106.

Wellington, J., & Osborne, J. (2001). *Language and literacy in science education*. McGraw-Hill Education.

Wenger, E. (1998). Communities of practice: Learning as a social system. *Systems Thinker*, *9*(5), 2-3.

Willer, H., & Kilcher, L. (2009). The world of organic agriculture - Statistics and emerging trends 2009. *Ifoam*, 12.

Woodley, E. (2009). Practical work in school science: Why is it important? *School Science Review, 91*(335), 49-51.

Wyatt, T. R., Chapman de Sousa, E. B., & Mendenhall, S. C. (2017). Professional development as a process of cultural brokering: Positioning coaches as cultural brokers. *Journal of Educational Research and Practice*, *7*(1), 8.

Yadav, H., Fatima, R., Sharma, A., & Mathur, S. (2017). Enhancement of applicability of rock phosphate in alkaline soils by organic compost. *Appl Soil Ecol., 113,* 80-85.

APPENDICES

Appendix A: Ethical clearance certificate

RHODES UNIVERSITY
Where leaders learn

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

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

15 March 2022

Prof Kenneth Ngcoza

Education Department

K.Ngcoza@ru.ac.za

Dear Prof Kenneth Ngcoza

Your application Using the indigenous technology of organic crop farming to mediate learning in Grade 12 Agricultural Science classes in peri-urban schools in the Oshana region in Namibia. , 2022-5334-6626has been reviewed by the Education Faculty Research Ethics Committee [EF-REC].

Ethics approval has been granted pending the required Permission Letters being obtained from the organisation(s) listed in your application:

Director of Education

School principals

Your application can be downloaded as a PDF version and forwarded with your permission letter request. Please refer to the Applicant User Guide for how to do so.

Please forward the required permission letter/s, once received, to the EF-REC Chair (E.Rosenberg@ru.ac.za) and to the Education Research Ethics Coordinators (g.chakona@ru.ac.za; d.dewys@ru.ac.za) in order for your approval to be finalised.

The Education Faculty Research Ethics Committee had the following comments on your application:

Sincerely

E Rosenberg

Professor Eureta Rosenberg

Chair: Education Faculty Research Ethics Committee

Appendix B: Regional Director consent letter

REPUBLIC OF NAMIBIA

OSHANA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS AND CULTURE
ASPIRING TO EXCELLENCE IN EDUCATION FOR ALL

Tel: 065 - 229800/25 *Private Bag 5516*
Fax: 065 - 229834
Oshakati

Enquiries: Hileni M Amukana
Ref: 13/2/9/1

Ms. Lydia N. Sheehama
Cell: 0812441081

SUBJECT: PERMISSION TO CONDUCT A RESEARCH IN OSHANA REGION

Your letter dated 18 March 2022 on the above caption bears reference.

Kindly be informed that permission is hereby granted to conduct research study at Ntuli SS and Oshakati SS in Oshakati Circuit, Oshana Region.

This permission is subject to the following strict conditions: (i) There should be minimal or no interruption on normal working schedule (ii) Ethical issues of confidentiality and anonymity should be respected and retained throughout this activity i.e. Voluntary participation, and consent from participants

Both Parties should understand that this permission could be revoked without explanation at any time.

Furthermore, we humbly request you to share your research findings with the Directorate of Education, Arts and Culture, Oshana Region. You may contact Ms. Hilma Nunyango-George, the Deputy Director; Programs and Quality Assurance (PQA) for the provision of summary of your research findings.

We wish you the best in conducting your study.

Yours sincerely,

18/03/2022

HILENI M. AMUKANA
REGIONAL DIRECTOR

18 MAR 2022

Cc Inspector of Education: Oshakati Circuit

Appendix C1: Principal's consent letters

oshakati senior secondary school

PBag X 5512 - Oshakati . Tel: +264 65 - 220 447 . email: oshakatisss@gmail.com

30 March 2022

Enq: Mr. OJ Shilongo
Cell: +264 812496261

To whom it may concern

Re: Permission to conduct an educational research at Oshakati SSS

I, the school principal of the above mentioned school hereby confirming that Mrs. Sheehama Lydia N. is granted a permission to conduct her Educational research at our school as per her request.

I thank you very for your understanding and support in this regard.

Faithfully yours

Mr. OJ Shilongo (Principal)

OSHAKATI SECONDARY SCHOOL
OFFICE OF THE PRINCIPAL
2022 -03- 30
OSHANA REGIONAL COUNCIL
REPUBLIC OF NAMIBIA

Appendix C2: Principal's consent letters

REPUBLIC OF NAMIBIA
MINISTRY OF EDUCATION ARTS & CULTURE
OSHANA REGION
OSHAKATI CIRCUIT

NTULI JUNIOR SECONDARY SCHOOL

Enq: Mr. Kenneth Mbukusa
Tel: 065 – 225202/ 0812492742

P.O. Box 3453
Oshakati
06 April 2022

Mrs. Lydia N. Sheehama
Cell: 081 2441981

SUBJECT: PERMISSION TO CONDUCT A RESEARCH AT NTULI SECONDARY SCHOOL

1. Your letter dated **18 March 2022** on the above subject beans reference.
2. It is with pleasure I write to inform you that permission is hereby granted.
3. We humbly request you to share your research finding with the school.
4. We wish you the best in conducting your study.

Yours sincerely

MR. KENNETH MBUKUSA
PRINCIPAL

MINISTRY OF EDUCATION
THE PRINCIPAL
NTULI JUNIOR SECONDARY SCHOOL
2022 -04- 06
P.O. BOX 3453, OSHAKATI
TEL: 065-225202
OSHANA REGION
REPUBLIC OF NAMIBIA

Appendix D: Teachers' Consent Letter

RHODES UNIVERSITY

EDUCATION DEPARTMENT
TEL: +27 (0) 46 603 8383
FAX: +27 (0) 46 622 8028

10 March 2022

Dear esteemed colleague

Subject: Invitation to participate in my research project

My name is Lydia N. Sheehama (Ndimulunde), a Science teacher at Impumbu S.S. I am currently enrolled part time at Rhodes University, South Africa for a Master of Education (MEd) degree in Science education. I write to humbly invite you to take part in my research project for a period of about three to four weeks.

The research study will focus on using the indigenous technology of organic crop farming to mediate learning in grade 12 agricultural science classes. It is worth noting that in this study you will be a *co- researcher* and your roles among others will be: to share with me your attitudes and pedagogical insights on the use of indigenous knowledge in your agricultural science class, to take part in all data gathering methods, to visit two expert community members who will demonstrate to us how crops are grown organically. During the presentations by the expert community members you will be expected to observe attentively, participate, and take notes in your journal that I will provide. The expert community members' presentations will take about 1h30 -2hrs each. Kindly note that the presentations will be videotaped/ audio taped with your permission. Lastly, you will reflect and co-develop the exemplar lessons that integrate indigenous knowledge presented by the expert community members. This research study will not interfere with your normal teaching time as all activities will be done after school at a time convenient with your schedule.

The key benefit of this study is that it is responding to the call in the national curriculum of integrating local knowledge in science teaching. Further, the presentation by the expert community members might change our teaching pedagogies and ultimately enhance our professional development.

Kindly note that your participation in this research is completely voluntary, you can withdraw at any time you wish if need be. I will also ensure that your identity and views are treated with the highest degree of confidentiality and anonymity. That means, your identity in video data will be anonymized, and pseudonyms will be used instead of your real name and school name. It is recognized however, that anonymity might be a challenge since we will be working together in this research study. Nevertheless, all data that will be gathered will not be used for other purposes apart from this study

If you require further information regarding this study, don't hesitate to contact me at +264 81 244 1981 or lydiandapandula@gmail.com or my supervisor Prof. Kenneth Ngcoza at +27 78 885 2143 or K.Ngcoza@ru.ac.za.

If you require any questions or raise any concerns regarding the way this research is conducted, you can directly conduct Rhodes University Education Faculty Ethics Committee chairperson, Prof Eureta Rosenberg at Tel: +27 (0) 46 603 8393 or Fax: +27 (0) 46 603 8093 or e.rosenberg@ru.ac.za. Alternatively, you can conduct Rhodes University, Research Office, Ethics Coordinator: ethics-committee@ru.ac.za, Tel: +27 (0) 46 603 7335 or Fax: +27 (0) 82 739 4378

I trust my request will receive your favorable consideration. Should you be interested, please complete and sign the consent form below. Signing the consent letter indicates that you have agreed to participate in this study, audio- recording interview and videotaped workshops that we will attend.

Yours Sincerely

_____

L.N. Sheehama

Declaration by participant (Agricultural science teacher)

I agree to participate in the research and I fully understand that my participation is voluntary and that I am at liberty to withdraw from the research study at any time I may wish to do so without any fear or intimidation.

Name……Signature……..Date……contact no……

Appendix E: Critical friend consent letter

RHODES UNIVERSITY
Where Leaders Learn

EDUCATION DEPARTMENT
TEL: +27 (0) 46 603 8353
FAX: +27 (0) 46 622 3028

10 March 2022

Dear esteemed colleague

Subject: Invitation to participate in my research study as a critical friend.

My name is Lydia N. Sheehama (Ndimulunde), a Science teacher at Iipumbu S.S. I am currently enrolled part time at Rhodes University, South Africa for a Master of Education (MEd) degree in Science education. I write to humbly invite you to take part in my research study as a critical friend for a period of about three to four weeks.

The research study will focus on using the indigenous technology of organic crop farming to mediate learning in grade 12 Agricultural science classes. I am humbly requesting you to be my co – researcher and assistant. Your roles among others will be; to record all activities with a video/audio recorder, to take pictures of all activities and to help me in collecting, transcribing and analyzing data from various data collection methods.

Kindly be informed that your participation in this study is voluntary and you're free to withdraw at any time if need be. Your identity, views and opinions will be treated with anonymity and confidentiality. Kindly note that all data collected will be used for academic purposes only.

If you require further information regarding this study, don't hesitate to contact me at +264 81 244 1981 or lydiandapandula@gmail.com or my supervisor Prof. Kenneth Ngcoza at +27 78 885 2143 or K.Ngcoza@ru.ac.za.

If you require any questions or raise any concerns regarding the way this research is conducted, you can directly conduct Rhodes University Education Faculty Ethics Committee chairperson. Prof Eureta Rosenberg at Tel: +27 (0) 46 603 8393 or Fax: +27 (0) 46 603 8093 or e.rosenberg@ru.ac.za. Alternatively, you can conduct Rhodes University, Research Office, Ethics Coordinator: ethics-committee@ru.ac.za. Tel: +27 (0) 46 603 7335 or Fax: +27 (0) 82 739 4378

I thank you in anticipation.

Yours Sincerely

L.N. Sheehama

Appendix F: Letter to the indigenous knowledge custodians (English version)

RHODES UNIVERSITY

EDUCATION DEPARTMENT
TEL: +27 (0) 46 603 8383
FAX: +27 (0) 46 622 8028

Letter to the Community Member 1 [English version]

10 March 2022

Dear Sir / Madam

Subject: Participation in research on the integration of local or indigenous knowledge in Agricultural Science

My name is Lydia N. Sheehama (Ndinulunde), a senior Science teacher at Ipumbu S.S. I am currently enrolled part time at Rhodes University, South Africa for a Master of Education (MEd) degree in Science education. I write to humbly request you to participate in my study as an expert community member for a period of about three to four weeks. The study will involve an intervention comprising of a demonstration or presentation of growing crops organically by the community members. Your role will be to present how crops are grown traditionally – particularly; ways of fertilizing the soil and controlling crop pests. Each presentation will take about1h30 – 2hrs only. Being someone knowledgeable about growing crops traditionally, I trust that you can run well a presentation to the teachers.

Your participation in this research will be highly appreciated and completely voluntary which means 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 will not be released to anyone else without your consent. I also ask for your permission to take videos of the presentation so that I can be able to analyze the presented information after the presentations. It is worth noting that your identity, views, or contributions will be treated with a high degree of confidentiality and anonymity.

If you require further information regarding this study, don't hesitate to contact me at +264 81 244 1981 or lydiandapandula@email.com or my supervisor Prof. Kenneth Ngcoza at +27 78 885 2143 or K.Ngcoza@ru.ac.za.

If you require any questions or raise any concerns regarding the way this research is conducted, you can directly conduct Rhodes University Education Faculty Ethics Committee chairperson, Prof Eureta Rosenberg at Tel: +27 (0) 46 603 8393 or Fax: +27 (0) 46 603 8093 or e.rosenberg@ru.ac.za. Alternatively, you can conduct Rhodes University, Research Office, Ethics Coordinator, ethics-committee@ru.ac.za, Tel: +27 (0) 46 603 7335 or Fax: +27 (0) 82 739 4378

I look forward to your favorable response and I thank you well in advance.

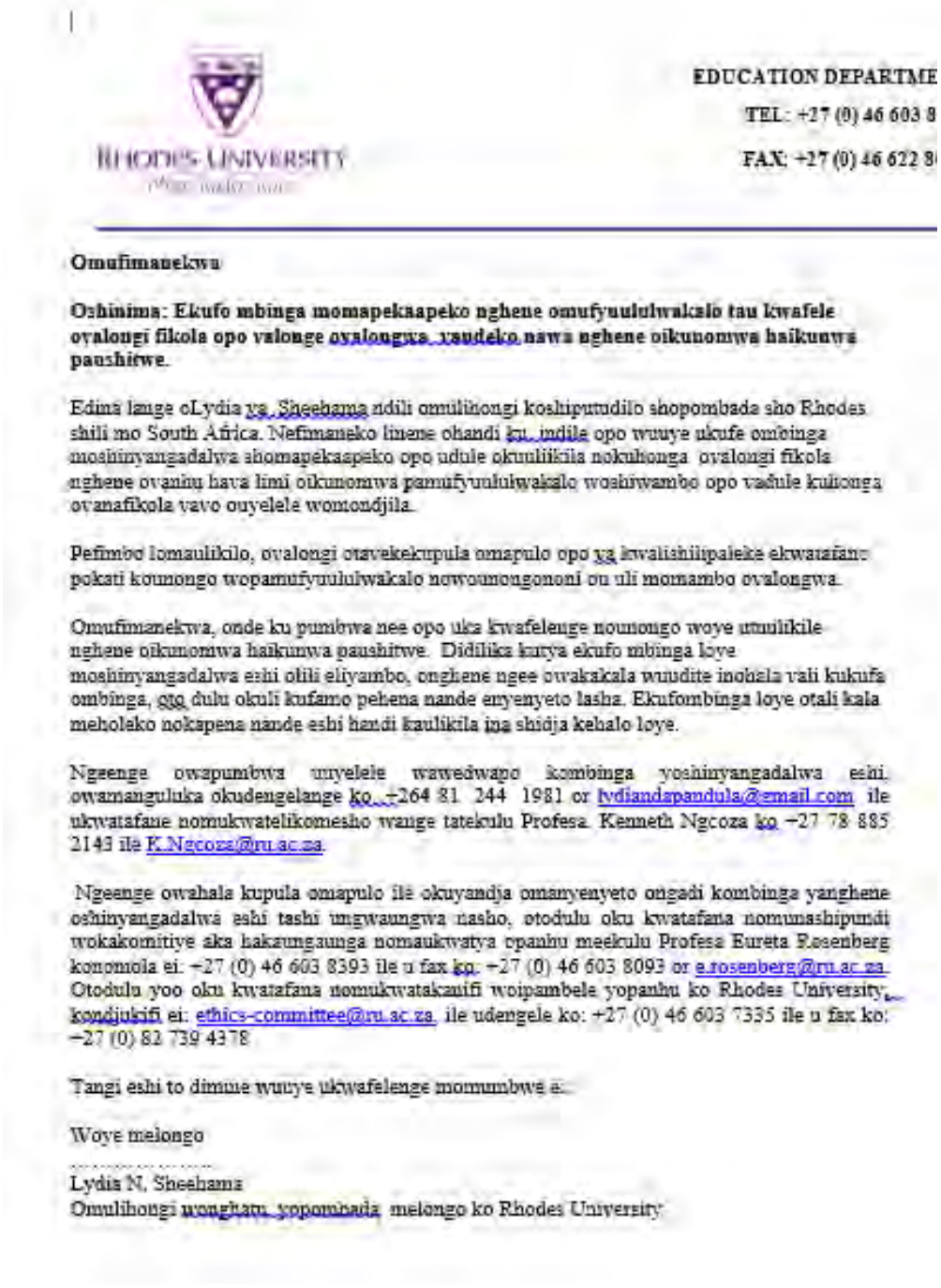
Yours Sincerely

_____
L.N. Sheehama

Declaration by participant (expert community member)
I agree to voluntarily participate in the research, and I fully understand that I am at liberty to withdraw at any time without any fear or intimidation if need be.

Name……Signature……Date……Contact no……

Appendix G: Letter to the indigenous knowledge custodians (Oshiwambo version)



RHODES UNIVERSITY

EDUCATION DEPARTME
TEL: +27 (0) 46 603 8
FAX: +27 (0) 46 622 8

Omufimanekwa

Oshinima: Ekufo mbinga momapekaapeko nghene omufyuululwakalo tau kwafele ovalongi fikola opo valonge ovalongwa vaudeko nawa nghene oikunomwa haikunwa paushitwe.

Edina langa oLydia ya Sheehama ndili omulihongi koshiputudilo shopombada sho Rhodes shili mo South Africa. Nefimaneko limene ohandi ku indila opo wuuye ukufe ombinga moshinyangadalwa shomapekaapeko opo udule okuuliikila nokuhonga ovalongi fikola nghene ovanhu hava limi oikunomwa pamufyuululwakalo woshiwambo opo vadule kuhonga ovanafikola vavo ouyelele womondjila.

Pefimbo lomaulikilo, ovalongi otavekekupula omapulo opo ya kwalishiilipaleke ekwatafano pokati koumongo wopamufyuululwakalo nowoumongononi ou uli momambo ovalongwa.

Omufimanekwa, onde ku pumbwa nee opo uka kwafelenge noumongo woye uuulikile nghene oikunomwa haikunwa paushitwe. Didilika kutya ekufo mbinga loye moshinyangadalwa eshi olili eliyambo, onghene ngee owakakala wuudite inohala vali kukufa ombinga, oto dulu okuli kufamo pehena nande enyenyeto lasha. Ekufombinga loye otali kala meholeko nokapena nande eshi handi kaulikila ina shidja kehalo loye.

Ngeenge owapumbwa uuyelele wawedwapo kombinga yoshinyangadalwa eshi, owamanguluka okudengelange ko +264 81 244 1981 or lydiandapandula@email.com ile ukwatafana nomukwatelikomesho wange tatekulu Profesa Kenneth Ngcoza ko +27 78 885 2143 ile K.Ngcoza@ru.ac.za.

Ngeenge owahala kupula omapulo ile okuyandja omanyenyeto ongadi kombinga yanghene oshinyangadalwa eshi tashi umgwaungwa nasho, otodulu oku kwatafana nomunashipundi wokakomitiye aka hakaungaunga nomaukwatya opanhu meekulu Profesa Eureta Rosenberg konomola ei: +27 (0) 46 603 8393 ile u fax ko: +27 (0) 46 603 8093 or e.rosenberg@ru.ac.za. Otodulu yoo oku kwatafana nomukwatakanifi woipambele yopanhu ko Rhodes University, kondjukifi ei: ethics-committee@ru.ac.za ile udengele ko: +27 (0) 46 603 7335 ile u fax ko: +27 (0) 82 739 4378

Tangi eshi to dimine wuuye ukwafelenge nomumbwe a.

Woye melongo

.....
Lydia N. Sheehama
Omulihongi wonghatu yopomnada melongo ko Rhodes University

Appendix H: Participants consent form

RHODES UNIVERSITY
Where leaders learn

RESEARCH PARTICIPANT INFORMED CONSENT LETTER
(PARTICIPANT)

PROJECT TITLE: **Using the indigenous technology of organic crop farming to mediate learning in urban schools in grade 12 Agricultural science classes.**

Lydia N. Sheehama (1989466), currently a Master's student at Rhodes University, has requested my permission to participate in the above-mentioned research project.

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

I am therefore aware that:

1. The purpose of this study is to explore the indigenous technology of organic crop farming to mediate learning in urban schools in grade 12 agricultural science classes in Oshana region in Namibia. The main goal for this study is to make science accessible and relevant to teachers who are regarded as learners in this study.

2. The intervention for this study will be composed of about two-hour long presentation and practical demonstrations by the expert community members. During the workshops, presentations and practical demonstrations, data will be gathered through; video/audio recording, participant observation, reflective journaling, document analysis and group discussions. The workshops will be conducted at a place and time that is convenient to me and other participants.

3. During the interview session, participants will be interviewed individually. In all gatherings all the COVID-19 regulations will strictly be adhered to. Should the COVID-19 restrictions be in force, alternative online sites such as Google Meeting, Zoom or WhatsApp will be used with my permission. The interview will take approximately 30-45 minutes and will be audio recorded with my permission.

4. By participating in this research project, I will contribute to knowledge and understanding in the mediation of learning in agricultural science classes.

5. My participation is entirely voluntary and should I at any stage wish to withdraw from further participation, I may do so without any prejudice.

6. I understand that participating in this study is voluntary and that I will not be compensated for participating.

7. There may be risks associated with my participation in the project. I am therefore aware that of the following steps:

   a) All information shared in the group is strictly confidential and will not be used for purpose other than of the above mentioned research project;
   b) All the data collected will be kept in a locked cupboard and electronic data will be kept in a computer only accessible through a secured password.
   c) The researcher intends to publish the research findings in the form of a thesis towards a Master's degree in Science Education, and later present it in educational conferences or journal articles. However, confidentiality will be maintained.

8. Any further questions that I might have concerning the research or my participation will be answered by the Rhodes Master's student (lydiandapandula@gmail.com) or her supervisor Professor Kenneth Mlungisi Ngcoza (k.ngcoza@ru.ac.za).

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

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

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

I have not been coerced or pressurised in any way. I therefore voluntarily agree to participate in the above mentioned research project.

....

Participant's signature Witness

Date ..... Date .....

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

Appendix I: Semi-Strucutred Interview Schedule

Proposed Research Title: Using the indigenous technology of organic crop farming to mediate learning in Grade 12 Agricultural Science classes

Preamble: Thank you Sir/Madam. The purpose of this interview is for us to discuss the integration of indigenous knowledge in Agricultural Science teaching particularly in the crop production section.

Please feel free to share with me your experiences by answering the following questions. If needs be, I may have some follow-up questions along the line.

QUESTIONS	**PURPOSE**
1. Could you please tell me how long you have been teaching Agricultural Science in Grade 12?	To determine the teachers' years of experience in teaching Agricultural Science in Grade 12.
2. Could you please share with me your experiences (the ups and/ or downs) when you teach the crop production section?	To determine the challenges teachers meet when teaching the subject. To determine teachers' fulfilling experiences in teaching Agricultural Science particularly in the crop production section.
3. What prior knowledge do you expect your Grade 12 learners to have about crop production?	To determine the prior knowledge that teachers expect their learners to have for a better conceptual understanding.
4. How do you make use of learners' prior knowledge when you teach the crop production section?	To find out if teachers integrate learners' prior knowledge into their lessons when mediating learning of the crop production.

5. What do you understand by the term indigenous knowledge (IK)?	Establish teachers' understanding about indigenous knowledge (IK).
6. Could you explain how do you integrate (or not) IK in your class when teaching crop production section?	To determine ways teachers' integrate IK or not in their Agricultural Science classes.

Adapted from Cetin-Dindar and Geban (2011, p. 89)

Appendix J: Inductive-Deductive analysis/thematic approach from collated teachers' responses for semi-structured interviews

Research Question:

What are Grade 12 Agricultural Science teachers' perspectives, experiences and pedagogical insights on the integration of IK in their classrooms?

Meaning of codes

Teachers' codes: T1-T4 (T= Teacher; R= Researcher)

Colour codes:

Teal: Benefits

Red: Challenges

Bright Green: Teaching methods/styles

Purple: Integration of IK

Blue: Prior knowledge

Yellow: Culture

Dark Yellow: Language

Pink: The concept of IK

Turquoise: Practical Activities

1. Could you please tell me for how long you have been teaching Agricultural Science in Grade 12?	**T1**: I have been teaching Agricultural Science in Grade 12 for about 19 years now. **T2**: For 15 years now. **T3**: I have taught it for seven good years now. **T4**: Eight years now.	**Emerging sub-themes**
2. What are your views about teaching Agricultural Science in your Grade 12 class?	**T1:** Uumh..my view is that Agriculture is an interesting subject that is close to our traditional ways of living, however, many learners do not really pass it with good symbols. **R**: What could possibly be the reasons to poor grades? [Follow-up question]	**culture in science (and this is also IK related and you could have probed this further to find out how this knowledge is passed on from generation to generation – see Kibirige and Van Rooyen, 2006)**

	T1: Alright.. I can say may be it is due to textbooks used which do not really include local agricultural practices or examples. This makes it difficult for learners to understand new agricultural knowledge and this might affect their performance as they do not understand. I also think that English which is used as a medium of instruction and also in textbooks might also be a challenge to learners because the majority of learners struggle to speak and understand English- which is a second language to them and foreign language too. I also feel that Agricultural Science syllabus is more theory-based than practical which may limit the purpose of passing practical skills to the learners which they supposed to put into practice after they complete their Grade 12 to earn a living or improve lives in their communities. I also find it to be more Biology than Agriculture itself thus I don't think if this new curriculum is really aiming at	**- Textbooks lack IK** **What makes learning difficulty** **English language in learning science** **Teachers' views on the subject in relation to practical activities [Herein lies the**

	teaching learners about how to ensure food security in their communities and in the society at large.	**importance of using easily accessible resources – see Asheela et al., 2021; Shinana et al., 2021]**
	T2: I would say that my general view about this subject in Grade 12 is that there is a gap in terms of content knowledge as there are completely new topics that were not taught in previous grades for example, organic crop farming amongst others is only found in Grade 12 as a topic but do not appear in lower grades. My other view is that Agriculture taught in school does not really refer to Agriculture practised home and I don't know why it has to be like that, as agriculture is practised in this region and other more regions especially growing of mahangu, beans, sorghum, just to mention a few.	**Gaps in the Subject Matter Contents (SMC)** **Lack of home knowledge in learning science** **Learners' cultural heritage /prior everyday knowledge (see Kuhlane, 2011).**

	T3: Mhh..I have a positive view about this subject as it is interesting to teach, although some learners struggle to comprehend the content. My view is that Agriculture is a practical subject that is why is categorised as a vocational subject in the National Curriculum. However, I can say that it is taught more theoretically than practical. **R***:* Can you please highlight or explain why it is perhaps taught more theoretically than practically? [Follow-up question] **T3**: Aaa.. I really do not know, but I think there are more reasons to that. One, practicals waste or consume a lot of time especially that our classes are overcrowded to +_ 45 learners per class. Secondly, schools lack materials or equipments needed to carry out the practicals. Thus, practicals are mostly only done for the sake of completing final practical examination component not really for learning purposes. However, I	**Teachers' views on practical activities** **Challenges of conducting practical activities**

	have observed overtime that learners do enjoy practicals and tend to do well in topics were practicals were carried out.	**Benefits of conducting hands-on practical activities**
	T4: Uumh.. for me Agricultural Science has to do more with practicals as a subject, however, I see that the opposite is happening. **R**: What do you mean by that Sir? Could you please expand a little bit on that Sir? [Follow-up question] **T4**: Uumh.. I feel like the Agricultural Science syllabus is concentrating more on the theoretical knowledge that learners need to know compared to the practical skills that the learners need to gain from the practical objective. Uumh.. however, even for the practical activities stated in the	**Teachers' views on practical activities**

	syllabus to be carried out, they are hardly ever carried out. This might be due to the big problem of lack of materials in schools such as fertilisers, pesticides, garden tools, laboratory materials/ apparatus, irrigation systems and shade nets and so on, due to the limited school budget.	**Challenges of conducting practical activities**
3. Could you please tell me your experience(s) of teaching the topic organic crop farming in your Grade 12 class?	**T1:** Uumh..my experience is that organic crop farming is a new topic in Grade 12 I can say it is not that easy to both teachers and learners as it was not taught in previous grades and learners know nothing or little about it. Looking at the information written in prescribed textbooks uumh.. this topic is not really well explained in details to open up learners minds. Uumh.. to add on that I don't think I have seen local examples in those textbooks to help learners understand this new topic, but	***Lack of learners' prior knowledge from previous grades*** ***Textbooks and IK*** ***Benefits of local examples***

	agriculture is practised in this area but is not referred to at school.	***Learners' cultural capital/prior knowledge***
	T2: Uumh.. thank you very much for the question. Uumh.. teaching this topic of organic crop farming in Grade 12 aaa.. it is quite exciting to see it as part of the syllabus as this is also what we do in our communities. To my surprise, learners find it difficult to understand it. **R**: Why do you think learners find it difficult if you have indicated that it is also what you practice in your communities? [Follow-up question – well done!] **T2**: Aa.. I think learners find it difficult to understand because their textbooks do not really link it to the local ways of growing crops. So, aa.. is like there are two agricultures now, the one they	**Understand of the importance of the use of local knowledge** ***What is difficult to teach?*** ***Lack of local knowledge in textbooks***

	practice home and the one they learn at school.	
	T3: Uumhh…my experience is that learners have a bit of understanding of what organic crop farming is all about, contextualising from the word organic where they say it means natural. Although some learners say organic means artificial such as NPK fertilisers.	**Learners' misconceptions**
	T4: Uumh.. This organic crop farming is a new topic in Grade 12, uumh.. so basically it is not taught in the previous grades (10-11) so this topic is a bit challenging for some learners to understand. Because it is new to them and most of them do not really perform well in this topic.	**Lack of prior knowledge from the previous grade(s)** **Learners' learning difficulty**

		Misconceptions
	Uumh.. I have also noticed that some learners do not even know the basic principle of compost as they just say it is manure while some may say that it is inorganic fertiliser.	
		Difficult to understand
	I have also noticed that some learners confidently say that organic crop farming is a modern way of farming.	
	Apart from that uumh.. I have also observed that some learners struggle to understand organic methods of controlling pests such as cultural pest control methods. Uumh lastly most of the learners do say that the best way to control pests is by using pesticides.	
		English language challenge
	R: What is possibly causing learners to struggle to understand this topic? [Follow-up question]	

	T4: I think umh.. is may be the comprehension of English that learners may be do not really grasp the concepts uumh.. may be English might be a problem for them to understand these concepts.	
4. What prior knowledge do you expect your Grade 12 learners to have about organic crop farming?	**T1:** Aaaa.. I expect them to know that in their communities people only use natural substances to grow crops for example animal manure. I also expect them to know the type of fertilisers that can be used in organic crop farming since they were taught about two types of fertilisers in lower grades: organic and inorganic fertilisers. I also expect them to know that cultural ways of controlling pests in crops for example using plastics and old clothing hanged on a stick pole, digging tunnels around the field etc.	***Local knowledge as learners prior knowledge*** ***Previous grades content as learners prior knowledge*** ***Culture in science***

	T2: I expect my learners to know that animal manure is an example of organic fertiliser, as they were taught about types of fertilisers in grade 11 aa.. I also expect them to know the different natural ways used to grow crops in their communities. For example, how they fertilise the soil using manure and methods of controlling pests in their fields, using natural means to help them classify understand different methods of controlling pests as they perform poorly in this section.	**Previous grade content as learners' prior knowledge** **Community/home-based knowledge as prior knowledge**
	T3: Uumh… I expect the learners to already know the methods of growing crops they use at home, aa.. because my understanding is that organic crop farming is just the same with traditional crop farming practised in their community all along is just that our	**Home knowledge as learners' prior knowledge**

	traditional farming practices are not documented. So I expect them to know about animal manure and how to apply it. **T4:** Aaa .. since Grade 12 learners have previously learned about types of fertilisers in Grade lower grades, so I do expect them to know which type of fertiliser should be used in organic crop farming.	**Realisation of cultural knowledge in Agriculture** **Previous grade(s) content as learners' prior knowledge**
5. What teaching methods or approaches do you use when teaching the topic organic crop farming?	**T1:** Thank you very much for the question. As I have earlier indicated that for me, agriculture is close to our tradition, I find this topic of organic crop farming to be related to our traditional ways of growing crops. Thus, I normally use this style of teacher-learner and learner-learner classroom discussion, whereby we openly discuss and debate about this topic by asking learners what they	**Tradition/ culture in Agriculture**

	understand by it, what substances are used, the advantages and disadvantages of organic crop farming just to allow the learners to air their views about the topic and for learners to learn from each other, and enable me to clear misconceptions if any.	**Learner –centred Approach** **Collaborative learning**
	But still you will find that some learners do not want to speak or take part in the discussions perhaps because of English language challenge or barrier rather.	**English language barrier in learning science**
	Uumh.. in addition, sometimes I give learners homework where they have to go and ask their parents the cultural things they use to fertilise the soil and control the pests and tell them to bring to school some samples of what they have found out from their parents.	**Eliciting cultural/ indigenous knowledge as learners prior knowledge** **Use of cultural artefacts**

	T2: Aaaaa thank you, sometimes I normally ask them to go and ask their parents just to tell them about the cultural ways they use to grow crops and control pests, and they come and present their findings in groups to the whole class. This enables learners-especially the one from townships to learn what indigenous knowledge is from others. But I think I will not do this anymore because it gives me a lot of work to translate into English and vice-versa and I struggle to do it.	**Role of culture in science** **Teacher's challenge in translating Oshiwambo to English**
	T3: Uumhh.. I don't really have a specific approach for it I just teach it like other subjects where I just ask learners few questions about the topic they have covered the previous day or grade and ask them	***Eliciting of learners' prior knowledge***

	what they understand by organic crop farming.	
	T4: Uumh.. This topic basically I start by introducing the topic what it is and ask learners questions in relation to the topic that they have learned in previous grades or topics to see if they recall some of those things they have learned in lower grades.	***Eliciting of learners' prior knowledge***
6. Are the challenges or limitations when you teach organic crop farming? If yes, could you please explain what they are and how do you manage them.	**T1**: Thank you mam for the question. Uumh.. I cannot say challenges are there, they are there, for example I struggle to make all learners understand what organic crop farming is as some of them keep answering in tests that organic crop farming uses inorganic fertilisers such as compost. This indicates that learners do not know what compost is or do not understand what inorganic fertiliser means.	***What is difficult to teach*** ***Learners' misconceptions***

	While the majority of learners just say compost is manure. **R**: What do you do to help them make the difference between the two? [Follow-up question] **T1**: I once let learners to carry out a practical activity about making a compost heap in the garden in groups of five to six learners. This seemed to have helped learners to make the difference between compost and animal manure as after a month they could see compost physically and not only hearing about it. I also tried to bring inorganic fertiliser (NPK) samples to the class to demonstrate to the learners the difference between organic and inorganic fertilisers. I also try to use a little bit of Oshiwambo in the class to help learners understand the content	***Use of hands-on practical Activities as a teaching strategy*** ***Benefits of practical activities*** ***Class demonstrations***

	better and I also relate to some local examples. **R**: Whenever you use Oshiwambo do learners seem to understand better than when you use English? [Follow-up question] Yes it really helps them to understand better. But in most cases I struggle to find appropriate local examples as there is nothing in the textbooks or syllabus that can guide me as a teacher to translate most of English concepts into Oshiwambo as English is a foreign Language to most of us.	**Use of local language and examples in science teaching** **Benefit of using local language** **Lack of local examples in textbooks** **English Language challenge**
	T2: Aaa..Obviously challenges are there as some learners fail to understand what organic crop farming is all about especially those who were born or live in townships.	**Learners' learning difficulties**

	Some learners struggle to understand and express themselves in English even if they know the answers. So I encourage them to say their answers in their vernacular (Oshiwambo) so I determine what they know. So, me and other few learners (who understand English) try to translate their answers into English for the assessment sake, because examinations are done in English. This is also another challenge as learners are not allowed to give answers in their local languages which they understand well. If they do so they will be marked wrong. But at least I encourage them to speak English no matter it is not proper.	**English language in science** **Assessment and IK**
	T3: Uumhh.. I do not experience any difficulties, but some learners struggle to master what organic crop farming means as some say it is artificial cop farming.	**Learners' learning difficulties and misconceptions**
	T4: Uumh.. One of the challenges is that it is difficult to make learners understand this topic and I	

	hope this research study will help me to teach this topic better, because I teach what is in the syllabus and textbooks but yet some learners are struggling to get the concepts. I also think that learners are not serious with their school work. They take Agricultural Science as an easy subject as they feel they practice it at home but in the end they are failing or passing with poor symbols.	
7. **(a)** What do you understand by the term indigenous knowledge (IK)?	**T1:** Mhh...How can I explain indigenous knowledge? Uumh.. indigenous knowledge is a local knowledge within a community,..uumh.. it is all about traditional knowledge, and ways of doing things culturally, the values and norms within a specific culture, or mhh.. the local community and within our families, knowledge passed from one generation and transferred to the next generation, if I can say in that way.	*Understanding the concept of IK*

	T2: Aaa.. I think indigenous knowledge is a legacy of local knowledge that was developed by our ancestors of a particular culture or areas which is then inherited from fore parents and then passed from one generation to another.	**Understanding the concept of IK**
	T3: Aaaa.. the way I understand IK I understand it as knowledge and experiences from the past that is passed on to the next generations.	
	T4: Uumh.. for me, I think that indigenous knowledge uumh.. refers to the cultural ways of aaa… doing things that we inherited from our parents and also our parents acquired them from their foreparents, which is specific to a certain culture. For example, Ovawambo people have inherited a culture of cultivating mahangu fields (Millet) as well as other crops uumh.. and keeping of livestock. Also, singing of traditional songs and dances, storytelling- done at 'Oshoto' and	

	rituals practised at birth, weddings or death.	
(b) Do you integrate indigenous knowledge in your class when teaching the topic organic crop farming? If yes, could you explain how do you use it?	**T1:** Uumh.. Yes, I try to integrate indigenous knowledge in my class where I can but in a limited way, because I was not trained from the institutions or in any workshop on how to use IK. And the materials we use- textbooks there is really little or no information about IK. On how do I use it uumh.. I do ask learners to explain what they use at home to fertilise their fields and cultural ways they use to control pests in their crops. I have seen that when I mix IK in my teaching especially when I say it in Oshiwambo, it really helps learners to understand better and participate well and also perform well in parts where I have used ik to explain the content.	**Limited integration of IK** *Lack of teacher' training* *Textbooks lack IK* *IK as learners' prior knowledge* *Benefits of local/ home knowledge and language in science teaching*
	T2: Uumh.. thank you! Yes I do integrate it a little bit, for example I normally used to send learners to go and ask their parents at home	**Integration of IK limited**

	about the cultural ways they use to grow crops, and then use their findings to define and explain organic crop farming. But the challenge is that there is no guideline in the syllabus aaa.. as well as in textbooks as to what specifically us teachers we should do as we were not trained about it.	**No guideline in the syllabus and in textbooks** **Lack of IK training**
	T3: Uumh.. not that much because it is not included in the syllabus so I find it difficult to explain to the learners because I also do not know most of the IK as I was never trained how to use it in my lessons. Uumh.. Also if you teach it to the learners, and if learners happen to give those explanations in the exam they are marked wrong so it is challenging and discouraging at the same time. But I think it is very much needed to be included in the syllabus so that we can integrate it in our lessons.	**Nothing in the syllabus** **Teacher's difficulty to explain IK to the learners due to limited IK knowledge** **No teacher training on IK** **IK not included/ accepted in exam** **Benefit of IK**

	I also recommend that IK must be taught at higher institutions where teachers are trained as a subject on its own so that when we go to schools we have that knowledge so that we can pass it on to our kids as I believe that local knowledge systems are our greatest identity and central to agriculture as well.	
	T4: Uumh.. Unfortunately I don't. **R**: Could you please give some reasons why you don't integrate it? [Follow-up question] **T4**: Uumh.. the reason why I don't incorporate it in the lessons is because it is uumh.. Not in the textbooks and syllabus and it also not accepted in assessments. So I don't want to waste time teaching about something that will not be accepted in the exam. Furthermore, I was also not trained on how to use it. Uumh.. I think growing up in town might also	**No integration of IK** **Lack of IK in textbooks, syllabus** **IK not accepted in assessments**

	have contributed to this as I lack most of the cultural or traditional knowledge as I did not really grow up in an environment that could make it possible for me to learn IK. However, I'm willing to learn about it because there is a saying that goes: "A society without culture is heading nowhere".	**Willingness to learn about IK** **Importance of culture**

Appendix K: Emerged Themes from teachers' semi- structured interviews in relation to literature/ theory

Research Question 1: *What are Grade 12 Agricultural Science teachers' perspectives, experiences and pedagogical insights on the integration of IK in their lessons?*		
Themes	**Sub-Themes**	**Literature/ Theory**
1. Teachers' views and experiences on	-Value of local / home knowledge in science(Agriculture)	Asheela et al. (2021); Hashondili (2020); Asheela et

teaching Agricultural Science	-Teachers' views on practical activities -Misconceptions on organic crop farming -Language usage	al (2021); Mavhunga and Rollnick (2013); Mhakure and Otulaja (2017); Millar (2010); Mukwambo et al (2014); Mutanho (2016); Nikodemus (2017); Roschelle (1995); Sedlacek and Sedova (2017), Shinana et al. (2021); Vygotsky (1978)
2. Teachers' understanding of the concept indigenous knowledge (IK)	-Comprehension of the term IK	Kibirige and Van Rooyen (2006); Magwentshu (2020); Mkabela (2015); Nyika (2017); Seehawer (2018)
3. Teachers' perspectives on the integration of indigenous knowledge in Agricultural Science lessons to mediate organic crop farming	-Teaching strategies or styles -IK as prior knowledge -Significance of culture and home language in teaching science -Perceived challenges on the integration of IK in science teaching	Abah et al. (2015); Aikenhead and Jegede (1999); Kibrige and Van Rooyen (2006); Le Grange (2007); Mavhunga and Rollnick (2013); Mavuru and Ramnarain (2017); Mukwambo et al. (2014); Seehawer (2018); Shulman (1986), Tylor (1999); Vygotsky (1978);

Appendix L: Workshop discussions schedule

Workshop: Presentation by the Indigenous Knowledge Custodians (IKCs) on compost making and organic pesticides

Questions:

1. How did you understand IK before the presentations by the Indigenous Knowledge Custodians?
   (i) Describe your experience with the IKCs.
   (ii) What did you learn new about IK after the presentation?
   (iii) What stood out for you or not during the presentation by the IKCs?

2. What is your new understanding on the importance of integrating indigenous knowledge in science lessons after the presentations?

3. What are your current views on the integration of indigenous knowledge in Agricultural Science teaching for example on organic crop farming?

Appendix M: Teachers journal reflections on a presentation of making compost and organic pesticides

QUESTIONS	ANSWERS
1. What are your current views on indigenous knowledge after the presentation by the Indigenous Knowledge Custodians?	
2. What did you enjoy (or not) during the presentation by IKCs?	
3. What have you learned (or not) from the IKCs presentations?	

4. Which science concepts did you learn from the presentations by the Indigenous Knowledge Custodians which relate to the crop production section?	
5. How your engagement in this presentation about indigenous technology of organic crop farming by the IKCs going to change the way you teach the crop production section and/or organic crop farming in particular?	
6. Suggest if there is a need (or not) to integrate local indigenous knowledge in science teaching? Motivate your answer.	
7. Any other contributions/suggestions?	

Adapted from Nyamakuti (2021, p.144)

Appendix N: Participatory observation schedule

Components	**Responses/Comments**
1. Introduction i) How the IKCs introduced the presentation? ii) The IKCs brought certain materials/tools to the presentation?	

If Yes, name them	
2. Method used i) IKCs explained how they culturally fertilise soil and control pests: outline the methods presented. ii) IKCs created on opportunity for interactions among the teachers and IKCs. iii) IKCs (practically) involve the teachers during the presentation.	
3. Language used i) Language used for communication during the presentation. ii) How the language used influenced teachers participation? iii)	
4. Teachers' engagement i) Teachers' actively engaged/show interests in the presentation/workshop teachers ask questions. ii) Teachers give their contributions/reflections on their teaching practices with regards to organic crop farming. iii) Teachers' take notes in their personal reflections journals.	

Adapted from Neporo (2022, p.185)

Appendix O: Exemplar lesson plan on organic crop farming that intergrates IK on methods of fertilising the soil.

Subject: Agricultural Science	**Grade**: 12	**Date**: 01/09/2023	**Duration**: 40min

1. **An appropriate short introduction**: Teacher asks learners what they call fertiliser in their local languages.

2. **Presentation of teaching and learning activities.**

	Teacher's activities	**Learners' activities**
Step 1	Ask learners to name the substances they use at home to fertilise their fields	Reflect and name the substances hey used at home to fertilise their fields.
Step 2	Asks learners to identify teaching resources/local substances brought to class such as dry leaves, animal dung etc.	Identify the substances.
Step 3	Instruct learners to get into groups of 5 to 6 and discuss how the substances they identified in step 2 can be used to fertilise the soil and briefly present their answers to the class	Get into groups, discuss and present their answers to the class.
Step 4	Explain the concept of organic crop farming using learners answers	Listen attentively and ask questions.

3. **Consolidation** Highlights the salient points of the lesson and give homework.

4. **Assessment: Homework/Learning Task**

   4.1. **Homework**: Instruct learners to go home and ask their parents on the various methods the traditional use to fertilise their soil.

   4.2. **Task**: Group learners in 5 to 6 learners and give them a practical investigation on making compost.

5. **Lesson reflection:** Teacher instruct learners to write in their diaries/note books what they have learned or not about organic crop farming in the relation to IK.

Appendix P: Various phases of the data-gathering process

Phase	Data collection method to be employed	Purpose	Research question
1	First workshop: Orientation	Orientate participants about the study and for participants to get to know each other. Discuss and collectively agree on the convenient meeting days and time.	None, just for orientation purposes
1	First workshop: Document analysis	To co-analyse the National Curriculum, Agricultural Science Grade 12 syllabus and prescribed textbooks to find out to which	1

		extend the curriculum provides guidelines on the usage of IK in science.	
2	Semi- structured interview	To find out teachers perspectives, experiences and pedagogical insights on the use of IK in their science lessons when teaching crop production section.	1
3	Participatory observation	To see how teachers interact, participate during the presentation.	2
3	Workshop discussions	To see whether the teachers have learned or not, interacted and participated during the presentation by the expert community members.	2
3	Journal reflections	To see whether there are changes or shift in teachers ZPD and to reflect on the entire research process. To reflect on the presentations and co-develop exemplar lessons that integrates the local indigenous knowledge shared by the community members.	2 3

Appendix Q: Proposed time frame

Date	**Targeted activity**
January-September 2021	Writing of chapter 1-4 & research proposal.
September – November 2021	Submission of research proposal to the education high degree committee (EHDC) for ethical clearance.
December 2021	Designing of data-gathering tools.
January - February 2022	Piloting of data-gathering tools.
March - April 2022	Data gathering.
May - June 2022	Data analysis.

July - August 2022	Discussion of findings.
September - November 2022	Write up of all chapters & submission of first draft.
December 2022	Correction, editing & submission of second draft.
January 2022	Proof reading and editing of write up thesis.
February 2023	Submission of final thesis for examination.