# Using the indigenous technology of dyeing and weaving African baskets as a cultural tool to mediate learning of chemical and physical changes

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**By**

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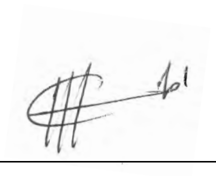
# Declaration of Originality

I Kakambi William, hereby declare that this thesis is my own original work and has not been previously submitted in any form for assessment or for a degree in any other higher education institution. Where I have used work from other scholars, such ideas have been acknowledged by means of quotations and reference according to Rhodes University Education Department Guidelines.



__________________________ December 2020

Signature Date

# Dedication

This thesis is dedicated to the following members of my family who gave me space to focus on this piece of work in a time when they needed my attention: my wife Pumulo Beauty Kakambi, my daughter Mabonenwa Clare Kakambi, my sons Mubila Micah Kakambi, Buitukiso Shellah Kakambi and my mom Ms. Vulunzi Maryclare Mabonenwa, whose artistic work of African basketry inspired me to carry out a study around it.

# Acknowledgments

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# Abstract

Literature has revealed that indigenous learners, especially in many African nations are subjected to learning school science in unfamiliar contexts. Learners in Namibia where this study was conducted are no exception. In consequence, learners experience cognitive conflict between school science and the experiences learnt at home and in the community. This is exacerbated, in part, by the fact that science teachers do not seem to know how to integrate indigenous knowledge in their science teaching. As an attempt to address this problem, some scholars call for the integration of indigenous knowledge into the science curriculum to provide a much needed context for learning science. It is against this background that this study sought to use the indigenous technology of dyeing and weaving baskets as a cultural tool to mediate learning of chemical and physical changes.

Underpinned by the interpretivist and Ubuntu paradigms, the study employed a qualitative case study research design. The study was conducted in the Zambezi region in Namibia. Four grade 8 Physical Science teachers, an expert community member, and a critical friend were involved as participants in this study. Data were gathered using semi-structured interviews, workshop discussions, participatory observation, and journal reflections. Vygotsky's socio-cultural theory and Mavhunga and Rollnick's topic specific pedagogical content knowledge were used as theoretical and analytical frameworks, respectively. A thematic approach to data analysis was employed to come up with sub-themes and themes.

The findings of the study revealed that all the participating teachers in this study had never been exposed to ideas on how to integrate indigenous knowledge in their science teaching. As a result, they all embraced and valued the indigenous technology of dyeing and weaving as relevant and useful in the teaching and learning of chemical and physical changes. This study recommends that there is a need to empower science teachers on how to integrate indigenous knowledge in their science teaching in order to make science accessible and relevant to their learners' lived worlds.



**Key words:** Physical Science, chemical and physical change, indigenous knowledge, African basketry, indigenous technology, dyeing and weaving, cultural tool, socio-cultural theory, TSPCK

# Table of Contents

# List of Tables

# List of Figures

## List of Abbreviations and/or Acronyms

| | |
|---|---|
| CK: | Content Knowledge |
| CPD: | Continuing Professional Development |
| IK: | Indigenous Knowledge |
| IT: | Indigenous Technology |
| LCE: | Learner Centered Education |
| LK: | Local Knowledge |
| MEAC: | Ministry of Education Arts and Culture |
| MKO: | More Knowledgeable Other |
| NCBE: | National Curriculum for Basic Education |
| PCK: | Pedagogical Content Knowledge |
| PK: | Pedagogical Knowledge |
| PLC: | Professional Learning Community |
| SMK: | Subject Matter Knowledge |
| TSPCK: | Topic Specific Pedagogical Content Knowledge |
| WS: | Westernised Science |
| ZPD: | Zone of Proximal Development |

# CHAPTER ONE: SITUATING THE STUDY

## 1.1 Introduction

The main goal of this study was to use the indigenous technology of [1]dyeing (*kubasa*) and weaving (*kuluka*) African baskets (*maselo*) as a cultural tool to support grade 8 Physical Science teachers in how to integrate indigenous knowledge. That was intended to mediate learning of chemical and physical changes in Physical Science lessons in the Zambezi region in Namibia. What triggered my interest to conduct this study are, firstly, my personal experiences which I will discuss later, and, secondly, the overwhelming evidence in the literature showing that school science content is taught in decontextualised ways. This thesis argues that the use of local or indigenous knowledge has the potential to provide opportunities for contextualization, making science more relevant and accessible to learners.

In this chapter, I describe the background of the study. Firstly, I discuss the international context of [2]local or indigenous knowledge (IK) integration and then the local context, based on Namibia's National Curriculum for Basic Education. This is then followed by the statement of the problem, purpose, and significance of this study. I further describe the research goal, research questions, and present a summary of the theoretical and analytical frameworks. Lastly, I provide the key concepts used in this thesis and the thesis outline. The chapter ends with a chapter summary.

## 1.2 Context of the Study

The advent of globalisation has allowed increased contact among once geographically isolated groups, with the result that traditional knowledge systems are being assimilated and in some

[1] In Silozi this is called *kubasa mubala* ni *kuluha Maselo.* Silozi is a lingua franca in the Zambezi region of Namibia.
[2] Local knowledge or indigenous knowledge (IK) or traditional knowledge are used interchangeably in literature and I have opted to use IK throughout this thesis.

cases, seemingly, disappearing together (Varani-Norton (2017). According to Easton (2011, p. 708), “Black African cultures themselves not only have their own traditions of inquiry but have undergone a great deal of change and admixture over the centuries”. Through globalisation, African countries have witnessed a shrinking of their international and local boundaries, with the international cultures becoming local while the local cultures are slowly fading away. For instance, Akanle, Adejare, Ademuson, and Adegoke (2018) posit that original African identities, such as tastes, fashions, consumptions and cultures are in favour of embraced globalised Western cultures. The situation has raised concerns of assimilation of Africans into western cultures and epistemologies in the name of globalisation.

Schröttner (2010) explains globalisation as a process of modernisation and westernisation, changing the world from traditional to modern societies. In the name of globalisation, western epistemologies have come to mediate our world at the expense of Afrocentric ways of knowing. Alongside globalisation, *inequalities,* and *injustices* in education have been promoted for indigenous learners (non-western) in postcolonial Africa (Sen, 2007).

According to Bifuh-Ambe (2020), indigenous learners, in their postcolonial classes, are offered a ‘one-size-fits-all’ instructional approach. Consequentially, this type of instruction has lowered the quality of education received by indigenous learners in their classrooms. Seemingly, English, Mathematics and Science have been elevated to become a standard measurement of intelligence in most African Nations. For instance, a large number of learners completing their final year of high school are likely to fail to achieve at least a D or C symbol in English. The learners may have scored more than the points required by colleges or universities for admission into programmes (other than English) of their choice, but are denied a place because of their marks for English. Scholars have observed that the African education system has a biased view of science; Eurocentric scientism has been promoted above Afrocentric epistemologies in science curricula (Sen, 2007).

Scholars agree that long before the colonial era, African indigenous knowledge systems (IKS) had sustained African communities and societies, from food production to medicine (Kibirige & Van Rooyen, 2006; Schröttner, 2010). In support of this view, Shizha (2013) explains that prior to colonisation, Africans were socialised and educated within African indigenous cultural contexts. For these reasons, some scholars are calling for a review of the science taught in African classes as it does not reflect the African ways of *knowing* and *being* (Aikenhead &

Jegede, 1999; Kibirige & Van Rooyen, 2006; Mukwambo, Ngcoza & Chikunda, 2014; Semali & Kincheloe, 1999). Supporting this position from an [3]Ubuntu perspective, Govender (2014) highlights that indigenous learner, mostly in African classrooms; learn science in an abstract context. That is, learners are taught science with no reference to their everyday lived experiences. Against this background, indigenous knowledge (IK) scholars are advocating for the global and regional mobilisation of indigenous knowledge integration in science teaching (Aikenhead & Jegede, 1999; Mukwambo et al., 2014; Shizha, 2013).

Designers of curricula in African countries apparently have accorded Eurocentric epistemology a superior status over the indigenous knowledge system (IKS) (Aikenhead; 2006; Aikenhead & Jegede, 1999; Mukwambo et al., 2014; Shizha, 2013; Wangola, 2002), and by embracing westernised school science curricula, indigenous learners are subjected to learning school science in unfamiliar contexts. The consequence of such choices has been felt and observed both in the learners' poor academic achievement, as well as the struggle faced by science teachers when mediating learning of certain science topics and concepts. From my personal teaching experience, for instance, I have noticed with great concern learners' lack of understanding of certain science topics, including chemical and physical changes. In this vein, Vos (2014) posits that this lack of improved learning and poor results in science might be caused, in part, by a weak relationship between concepts and contexts. This resonates well with Mavuru and Ramnarain's (2017) assertion that normally, when learners learn science in unfamiliar contexts, there seems to be no linkage between the school science and their everyday experiences (Aikenhead, 2006; Le Grange, 2007).

Literature has revealed a number of benefits associated with the integration of IK into science lessons. For instance, Kibirige and Van Rooyen (2006) advanced that IK could enrich science teaching by using IK as indigenous *prior* knowledge in science lessons. IK may show learners the relevance of science to their own lives and interests (Govender, 2014; Ogunniyi & Ogawa, 2008; Rosales & Sulaiman, 2016; Webb, 2013). It may also increase learners' participation in science lessons (Sedlacek & Sedova, 2017) as well as lead to greater parental involvement (Klein 2011; Mateus & Ngcoza, 2019). Aikenhead and Jegede (1999) believe that IK may

[3] Ubuntu is an African-centred world-view that emphasises the good-of-all, harmony, mutual respect, relational understanding, interdependence, interrelationships, or the interconnectedness of all phenomena (Ogunniyi, 2007a).

contextualise school science. For instance, examples found in school textbooks, for example, preservation of food by refrigeration are emended in western contexts. Yet, learners mostly from rural areas may not be familiar with refrigerators. Therefore, the idea of food preservation can be contextualised by the indigenous technology of smoking or sun drying. Based on these benefits, it could be assumed that IK may increase learners' academic achievement, whereas neglecting IK will have the opposite effect. Next, I look at Namibia's science curriculum.

## 1.3 Expectations of the Namibian Curriculum

Namibia is among several African countries (others are Zimbabwe, Tanzania, and South Africa) which have made significant progress with regard to IK integration in science teaching and learning. Such progress is evident in Namibia's national curriculum for basic education (NCBE), where it emphasises that the type of knowledge to be imparted to learners is "knowledge that embraces indigenous knowledge (IK) and national culture as well as international and global culture" (Namibia. Ministry of Education, Arts, and Culture, [MEAC], 2016, p. 5). The curriculum statement supports IK integration in science teaching, although little has been done to support science teachers on how they can go about integrating IK into their lessons. In other words, there is a disjuncture or gap between curriculum formulation and implementation.

Studies by Asheela (2017), Nikodemus (2017), and Simasiku (2017) in Namibia similarly revealed that teachers seem to lack awareness of IK. Simasiku's (2017) observations in particular reveal that some teachers lacked the pedagogical skills of integrating IK into their classes because they had not been trained in the area of IK integration. This resonates with Ogunniyi's (2007a) sentiments that teachers who understand and use IK in their science lessons are those who have been trained in the field at university. Against this background, scholars are recommending capacity building workshops and training, if the integration of IK into school science is to be realised (Nashidengo, 2013; Simasiku, 2017). This study thus aimed at mobilising the indigenous technology of dyeing and weaving of African baskets with the aim of co-developing exemplar lessons to mediate the learning of chemical and physical changes in grade 8 Physical Science rural schools in Namibia. In the sections below, I discuss some of the expectations of the Physical Science curriculum in Namibia.

### 1.3.1 Approach to teaching and learning Physical Science

Physical Science in Namibia is one of the subjects making up the Natural Sciences area of learning. The Namibian national curriculum for basic education shows that the Natural Sciences learning area comprises the following subjects: Environmental Learning (pre-primary), Environmental Studies (grades 1-3), Natural Science and Health Education (grades 4-7), Elementary Agriculture (grades 5-7), Life Science (grades 8-9), Physical Science (grades 8-9), Agricultural Science (grades 8-12), Biology (grades 10-12), Physics (grades 10-12) and Chemistry (grades 10-12) (Namibia. MEAC, 2016).

This particular study focused specifically on teaching Physical Science in the junior secondary phase, grades 8 and 9. In this phase, Chemistry and Physics are combined into one subject, Physical Science. However, at the senior secondary phase (grades 10-12), Physical Science splits into Chemistry and Physics. This suggests that at the end of the junior secondary phase (grade 9), learners have an option to study either Chemistry or Physics. Stein, Larrabee and Barman (2008) explain that Chemistry, Physics, and Physical Science are subject areas regarded as difficult for both teachers and learners alike, because they include concepts that are too abstract to understand. Science teachers are thus tasked to ensure that the abstract concepts are made relevant to the learners' lived experiences. Against this background, the Namibian Ministry of Education, Arts, and Culture (Namibia. MEAC, 2015, p. 4) proposes that:

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

Teaching strategies that build on learners' existing knowledge and experiences from everyday sociocultural interactions are vital in the learners' subsequent learning (Kasanda, Lubben, Gaoseb, Kandjeo-Marengaa, Kapenda, & Campbell, 2005; Nyika, 2017; Ogunniyi, 2007a; Roschelle, 1995). This amplifies the call for teachers to employ teaching strategies that draw and challenge learners to use their socio-cultural background experiences and cultural worldviews in class which can potentially reinforce their learning (Erinosho, 2013; Vygotsky, 1978). In this vein, Kreisler and Semali (2001) explain that opportunities are lost when teachers ignore their learners' prior knowledge of indigenous ways of knowing. It is recognised, however, 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). Therefore, teachers need to be skilful in eliciting and refining learners' prior knowledge to accommodate new information. In the section that follows, I discuss conducting practical investigations – another aspect central to the teaching of Physical Science in Namibia.

### 1.3.2 Practical investigations in science teaching

In the junior secondary phase of Physical Science, the continuous assessment tasks include practical investigations, which are intended to assess learners' practical skills. As a result, Namibia's Natural Sciences Subject Policy Guide for grade 8-12 expects Physical Science teachers to conduct practical work (Namibia. MEC, 2008). To provide enough time for hands-on practical activities or experiments (Asheela, Ngcoza, & Sewry, 2021), each science subject is allocated a double lesson period on the timetable. Moreover, at the end of each topic in the syllabus, there are a number of suggested hands-on practical activities/demonstrations that all learners should be exposed to, as a minimum requirement. This is aimed at preparing and equipping learners with the practical skills and knowledge required, especially for the senior secondary practical examinations papers.

Although hands-on practical activities and investigations are such an important aspect of science teaching in Namibia, in many schools it remains a challenge to conduct them. A number of scholars have revealed that most of the Namibian secondary schools have inadequate resources available in their science laboratories to teach practical work (Asheela et al., 2021; Liswaniso, 2019; Marenga, 2011; Nikodemus, 2017). Further, Liswaniso (2019) alludes that lack of practical work leads to poor performance by the learners in the practical examinations. In my view, indigenous technological knowledge (ITK) could offer alternative resources at little to no cost to conduct practical work as required in the Physical Science curriculum. Glimpses of such opportunities have been mentioned in a number of studies conducted in Namibia. For instance, Ndahalomwenyo (2012) investigated cultural beliefs/everyday experiences about the rainbow (reflection of light in the curriculum); Asheela (2017) explored using easily accessible resources (she used [4]*oshikundu*); and another scholar, Nikodemus

[4] *Oshikundu* is a non-alcoholic beverage made by Ovambo people in Namibia and it is similar to *amarhewu* which is made from maize meal. Both these traditional beverages are said to be non-alcoholic because the alcohol content in them as a result of the fermentation process is insignificant.

(2017) also used *oshikundu* – but this time to mediate learning of the concept of rates of reactions.

This study focused on teachers' pedagogical content knowledge (PCK) (Shulman, 1986) of IK integration in science lessons to mediate learning of school science concepts in particular physical and chemical changes. My assumption in this study is that the teachers' failure to integrate IK in their teaching is due to their lack of awareness of IK integration, especially the ability to make the connections between IK and the school science concepts.

As a science teacher in Namibia, I can confirm that many teachers have not been trained on IK integration at their various teachers' training institutions. Despite the fact that a few studies have been conducted in Namibia exploring IK integration in science teaching, none of these studies have been conducted in the Zambezi region of Namibia, which focused on equipping teachers on how to integrate indigenous knowledge. In this study, I therefore mobilised the indigenous technology of dyeing and weaving African baskets with the aim of co-developing exemplar lessons that integrate indigenous knowledge to mediate the learning of chemical and physical changes in grade 8 Physical Science. It was hoped that this indigenous technology would afford the science teachers an opportunity to identify the science concepts embedded in it and to ultimately use it to contextualise science their own classrooms.

### 1.3.3 Visualisation in science learning

Wiebe, Clark, and Haase (2001) accentuate that using indigenous technology as a cultural tool for mediating classroom science allows for the visualisation of scientific concepts, presenting learners (teachers in the context of my study) an opportunity to make sense of new science concepts in new but familiar contexts. To Cook (2006), visualisation is a teaching and learning approach in which science instruction is combined with visual and verbal information. In her study, for instance, Hashondili (2020) observed that as a result of attending presentations by community members, her participants viewed indigenous knowledge as visualisations and sense making of science concepts. In this study, visualisation formed part of my analytical tools to explore what form of representation the science teachers use to mediate learning of chemical and physical changes. According to Mavhunga and Rollnick (2013), the concept of representation is concerned with how the learning content is presented to the learners during teaching, such that it carries meaning.

In this study, the different stages of preparing the dyes and other weaving materials offered the four grade 8 Physical Science teachers and me an opportunity to visualise or observe the chemical and physical changes. For instance, the fresh palm leaves and weaving grass are soft and green in colour and very flexible. After sun drying, however, both the palm leaves and weaving grass lose their flexibility and become hard and brittle. Their colours also change permanently; the palm leaves turn from green to creamy white. During weaving, the lack of flexibility is reversed by soaking the palm leaves in water; the weaving grass too is sprinkled with water to increase flexibility. This flexibility makes the coil technique possible and could be used to practically investigate the concept of osmosis (Nangolo, 2018). The palm leaves are dyed, for lacing or coiling, allowing the weaver to make different patterns; however, these patterns can be reversed if the weaver detects a mistake. In the section that follows, I discuss my personal experience as a learner as well as a science teacher.

### 1.4 My Personal Experience

I was born and raised in a rural area, surrounded by indigenous practices, which formed part of our livelihood, such as collecting fire wood, starting a fire and fermenting of fresh milk. When I talk about indigenous knowledge, my past experiences come into play. I recall when I arrived at the senior secondary school in town, where I matriculated my Biology teacher frequently called me 'village boy', after he realised I was from a junior secondary school located in the rural area. I used to feel belittled and dehumanised, but if I were to turn the clock back today I would feel proud to be called by this name as it actually carries a concept of *identity*. Scholars such as Cocks, Alexander, and Dold (2012) and Smith (2013) emphasise the importance of cultural revitalisation.

Growing up with my grandparents was a blessing to me. They engaged me in numerous activities, preparing me for adulthood tasks. My grandfather had a slogan: *"Hata moni hata, mwendi ukaba mutu"* this is translated as "step onto my footsteps or copy what I do; you will be able to sustain yourself when you grow up". I learnt many skills at a very early age, not only from my parents but also from other elders in our village and surrounding communities. For instance, pounding and sieving maize, sorghum, and Mahangu flour for mealie meal as well as herding cattle were my daily chores. Other skills and knowledge I learnt included controlling a plough, collecting and purifying rainwater collected in ponds, collecting and preserving wild fruits such as *Munzinzila, Muchenje, Mumaka*, and using energy from the sun. Little did I know that these were relevant to science, and my teachers at school did not make mention of these either.

At the school, my teachers disregarded the knowledge I had acquired from home because no reference was made to it. Instead, they made a laughing stock of me since I was from the village. It seems that the cultural capital I possessed was not required at school and was regarded as irrelevant. Yet, Aikenhead and Jegede (1999) emphasise that taking into consideration such knowledge could bridge the gap between home and school science. Instead, all we were required to do was to memorise concepts without understanding them. Additionally, we had to write essays on topics and things which we had not heard of nor seen, for example, 'a journey by train'. Due to the learning environment that was not conducive in the school, I dropped out of school twice – in grade 6 and also when I was in grade 8. The things we were learning at school did not make sense to me, compared to the excitement and joy we had at home.

I only came to realise the place of local knowledge in science teaching when I was studying for a bachelor's degree at Rhodes University. During the first session, we talked extensively about indigenous knowledge and one community member presented a practical demonstration of making *Oshikundu,* an Oshiwambo non-alcoholic drink. That was conducted to illustrate the fermentation and formation of carbon dioxide (Asheela, 2017). I could not believe the number of scientific concepts that emerged from the practical demonstration of making *Oshikundu*. As a result, I was convinced that there was science in our traditional practices.

After exposure to indigenous knowledge at Rhodes University, while studying for my Bachelor's degree, it dawned on me that actually there is science embedded within these cultural practices. On reflection, if in the past reference to such cultural knowledge and practices had been made in science lessons, science instruction could have been more understandable to many of us. For instance, I learned how to milk a cow and how to ferment fresh milk. The fermentation process of fresh milk to sour milk can be a great resource to Physical Science teachers. The indigenous technology can be used to mediate the learning of concepts such as rates of reactions, catalyst, mixtures, separating mixtures, production of carbon dioxide as well as the concept of acids. All these came to light after enrolling in the master's programme with Rhodes University. During the research design course in

Grahamstown, I was privileged to witness a practical demonstration of making [5]*umqombothi*. We call it *Sinkontini* in the Zambezi region of Namibia; it is a very strong alcoholic beverage.

The process of making *Sinkontini* is familiar to me, as my mother is a great brewer of this home-brewed alcoholic beer. However, at Rhodes University, I came to learn of its potential place in mediating the learning of school science concepts. During the whole practical demonstration by the expert community member (referred to as the 'expert" from here onwards), I felt more attached to the whole process. My eyes were opened to see beyond the mere process of making *Sinkontini*. The science concepts embedded in the process surfaced. I thought if the identified concepts were mediated using indigenous practices as vehicles, science was going to be more interesting and relevant to learners (Aikenhead & Jegede, 1999).

In hindsight, it could be argued that the way my teachers taught me science has greatly affected my teaching practice. I realised that I had been promoting rote learning at the expense of conceptual understanding. Had my Physical Science teacher in grade 8, for instance, compared carbon dioxide preparation to fermentation of *Sinkontini* (traditional beer) or gas produced when sour milk ferments, I may have conceptualised and enjoyed the lesson on carbon dioxide preparation in grade 8. It is against this background that I focused my study on mobilising the indigenous technology of dyeing and weaving African baskets to mediate learning of chemical and physical changes in grade 8.

African basketry is the artistic work of dyeing and weaving baskets. The traditional practice has been part of my life from a very young age. This artistic work is my mother's leisure activity as well as a source of income. For instance, money from the sale of baskets was used to pay my school fees, buy my uniform, and other family equipment. I also assisted my mother in her work. For instance, as a child, I would accompany and help her to collect the weaving grass and the young palm leaves as well as different plant extracts to make dyes. Little did I know there were Chemistry and Physics embedded in this traditional practice and that later, I would explore the possibility for teachers to use the indigenous technology of dyeing and weaving to mediate the learning of chemical and physical changes.

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[5] *Umqombothi* is an alcoholic beverage made by most families in South Africa and its alcoholic content is about 3%.

### 1.5 Statement of the Problem

A number of studies have been conducted in Namibia (Asheela et al., 2021; Nikodemus, 2017; Simasiku, 2017) revealing that science teachers struggle to integrate learners' indigenous knowledge. Importantly, these Namibian scholars highlighted that a great number of teachers lack awareness as well as pedagogical insights of integrating indigenous knowledge (IK) into their science lessons.

Although the Namibian curriculum supports the integration of IK in theory, it remains unclear or silent on how teachers should go about integrating learners' IK into their science teaching. Against this background, I have been motivated to build on studies (Homateni, 2013; Liveve, 2017; Nikodemus, 2017; Simasiku, 2017) through mobilising an indigenous technology of dyeing and weaving African baskets, and how it can be used to support grade 8 Physical Science teachers in mediating learning of chemical and physical changes.

### 1.6 Purpose and Significance of the Study

The purpose of this study was to explore and understand the experiences of the four grade 8 Physical Science teachers exposed to the indigenous technology of dyeing and weaving African baskets with a view to make science accessible and relevant to learners' everyday life experiences. This study was further intended to address the existing tension between curriculum formulation and implementation in Namibia. The Physical Science teachers' attitudes, experiences, and pedagogical insights in mediating the learning of chemical and physical changes as well as integration of indigenous knowledge in their science lessons were explored. Significant to the study was the use of indigenous technological knowledge (ITK) in dyeing and weaving African baskets, with the aim of co-developing an exemplar lesson to mediate learning of chemical and physical changes. It was hoped that this study could be a form of support in the sense of continuing professional development for me and the grade 8 Physical Science teachers involved in the study.

### 1.7 Research Goal

The main goal of this study was to mobilise the indigenous technology of dyeing and weaving of African basketry to mediate learning of chemical and physical changes. To achieve this goal, the following research questions were addressed:

### 1.8 Research Questions

1. Based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation?
2. During the workshop interactions with the expert community member, what opportunities emerged for the grade 8 Physical Science teachers to bridge the gap between curriculum formulation and implementation of IK?
3. How can the grade 8 Physical Science teachers be supported in co-developing exemplar lessons on chemical and physical changes that integrate concepts from the indigenous technology of dyeing and weaving of African baskets?

### 1.9 Theoretical and Analytical Framework

This study is informed by Vygotsky's (1978) socio-cultural theory and Shulman's (1986) pedagogical content knowledge (PCK) framework. Vygotsky's (1978) socio-cultural theory (SCT) asserts that learning occurs through social interactions. That is, learners interact with cultural materials in their society as well as with more knowledgeable others. Within the SCT, I focused on the mediation of learning, social interactions and the zone of proximal development (ZPD) as lenses.

Shulman's (1986) PCK underscores the distinctive knowledge types that subject teachers ought to have to successfully mediate learning of subject content. Within PCK, Mavhunga and Rollnick (2013) identify five topic specific pedagogical content knowledge (TSPCK) components: students' prior knowledge (including misconceptions), curricular saliency, what is difficult to teach, representations including analogies and conceptual teaching strategies have been used as the analytical framework.

### 1.10 Data Generating Techniques

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

- Semi-structured interviews;
- Workshop discussions;
- Participatory observation; and

- Journal reflections.

### 1.11 Definition of Key Concepts used in the Thesis

Local knowledge, indigenous knowledge (IK) or traditional knowledge can be used interchangeably. However, I will use indigenous knowledge (IK) throughout the thesis. Below are some of the key concepts used in the thesis:

**Indigenous Knowledge:** A legacy of knowledge and skills unique to a particular indigenous culture and involving wisdom that has been developed and passed on over generations (Kibirige & Van Rooyen, 2006).

**African Basketry:** The artistic work of decorating and weaving baskets (Gerdes, 2007).

**Dyeing:** The process of changing the colour of the palm leaves to the desired color, using natural dyes**.**

**Weaving**: The coil technique used to stitch up the thatch grass and the palm leaves.

**Socio-cultural theory (SCT):** A social learning theory that focuses on how learning occurs as a result of interactions and how culture, cultural beliefs and attitudes affect the interactions (Vygotsky, 1978).

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

**Westernised science: I**n this study the term refers to school science whose content and contexts are western based, which is foreign to Africans.

### 1.12 Thesis Outline

This thesis is presented in seven chapters:

**Chapter One: Situating the Study**

This chapter presented the international, regional as well as the Namibian context of the integration of indigenous knowledge (IK) into the science curriculum. Thereafter, the statement of the problem, purpose and significance of the study, research goal, questions, theoretical and analytical frameworks were discussed. Lastly, the data gathering techniques were introduced, followed by the definition of key concepts used in this study.

**Chapter Two: Literature Review and Theoretical Framework**

The second chapter provides an overview of the relevant literature in relation to IK integration into science teaching and learning. Chemical and physical changes, prior knowledge, indigenous knowledge as well as teachers' continuing professional development in Namibia are discussed. The chapter ends with a discussion of the theoretical and analytical framework.

**Chapter Three: Research Methodology**

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

**Chapter Four: Analysis of Semi-structured Interviews**

In chapter four, the data from semi-structured interviews

In this chapter, I present the qualitative data generated from the semi-structured interviews to answer research question one. The data gathered showed that the science teachers have some understanding of prior knowledge and that everyday knowledge or indigenous knowledge is the main component making up the learners' prior knowledge.

**Chapter Five: Participatory Observations and Reflections**

In this chapter I present an analysis and discussions of the data generated from the participatory observations during the presentations made by the expert community member on dyeing and weaving African basketry.

**Chapter Six: Co-development of an Exemplar Lessons**

In this chapter I present an analysis and discussion of the data generated from the discussion and the development of an exemplar lesson and the teachers' designed lessons.

**Chapter Seven: Summary of Findings, Recommendations and Conclusion**

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

### 1.13 Chapter Summary

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

# CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

## 2.1 Introduction

The study was aimed at mobilising the indigenous technology of dyeing and weaving of African baskets to mediate learning of the concepts of chemical and physical changes in grade 8 Physical Science classes. In this chapter, I thus discuss literature relevant to the concepts of chemical and physical changes and the challenges faced by teachers when mediating learning of these concepts. Furthermore, I discuss literature relevant to IK and its implication for teaching science as well as the challenges faced by teachers in integrating indigenous knowledge in science lessons. The chapter ends with a discussion of Vygotsky's (1978) socio-cultural theory and Shulman's (1986) pedagogical content knowledge (PCK) as my theoretical and analytical frameworks, respectively.

## 2.2 Chemical and Physical Changes

Chemical and physical changes are fundamental concepts in the study of the nature of matter in Namibia's science curriculum. The two concepts are introduced and taught simultaneously, from grade 8 through to grade 12. These concepts are central to the Chemistry curriculum, in order to study and understand chemical reactions. As highlighted earlier, mediating learning of chemical and physical changes has been a challenge for many grade 8 Physical Science teachers. In this study I explored the processes involved in the indigenous technology of dyeing and weaving African baskets together with the Physical Science teachers in order to find opportunities to mediate learning of chemical and physical changes in grade 8 classes.

The following are the expectations or learning objectives of the topic chemical and physical changes, as stated in Physical Science syllabus for the junior secondary phase. According to the syllabus (Namibia. MEAC, 2015. p. 12), learners should be able to:

- Describe physical change and chemical change;
- Distinguish between a physical and a chemical change;

- Give examples of chemical changes or reactions in everyday life and industrial processes; and
- Describe changes in everyday life and in industry and identify them as physical or chemical changes.

The nature of changes, when matter undergoes transformation, may lead to the formation of different substances. Matter may undergo chemical (permanent) or physical (temporary) changes. Britz and Mutasa (2010) explain that a chemical change involves atoms in a substance undergoing rearrangement, resulting in one or more substances that are chemically different. Similarly, Clegg (2012) states that a chemical change is a permanent change in which new substances, which cannot be changed back into the original ones, are formed. Van Niekerk (2016) similarly explains a chemical change as a change in which the chemical properties of a substance change. The problem is that these descriptions are all very abstract, and thus difficult to teach to grade 8 learners.

Du Toit, Marais, McLaren, Taylor and Webber (2018) further show that, during a chemical change, a chemical reaction occurs, in which bonds are formed and/or broken. This explains the formation of new substances and why the new substances formed have a different chemical composition. For instance, burning a white piece of paper to illustrate a chemical change yields the following: the white paper changes into smoke and black ash (Carbon); chemically, the carbon atoms in the paper combine with oxygen to form, among others, carbon dioxide (gas) and ash (solid) during the combustion process. Other examples of chemical changes include: rusting (corrosion), respiration, photosynthesis, cooking food, eating food, burning wood and fruit ripening.

Additionally, Clegg (2012) explains a physical change as a temporary change, whereby no new substances are formed. Haimbangu, Poulton and Rehder (2017) state that physical changes involve changes in the physical properties of matter, such as state or colour. Du Toit et al. (2018) further point out that physical changes are easy to reverse. A reversible change goes both ways. This suggests that a substance that has undergone a change can be changed back to its original form. Table 2.1 summarises the characteristics of chemical and physical changes.

**Table 2.1: The characteristics of chemical and physical changes**

| Properties of chemical changes | Properties of physical changes |
|---|---|
| New substances formed | No new substances formed |
| Permanent change | Temporary change |
| Difficult to reverse | Can easily be reversed |
| Heat is always involved | Heat is not always involved |
| Change in colour | No change in colour |
| Change in chemical properties | Change in physical state |
| Chemical composition of products different from reactant | Chemical composition of products are the same as reactants |

Source: Britz and Mutasa (2010, p. 58)

### 2.2.1 Difficulties in mediating learning of chemical and physical changes

Most science teachers will confirm that the topic of chemical and physical changes is easy, yet they are surprised at their learners' lack of understanding of the topic. If learners lack understanding of chemical and physical changes early in grade 8 they will find it difficult to understand chemical bonding or chemical reactions in the senior secondary phase. Evidence of the challenges faced by learners in their understanding of these concepts is revealed in the national examiners' reports on grade 9 (JSSEE, 2018), grade 10 (JSC, 2016) and grade 12 (NSSCO, 2014) as follows:

- The Junior Secondary Semi-External Examination Moderator's Report (JSSEE, 2018, p. 52) Question 3: "The entire question was poorly answered. The question was totally misunderstood as many learners thought it was a chemical change. Most learners incorrectly identified the change as a chemical change and in turn gave the properties of chemical changes" (Namibia. Ministry of Basic Education, Arts and Culture, 2018);

- Grade 10, JSC Physical Science, Examiner's Report: It surprised national markers that "many candidates did not know the difference between physical change and chemical change … candidates failed to identify which change can be reversed" (Namibia. MoEAC, 2016, p. 243); and
- Grade 12, Physical Science NSSCO, Examiner's Report: "Learners confused the difference between physical and chemical testing of water, which relates to physical and chemical change/ reactions topic" (Namibia. MoEAC, 2014).

The Namibian case as revealed in the examiners' reports above, concurs with Ahtee and Varjola's (1998) study which probed learners' thinking about chemical changes and found that learners had difficulty in distinguishing chemical change from physical change. Similarly, Yan and Talanquer's (2015) study revealed that students struggled to understand transformations in matter. Another study based in Ghana, conducted by Hanson, Twumasi, Aryeety, Sam, and Adukpo (2016) revealed a good number of Ghanaian students had a higher level of conceptual understanding about changes in chemistry. This study further showed that some students could provide correct definitions for physical and chemical changes but could not apply them in subsequent probes, which revealed superficial understanding of concepts.

To teach for conceptual understanding in Physical Science, teachers need to be conscious of the different pedagogical approaches to science teaching. According to Susilaningsih, Fatmah, and Nuswowati (2019), both concepts in Chemistry and Physics are studied at three major levels: macroscopic, microscopic and symbolic. Treagust, Chittleborough, and Mamiala (2003) explain the macroscopic level as a chemical phenomenon that can be observed directly and includes events in everyday life. The microscopic level (substance forming) or particulate level chemical phenomena are not easily seen directly and are usually depicted by atomic theory of matter in terms of particles such as electrons, atoms and molecules (Davidowitz, Chittleborough, & Murray, 2010).

Hanson et al. (2016) claim that in their attempt to help learners with misguided distinctions between chemical and physical changes, teachers introduce chemical reactions as rearrangements of atoms without explaining that it implies changes in discrete and constituent particles that result in the formation of a new substance. These scholars further claim that the teachers fail to link the new concept to students own understanding about chemical and physical properties of matter.

To mitigate this, Mavhunga and Rollnick (2013) advise that teachers should possess the necessary pedagogical content knowledge if their instructions are to meet their learners' learning styles. Moreover, teachers with a superficial understanding of how their learners learn spend most of their teaching time giving factual knowledge or information for learners to master to regurgitate it during examinations. Namibia's national curriculum for basic education expects science teachers to teach in a transferable manner in order for their learners to understand the concepts (Namibia. MEAC, 2016). What this means is that our teaching should enable our learners to apply the scientific ideas, manipulate and solve problems in their everyday lives or other learning areas.

Most Physical Science textbooks used in Namibian schools tabulate the characteristics of the chemical and physical changes (Britz & Mutasa, 2010; Clegg, 2012; Du Toit et al., 2018; Van Niekerk, 2016) and the teachers have conformed to the approach. Seemingly, tabulating the differences between chemical and physical changes only encourages rote learning among learners. Learners memorise and regurgitate such facts about chemical and physical changes during examinations, without understanding the concepts.

With this approach, it may be very difficult for teachers to detect their learners' misconceptions of the topic. As was the case in this study, learners might either forget completely or confuse the characteristics of the chemical changes with physical changes and vice versa. Literature also suggests that teachers may also transfer their misconceptions of a topic to their learners. For instance, Stein et al. (2008) maintain that misconceptions about Physical Science concepts are not limited to children; they are maintained throughout high school and into colleges. Further, they believe that science teachers' conceptions of scientific concepts have a direct and important influence on their learners' conceptualisations of such concepts. With this in mind I decided also to explore the science teachers' attitudes, experiences and pedagogical insights when mediating learning of chemical and physical changes in their classrooms.

My interest in exploring chemical and physical changes in grade 8 was triggered by my own learners' failure to answer questions that require them to apply the knowledge of these processes. For instance, for the past 10 years of my teaching experience of Physical Science, I have been grappling with how to assist my learners to build conceptual understanding of certain science concepts. A few examples of these concepts include: catalyst, diffusion, chemical change, physical change, pressure and force. After learning how abstract and foreign these concepts are to the learners, and that IK integration might minimise their foreignness, I decided to explore the concept of chemical and physical change. I worked *with* grade 8 Physical Science teachers with a view to co-developing an exemplar lesson integrating the cultural practice of African basketry. Essentially, this study was a practical pedagogical approach that was aimed at popularising the anchoring of science instruction in learners' prior or everyday knowledge (local knowledge).

### 2.2.2 Changes in dyeing and weaving of African baskets

The art or craft of making baskets is one of the oldest practices on the African continent, passed on from generation to generation. Gerdes (2007) defines African basketry as the artistic work of weaving and decorating baskets. In his study conducted in Mozambique, Gerdes (2007) used this artistic work to study ethno-mathematics, with a focus on patterns. Evidence from literature supports the pedagogy of associating, for instance, science concepts with examples of knowledge and practices from everyday lives. Çepni, Ülge and Ormanci (2017) argue that association in daily life provides for meaningful learning of science concepts. Together *with* the four grade 8 Physical Science teachers, my critical friend and I explored opportunities to mediate learning of chemical and physical changes embedded in the traditional processes of dyeing and weaving.

#### *2.2.2.1 The dyeing process*

A number of processes are involved when dyeing the palm leaves strips used for weaving and decorating the baskets; some can illustrate both chemical and physical change. To dye the palm leaves the strips are either sun-dried or freshly boiled together with dyeing agents. Drying causes the freshly collected palm leaves strips to lose their water content (osmosis); when this happens, they become brittle. Thereafter, the palm leaves strips are dyed with a particular colour. Natural dyes are used instead of artificial dyes. The natural dyes or dyeing agents are extracted from various parts of plants like roots, stems, bark, leaves, fruits and seeds which may contain colouring matter (Vankar, 2000). In recent years, waste materials such as old rusty cans have also been collected and used as dyeing agents. For instance, the old rusty cans are collected, soaked together with the palm leaves strips to be dyed, for three or four days. After three or four days, the palm leaves strips turn grey from nature green (for fresh palm leaves strips) or from creamy white (dried palm leaf strips) to charcoal. After treating the palm leaves strips with the different natural dyes they permanently turn dark brown, pink, charcoal, yellow and black (see Table 2.2 below).

**Table 2.2: Dyeing agents for the Makalani palm leaves**

| Dyes used/ Dyeing agents | Plant name (where available) | Latin name (where available) | Colour |
|---|---|---|---|
| *Muzinzila* | Bird plum | *Berchemia discolour* | Deep red brown |
| *Makapa (rusty tin)* | - | - | Charcoal |
| *Mabele/Mahera* | Sorghum | *Sorghum bicolour* | Salmon pink |
| *Mukokoshi* | Na | *Diospyrus chamaeth* | Yellow |
| *Muhatula* | Na | *Indigofera cinctoria* | Lilac |
| *Litati (Icheka)* | N/A | *Aloe zebrina* | Lemon yellow |
| *Mutakula* | Magic guarrie bush | *Euclea divinorum* | Olive brown |
| *Musweti* | Blue bush | *Diospyrus lyciodes* | Mustard |
| *Muzauli* | False mopane | *Guibourtia coleosperma* | Bark = beige; leaves =charcoal |
| *Muhonono* | - | - | Deep black |

Source: Suich and Murphy (2002, p. 14)

Heat is also involved in the dyeing process. For instance, the dried palm leaves or fresh palm leaves strips are boiled with a specific dyeing agent depending on the desired colour. Boiling the palm leaves in the dyes helps to speed up the dyeing process.

During the process of dyeing, changes in the chemical and physical composition of the palm leaves strips takes place. For instance, when the midribs are removed during the splitting of the palm leaves strips, the strips are made thinner by splitting them further (change in physical properties). Though this may be difficult or confusing to classify as physical change since it cannot be reversed, learners will have an opportunity to visualise that the splitting process only affected the physical properties of the palm leaves strips, as the chemical properties have not changed. Looking at the whole process of dyeing we may learn that it also illustrates the procedures and processes for conducting a scientific experiment. The dyeing process provides an opportunity for one to look at the reactants and how they are affected, at the end of the dyeing process (products).

#### *2.2.2.2 The weaving process*

In this section I discuss a few processes involved in weaving that illustrate or can be used to help learners observe or visualise physical changes. To illustrate that a physical change can be easily reversed, we look at how the size of the coil is maintained while weaving. Weaving uses a coil technique and during weaving, the weaving grass is continuously fed or added to a coil to maintain its size. As the weaver is weaving, the size of the coil decreases. To maintain the right size, a few straws of weaving grass are cautiously and gradually added and woven. If by mistake, more or a fewer straws of weaving grass are woven the coil size will be bigger or too small. In this case the coil can be unwoven and the size of the coil is adjusted removing some straws (coil is bigger) or by adding some straws of weaving grass (coil is too small). These observed changes during weaving may be used to illustrate the course of physical changes.

Other processes that could illustrate a physical change during weaving involves the symbols or embroidery of geometric patterns that are woven into the baskets. Using the dyed strips of palm leaves, the decorations can be changed as desired by the weaver during the weaving process. For instance, if a weaver detects a mistake or an omission in terms of her pattern she will just undo the unwanted coil. Moreover, the shape and size of the basket is determined by its use or purpose. For example, we have flat plate shapes mostly for winnowing and the large bowl-shaped baskets are for carrying things during harvest times, collecting and transporting food and possessions (Suich & Murphy, 2002). A weaver can, therefore, change a flat plate-shaped basket to a bowl-shaped basket by simply increasing the number of coils on it.

During the weaving process, the weaver soaks the palm leaves strips in water which could be used to illustrate physical changes. For instance, the dried palm leaves are brittle and cannot be used to weave, but when soaked in water the palm leaves strips becomes soft and flexible as they absorb more water. The flexibility attained is not permanent and can be easily lost by drying the soaked palm leaves strips in the sun. The finding of this study has a wider application in education across the African continent. Statistics show that most baskets produced in Namibia are found in the Zambezi and Kavango (both east and west) regions and the four regions of former Owamboland, and fewer baskets from the Kunene Region (Terry, Lee, & Le Roux, 1994). It is also recognised that the traditional knowledge of basket-making goes beyond the regional boundaries of Namibia to the vast territories of the African continent (Gerdes, 2007).

#### *2.2.2.3 The supply of raw materials*

Paxton (2018) shows that there is increased stress on natural resources such as trees *(Berchemia)*, the *Makalani* palm and weaving grass, and these resources are declining. These changes to the local environment due to human impact may be temporary or permanent, and learners may be allowed to debate these changes in their classrooms. If the raw materials are harvested in an unsustainable manner, these natural resources may fail to rejuvenate. According to Paxton (2018), the excessive use of *Berchemia (Munzinzila)* bark as a dye resource damages the trees. When fresh bark is continuously cut or removed from the tree, it causes the tree to dry up and die. Consequently, this has made it more difficult to access these raw materials. The loss of access to raw materials comes at a cost - people are forced to walk longer distances and deeper into the bush to find suitable *Munzinzila* trees with good quality bark. The palms and weaving grasses costs have increased too; young men and non-weavers collect and sell the palm leaves and other plant extracts used for dyes to weavers, who cannot walk longer distances.

Previously accepted traditional ways of harvesting the raw materials are changing as weavers and non-weavers involved in harvesting these resources have received training in sustainable methods of harvesting. Instead of cutting the fresh bark, for instance, weavers are encouraged to only collect the dead bark from the *Munzinzila* tree. With the harvesting of the palm leaves, knives are used to cut the frond only, instead of cutting out the heart of the palm tree with a hoe or panga. To assist the weavers and protect the natural resources in the Kavango East region of Namibia, the Omba Arts Trust and weavers have embarked upon an initiative to establish homestead gardens since 1994. According to Paxton (2018), the homestead gardens are proving to be successful regarding the germination and growth of the *Makalani* palm, the *Berchemia* and other useful trees that were planted. Their success story shows that from November 1994 to December 2015, a total of 2,650 palms and 460 other trees (mainly species used for dyes) were planted in a total of 24 palm gardens (Paxton, 2018). A number of learners may be involved in harvesting these raw materials used as dyeing agents or material for weaving. When reference is made to this knowledge learners might be more interested in the lesson. I now discuss the relation of this knowledge to prior knowledge.

### 2.3 Indigenous knowledge and learners' prior knowledge

Kibirige and Van Rooyen (2006) define indigenous knowledge as 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, Mkabela (2015) explains IK as unique local knowledge existing within and developed in a particular geographical area, possessed by people in a given cultural framework. This knowledge is gained by people from birth as they live and work in their communities (Nyika, 2017). According to Seehawer (2018), having been developed locally for the people and by the people of that locality, IK has been passed on from parents to their children. The elders of the community are the custodians of the IK, which is manifested through different aspects of life, such as: cultural norms/customs, cultural beliefs, values, songs, languages, technologies, artifacts, games, food, rituals and ceremonies. (Klein, 2011; Magwentshu, 2020; Nyika, 2017; Seehawer, 2018). Furthermore, Kibirige and Van Rooyen (2006) and Mkabela (2015) identify IK as unique knowledge which would be foreign and alienating to non-indigenous learners if used in school science. Indigenous learners acquire IK from birth through to adulthood (Nyika, 2017).

IK scholars are concerned that indigenous knowledge is becoming unpopular, devalued, and in danger of being lost (Aikenhead & Jegede, 1999; Baquete, Grayson, & Mutimucuio, 2016; Das Gupta, 2011; Msuya, 2007; Shizha, 2013). From an educational perspective, instead of promoting IK, curriculum designers in most African countries have accorded western epistemologies superior status in our education. As a result, school science is decontextualised since the concepts and content are based in a western context. In so doing, school science has been inaccessible to indigenous learners due to its abstractness and contexts unfamiliar to the learners. According to Baquete et al. (2016, p. 2), "scientific knowledge is a cultural artefact of ‘western’ culture, where ‘western’ refers to Eurocentric, and includes countries outside Europe where the dominant cultural identity is derived from Europe”.

Das Gupta (2011) found that indigenous knowledge is well-suited to addressing specific learners’ needs in local contexts using locally available resources. In support of this position, Baquete et al. (2016) advocate that incorporating indigenous knowledge into school curricula could have a positive effect on learners’ interest in science, and at the same time help the learners to value and keep alive the knowledge of their parents and grandparents. There are two major reasons for using everyday contexts in science teaching; in the first place, everyday contexts are used to improve learners’ learning and, secondly, everyday contexts are used for curriculum appropriateness (Kasanda et al., 2005). In the case of this study, the indigenous technology of dyeing and weaving African baskets as an example of everyday context or IK, was used to improve a learner’s conceptual understanding of chemical and physical changes.

It appears that prior knowledge has been limited to learners’ formal learning experiences such as exposure to curricula or previous grade knowledge. Little has been done to promote indigenous knowledge as a special case of prior knowledge. Because of the weak link between learners’ indigenous knowledge and prior knowledge, learners’ everyday knowledge has been under-utilised as prior knowledge. Similary, Kuhlane (2011) and Hashondili (2020) show that prior everyday knowledge could be in the form of learners’ local knowledge or knowledge acquired from home or from the community.

A number of scholars have revealed the significance of eliciting learners’ prior knowledge before introducing or teaching new information. For instance, Ozmen (2004) posits that eliciting learners’ prior knowledge helps to reveal their difficulties and misconceptions prior to, during, or after the instruction. Further, Ozmen claims that learners have pre-existing conceptions about scientific phenomena which can interfere positively or negatively with the learning of correct scientific principles. A similar position is maintained by Roschelle (1995) who asserts that the knowledge and experiences the learners bring to class, are important factors that need the teacher’s consideration while designing teaching instruction. Sedlacek and Sedova (2017) similarly believe that teaching that builds on learners’ prior knowledge motivates learners to actively participate in classroom activities. A number of scholars believe that eliciting learners’ prior knowledge assists learners in refining their everyday experiences or conceptions to fit with the desired classroom instructions (Mawere, 2015; Stein, Larrabee,

& Barman, 2008; Tobin, Rennie, & Frazer, 1990). In this vein, Tobin et al. (1990, p. 3) recommend that for meaningful acquisition of new knowledge the prior knowledge should be "elaborated and changed based on fresh meanings negotiated with peers and the teacher".

Cepni, Ulger, and Ormanci's (2017) position is that during teaching and learning, examples given from everyday life are more concrete and increase the permanence of information. For instance, in their study conducted in South Africa, Mavhunga and Kibirige (2018) found that integrating learners' everyday knowledge of swings in the playgrounds made it easier for learners to understand the concepts related to the pendulum. Indigenous knowledge is not explicit in most cases. The use of concepts such as everyday life, experiences from home, knowledge from the local environment should be regarded as synonyms with indigenous knowledge. This is why this study positioned learners' prior knowledge as indigenous knowledge and explored how such knowledge can be integrated in science teaching. Though the topic, chemical and physical changes, is not taught in the junior and senior primary phases, the researcher does not in any way suggest that the grade 8 learners have no relevant experiences of these chemical and physical changes from home.

### 2.4 The need for the integration of IK into school science

The driving force behind the integration of indigenous knowledge into science teaching in recent decades is the Ubuntu philosophy. According to Venter (2004), Ubuntu is a concrete manifestation of the interconnectedness of human beings; the embodiment of the African culture and lifestyle. This expression means that each individual's humanity (I) is ideally expressed in relationship with others (we) so as to truly express the (I) (Oviawe, 2016).

Literature has revealed that the science taught in African science lessons is typically western and as a result, the values and cultures of Africans are not considered and remain neglected (Mavuru & Ramnarain, 2017; Mukwambo et al., 2014). Admittedly, it should be borne in mind that learning school science in an unfamiliar context in most cases creates cognitive dissonance between the learners' home experiences and the new classroom knowledge (Aikenhead, 1996; Le Grange, 2007). As a result of this dissonance, indigenous learners have experienced science as a difficult subject and have lost interest in learning it (Kroma, 1995). Based on empirical evidence from their studies, scholars in IK have reiterated the call for the integration of indigenous knowledge into school science to make it relevant and accessible to indigenous learners (Aikenhead & Jegede, 1999; Mukwambo et al., 2014; Seehawer, 2018; Shizha, 2013).

### 2.4.1 The need for the integration of IK in science lessons

Many scholars have shown concern with regard to the contexts in which school science is taught. These scholars cite that school science is decontextualised (Aikenhead & Jegede, 1999; Hashondili, 2020; Mavuru & Ramnarain, 2017; Mukwambo et al., 2014). Since learners experience school science as 'foreign', they seem to experience cognitive conflict between school instruction and the experiences learned at home (Le Grange, 2007). In view of this, IK integration can possibly contextualise school science, providing the much needed familiar context. Baquete et al. (2016) support this argument, stating 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 helping the younger generation to recognise its value" (p. 1). Weiland (2015) maintains that learning is enhanced when it occurs in contexts that are culturally, linguistically and cognitively meaningful. Furthermore, when familiar contexts are used, learners are likely to be motivated to participate in new subject matter presented to them, as they can easily identify with it (Aikenhead & Jegede, 1999; Mhakure & Otulaja, 2017; Sedlacek & Sedova, 2017). Culturally sensitive curricula and teaching methods reduce the foreignness of science content and make science concepts accessible to learners (Mukwambo, et al., 2014; Taylor & Cameron, 2016). In their study, Kibirige and Van Rooyen (2006) found that science teaching is enriched when IK is used as prior knowledge in the classrooms.

Moreover, indigenous knowledge and resources are easily available at little to no cost (Asheela, 2017; Nikodemus; 2017; Shinana, 2019; Liveve; 2017) and may be used instead of laboratory chemicals and equipment that are often unavailable and expensive for most schools especially, rural schools such as my school. Additionally, IK has the potential to provide real life experiences to the learners, a cultural tool to facilitate learners' access to real science (Rosales & Sulaiman, 2016; Seehawer, 2018; Vygotsky, 1978). Learners bring experiences of IK to class, which should then be used by teachers as a foundation for new knowledge or instructions (Mavuru & Ramnarain, 2017; Nyika, 2017).

The popularity of IK in science lessons in Namibia can only be enhanced if science teachers begin to integrate it. Mukwambo et al. (2014) posit that integrating IK in science lessons will result in more examples of indigenous knowledge practices used in the classroom. With more examples of IK used in school science, it might be easier to document some of the indigenous knowledge practices for new generations of teachers. Moreover, valuing IK in school might lead to an increase in parental and community members' involvement in school matters (Hashondili, 2020; Klein, 2011; Mateus & Ngcoza, 2019). In this regard, a study conducted by Klein (2011) in Namibia revealed that when parents frequently interact with teachers, the parent-teacher relation is likely to be strengthened. Klein (2011) further observed an improvement in learners' discipline when parents regularly visit the school to support teachers. Given these benefits, one may wonder why so little has been done to make use of this knowledge resource in school science. In the next section, I discuss some of the challenges faced by educators in IK integration.

### 2.4.2 Challenges encountered by teachers in integrating IK in science teaching

Although the official curriculum statement in the national curriculum for Basic Education (Namibia. MEAC, 2016) calls for teachers to integrate IK in their teaching, there is no formal framework for either beginner or experienced teachers for how the integration should be done. Thus, IK integration has been left to the teachers' discretion with an option either to integrate it or not. Another challenge is that local knowledge or IK is implicit in curriculum documents; it is not clearly stated for teachers to know exactly what it is and how they can approach it.

In light of this, Seehawer's (2018) study revealed a number of challenges with regard to IK integration in science; among these challenges are:

- Teachers themselves do not have IK, or they do not have the right IK;
- Teachers' training institutions do not prepare teachers for integration of IK; and
- Curriculum rigidity - teachers only teach to prepare learners for tests and examinations (examinations do not include IK).

It appears that modernisation has overshadowed our indigenous ways of life. As a result the youth have no time to learn about their culture; they are overwhelmed by the technology of social media such as WhatsApp, Facebook, Twitter and other amusement. Nonetheless, Mkabela (2015, p. 285), believes that "although people from rural communities may live in urban suburbs they take their IK along with them". It is recognised, however, that young people who became teachers at the time when they were living in urban areas may greatly lack IK in terms of its practices. The only way this young generation of teachers can acquire IK is from their teacher training institutions.

Another challenge highlighted by Nikodemus (2017), is that Namibian classrooms are culturally diverse. As a result, he faced tough questions from his research participants regarding whose IK is to be included in the class. As a counter argument to this finding, instead of viewing cultural diversity as a challenge, Seehawer (2018) recommends that science teachers should take their learners to a place where they can learn about an indigenous practice, or invite expert community members to school to share their knowledge with the rest of the class (Mayana, 2020; Nikodemus, 2017). In support, scholars such as Khupe (2014) and Seehawer (2018) believe that allowing learners to discuss indigenous knowledge practices as practised in their family and community can enrich lessons with multiple perspectives. It is against this caveat, that in this study the cultural practice of dyeing and weaving baskets provided opportunities for participants to learn the different names of dyeing materials as well as patterns and design techniques of weaving, as practised in their different communities.

Another significant challenge to IK integration could be due in part to the fact that African languages seem to be neglected and the argument is that science concepts and terminologies are yet to be developed in these languages (Mukwambo et al., 2014; Wolff, 2018). Msimanga and Lelliot (2014), Mavuru and Ramnarain (2017), and Nhase (2019) affirm in their studies that learners' home language facilitates their understanding of science concepts. However, they admit that teaching a science concept in a home language (other than English) is a challenging task because teachers have a limited vocabulary in African languages for scientific concepts. The greatest challenge in this case is that learners may grasp the concept being taught in their local language, but may find it difficult to apply the required scientific concepts. According to Mashegoane (2017), the absence of certain science terminologies in indigenous languages poses a challenge not only to learners, but to teachers as well.

### 2.4.3 Criticism of the integration of IK in the science curriculum

The proponents of IK integration in science lessons have cautioned against romanticising IK as the solution to the teaching of science (Keane, Khupe, & Muza, 2016; Mhakure & Otulaja, 2017; Ogunniyi, 2007a). These scholars underscore that not everything labelled indigenous knowledge is valuable and suitable for use in science lessons, highlighting the 'myths' and unscientific beliefs associated with IK.

For instance, Hodson (2009) acknowledges the benefits and value of indigenous knowledge while maintaining at the same time that IK works well in contexts in which it was developed. Thus it should not be valued on its own merits and cannot be accorded the status of science. Furthermore, Hodson (2009) argues that IK cannot be science on the basis that well-meaning people say it is science; to be classified as science it must meet the criteria for judging whether it is science or not. A good example in this regard is spirituality.

Some IK scholars regard African spirituality as a central aspect of IK (Breidlid, 2013; Msimanga & Shiza, 2014). This is why some scientists have refused to acknowledge indigenous knowledge as 'science' (Snively & Corsiglia, 2001). The spiritual aspect of IK has potentially cast a shadow of doubt over the recognition and integration of IK in science teaching (Cobern & Loving, 2001). This was also confirmed by Kibirige and Van Rooyen (2006), saying the spiritual aspect makes IK incompatible with science. Scientific knowledge can be tested using scientific equipment, but the spiritual aspect of IK cannot be tested, because it is not physical. This is why teachers should take great care when handling learners' IK in their classrooms as they possess both scientific and non-scientific knowledge experiences. However, IK scholars seem to hold different views with regard to spirituality. Otulaja, Cameron and Msimanga (2011, p. 698), for instance, suggest that "only some aspects of IK are spiritual and the rest has to do with the science of day to day experiences".

Though acknowledging some of the benefits of IK in mediating the learning of science concepts, critics such as Cobern and Loving (2001) propose a separatist approach to IK recognition and integration into science teaching. They maintain that it would be better if IK were to stand on its own and not be integrated into school science as it will still be dominated by western science as it is. Snively and Corsiglia (2001) do not agree with this view arguing that "indigenous science offers important science knowledge that western modern science (school science) has not yet learned to produce" (p. 82). Le Grange (2007) proposes a complementary approach, showing that IK and school science should not be seen as competing perspectives, but should be viewed as complementary; they can both exist without the one displacing the other.

In light of this, Taylor and Cameron (2016) further identify three perspectives to relate the relationship between school science and indigenous knowledge system (IKS): "inclusive, exclusive and intersecting perspective" (p. 36). In contrast to Cobern and Loving's (2001) separatist or exclusive stance of science and IK, I support the intersecting perspective and used this to underpin this study. Figure 2.1 below shows Taylor and Cameron's (2016) three perspectives framework.

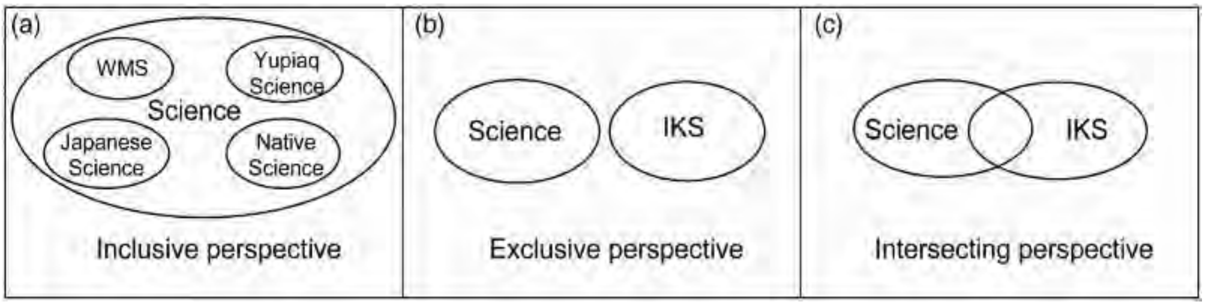


**Figure 2.1: Three perspectives of the relationship between science and IKS (adapted from Taylor & Cameron, 2016, p. 36)**

I opted to frame this study in the intersecting perspective because it does not advocate that we replace school science with IK in our curriculum. Instead, it advocates for the utilisation of the intersection between IK and school science. Correspondingly, Mukwambo et al. (2014) affirm the existence of a dialectical relationship between IK and school science. They highlight that IK is embedded in school science. IK also serves as a bridge in classroom discourses to reduce the foreignness of school science concepts and content (Aikenhead & Jegede, 1999; Ogunniyi & Hewson, 2008). However, the intersection perspective requires science teachers to be well acquainted with learners' IK. For this reason, I thought it appropriate in this study first to expose the grade 8 Physical Science teachers to the indigenous technology of dyeing and weaving African baskets before introducing an element of professional development.

### 2.5 Teachers' Continuing Professional Development in Namibia

Teacher education and continuing professional development in Namibia are areas that need greater attention to prepare teachers to embrace IK in their lessons as required by the curriculum. Little seems to have been done in preparation of both pre-service and in-service teachers to embrace an indigenised science curriculum, apart from the curriculum statement of intent in (Namibia. MEAC, 2016). For instance, a greater number of teachers continue graduating from our institutions of higher learning without being explicitly exposed to the ideas of IK as a resource and how it could be used to enhance the teaching and learning in their classes. Fernandez's (2015) suggestion that central teacher development should be an explicit goal of teacher training courses provides a vehicle for exposure to the integration of IK into the curriculum. Since teacher training institutions seem not to adequately prepare pre-service teachers for teachers' continuing professional development (or staff development) remains the only option through which teachers can be assisted to improve on their teaching practice as reiterated by Eun (2008).

According to the University of Namibia's Continuing Professional Development (CPD) Unit (2013. p. 4), CPD is "a process by which educators engage in on-going learning beyond their initial university education, aimed at equipping in-service teachers with knowledge and skills relevant to the new challenges in the classrooms". Similarly, Mehta (2019) explains teachers' CPD as a process of training and developing the teachers' professional knowledge and skills through independent interactive learning. To Ngcoza and Southwood (2015), continuing professional development is an ongoing programme of capacity and knowledge building for in-service teachers.

The element of teachers' CPD in this study was achieved by engaging the participating Physical Science teachers through a series of workshop discussions, learning from curriculum documents as well as from presentations by the expert community members. The workshops were aimed at exposing the participant teachers to the use of indigenous knowledge as a vehicle for mediating learning of scientific concepts in their science lessons. Supporting this intervention, Shabani (2016) suggests that CPD for teachers should include a comprehensive range of focused training where professional learning is expected. It was one of the chief goals of this study that through the planned workshops, the pedagogical content knowledge (PCK) of the four Physical Science teachers (Mavhunga & Rollnick, 2013; Shulman, 1986) be influenced in terms of IK integration in science lessons.

Moreover, Eun (2008) recommends workshop discussions as appropriate and effective learning spaces for teachers to interact with each other. The workshop discussions in the study afforded the Physical Science teachers an opportunity to reflect retroductively on their teaching approach. Teachers have been neglecting the learners' cultural capital, the everyday life experiences they bring to school. Further, opportunities for development were created, for instance the presentations by the expert community member was aimed at enabling the teacher to plan lessons for future teaching.

The interactions that took place in the workshops were intentional and deliberate to promote collaborations among these professional learners. According to Katz and Earl (2010), capacity building depends on intentionally fostering and developing the opportunities for members to examine their existing beliefs and to challenge what they do against new ideas, new knowledge, new skills, and even new dispositions. Most importantly, the teachers critically interrogate their teaching practice through reflections and collaboratively learnt from one another (Chauraya & Brodie, 2018). During the workshop, the teachers explored how to select indigenous knowledge practices that best fit classroom science. These are also known as culturally responsive teaching strategies (Mhakure & Otulaja, 2017; Naidoo & Vithal, 2014). Since elders are custodians of the cultural heritage and wisdom, they have an important role to play in making teaching and learning culturally responsive.

### 2.6 Indigenous Elders

Learners' parents and community members have been regarded as sources of funds as well as problem solvers when there are disciplinary issues in the school. In this regard, the call to integrate IK enables indigenous elders to be the custodians of IK new roles (the more knowledgeable others). That is, indigenous elders can play a 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 were not for the Ubuntu of the expert community member who agreed voluntarily to share her cultural heritage and wisdom on dyeing and weaving baskets. 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 (ILP). ILP calls for the active involvement of indigenous elders who are the custodians of IK and speakers of indigenous languages in education. This concept resonates with Klein's (2011) study affirming that elderly people could be resources for every teacher in the school if they were to be actively involved in school activities. The expert basket weaver was so excited to have an opportunity to share her knowledge with us. This study has revealed that we can either invite these elderly people to school or visit them wherever they are located.

Apart from providing opportunities to mediate learning of chemical and physical changes, African basketry does offer opportunities for the integration of cross-curriculum themes of environmental sustainability. Environmental sustainability calls for the utilisation of natural resources such that the resources are not depleted. This is why Dei (2000) posits that indigenous knowledge holds significant possibilities for social and ecological sustainability because "ecological unity focuses on the responsible use of land and natural resources according to the principles of sustainability" (p. 79).

In this study, the expert basket weavers shared their knowledge of environmental sustainability; these weavers have been taught how to cut and dye materials in a way that causes the least damage to the environment. Without the knowledge of environmental sustainability, the palm and dye plants, especially the palm population, could already have been depleted, while the *Munzinzila* trees could be extinct. In this regard, the women have been taught to use a sharp knife, to only cut the bottom of the new palm frond and to leave some new leaves behind. When collecting dyes, women are taught to cut small strips of bark from different places on the tree trunk (Suich & Murphy, 2002) to prevent damage to the trees as they can dry out. In the next section I discuss the theoretical and analytical framework informing this study.

### 2.7 Theoretical and Analytical Frameworks

In my pursuit of an appropriate theoretical and analytical framework two complementary theories emerged: Vygotsky's (1978) socio-cultural theory (learning theory) and Shulman's (1986) theory of Pedagogical Content Knowledge (PCK). Vygotsky's (1978) socio-cultural theory was used as a theoretical framework. Within Shulman's (1986) PCK, I drew on the seminal work of Mavhunga and Rollnick (2013), with a focus on the five topic specific pedagogical content knowledge (TSPCK) components as my analytical framework. I now discuss each of these below.

#### 2.7.1 Theoretical framework: Socio-cultural theory

Vygotsky's socio-cultural theory is a learning theory that explains the link between learning and human development (Vygotsky, 1978). The theory also enables opportunities for investigation of how teachers mediate learning. Vygotsky (1978) argued that learning takes place on two levels. First on the social level which is between humans (interpsychological) and later, on the individual level, inside the learner (intrapsychological). In support, McRobbie and Tobin (1997) assert that at the social level, meaning is constructed by individuals only when new information interacts with their existing knowledge. Thus meaning-making from new information is negotiated and achieved through integration of that new information with existing (prior) knowledge. Rojas-Drummond, Torreblanca, Pedraza, Vélez, and Guzmán

(2013) also advance in their study that learning and development are realised through interactions between teachers (the more knowledgeable others; in the case of this study, the two expert basket weavers) and learners who were less knowledgeable (the grade 8 Physical Science teachers in terms of IK). Socio-cultural perspectives on learning and development are a cultural accomplishment, connected to the particular collections of relationships and practices (Tzou, Meixi, Suárez, Bell, LaBonte, Starks, & Bang, 2019). Learning or habit formation is completely blended and inseparable from the process of human development, as evidenced in this study.

The cultural practice of dyeing and weaving African baskets was purposively used as a mediational cultural tool to mediate the learning of scientific concepts of chemical and physical changes. The study allowed space for interactions between the expert community member (the more knowledgeable) and the four Physical Science teachers, my critical friend and I (learners). Within Vygotsky's socio-cultural theory, I focused on three concepts, namely, *mediation of learning*, *social interactions* and the *zone of proximal development* (ZPD)

#### *2.7.1.1 Mediation of learning*

Mediation encompasses the use of cultural tools such as language and materials to achieve the learning goal (Vygotsky, 1978). Vygotsky (1978) further explains mediation as a link between teachers and learners that directly affects learners' understanding of knowledge and skills in science. Building on Vygotsky's seminal work on mediation, Kozulin (2004) indicates that mediation involves the interactions between the teacher, subject content and learners for the acquisition of knowledge. Mediatory tools can be material tools, a system of symbols, cultural artifacts, or humans within a social environment (Vygotsky, 1978). Mediational tools serve the purpose of conveying or transmitting the abstract concept to the concrete level. Figure 2.2 shows a diagrammatical representation of the Vygotskian mediation triad linking.

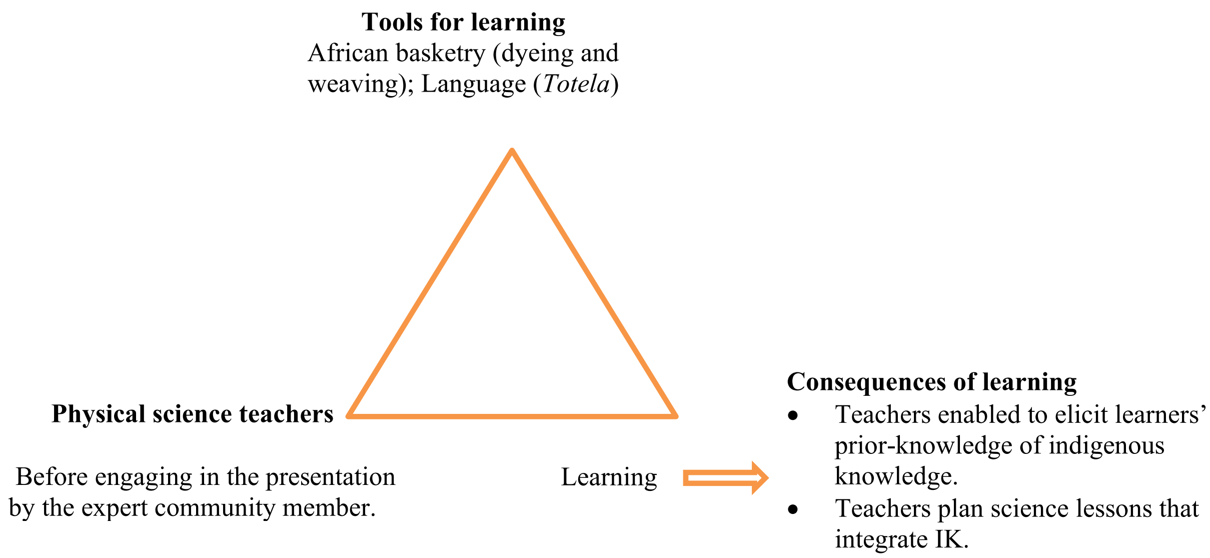


**Figure 2.2: Mediation triad linking adopted from Vygotsky (1978, p. 54)**

In this study, the concept of mediation came into play during the presentation on dyeing and weaving processes by the expert community member, the 'more knowledgeable other' in Vygotskian terms (MKO); two mediatory tools – humans as mediator (the expert community member) and cultural artefacts (African baskets) – were employed in this study. During the practical demonstration, the expert community member used the *Totela* language to mediate learning.

African basketry was purposively chosen as a mediatory tool, to mediate school science concepts related to chemical and physical changes. During the presentation on dyeing and weaving, there was increased social interaction among all the participants as a result of the use of the [6]*Totela* language, which agrees with Sedlacek and Sedova (2017). By using her home language, *Totela,* the expert community member, became confident, to eloquently complete her presentation without struggling for word or a term. Language is an important tool, because without language it would be impossible to socialise and interact. It is regarded as a vital cultural tool through which learning and thinking are shaped (Mika, 2018). During the presentation by the expert community member there was no need for translation because *Totela* is one of the dialects spoken in Zambezi that is understood by more than 95% of the people in Zambezi region of Namibia.

[6] *Totela:* is one of the dialects spoken in the Zambezi Region of Namibia.

#### *2.7.1.2 Social interactions*

The world is a social space where individuals interact with each other and negotiate meaning of their world (Vygotsky, 1978). Tam (2015, p. 35) claims 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". The collegial interactions during the workshops in this study were central to the co-development of model lessons integrating dyeing and weaving of African basketry as an exemplar. In this study, social interactions between the members of the Professional Learning Community (Chauraya & Brodie, 2018) – the four Physical Science teachers, my critical friend and I – were central to this study, as they formed part of my units of analysis for my research question two:

> *RQ 2: During the workshop interactions with the expert community member, what opportunities emerged for the grade 8 Physical Science teachers to bridge the gap between curriculum formulation and implementation of IK?*

#### *2.7.1.3 Zone of Proximal Development*

Vygotsky (1978, p. 86) defines the zone of proximal development (ZPD) as "the distance between the actual developmental 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". Based on this definition, we can say the ZPD is the developmental difference between what the learner already knows and can do independently, and what is to be learned or what learners can do with the help of more knowledgeable others. In relation to teacher development, which is a central theme in this study, the teachers' ZPD is a learning space between their present level of teaching knowledge and their next (potential) level of knowledge, attained with the help of others (Blanton, Carter, & Westbrook, 2001; Shabani, 2010).

In the context of this study, the four grade 8 Physical Science teachers, my critical friend and I were in the role of learners and were engaged within their ZPDs, during the workshops on document analysis, practical demonstration of dyeing and weaving baskets as well as co-development of model lessons integrating African basketry. It was expected that there would be a shift in the teachers' ZPD after their participation in the presentation by the expert community member and through collegial conversations. The premise for capacity building workshops and training according to Vygotsky (1978) is that "what a child can do in collaboration with others today, tomorrow he will do it alone". I purposively chose African basketry as a mediatory tool to influence the Physical Science teachers' perceptions regarding indigenous knowledge integration in science lessons. The Physical Science teachers' ZPD is a measure of their understanding of IK and how it can be integrated into the topic of chemical and physical changes and where they are after participating in the indigenous practice and workshop discussions. For instance, after co-developing a model lesson in this study, the science teachers were able to plan their own science lessons and to continue integrating IK into their future science lessons. The model in Figure 2.3 below (adapted from Shabani, Khatib, & Ebadi (2010, p. 242) shows how the ZPD of teachers were influenced in this study.

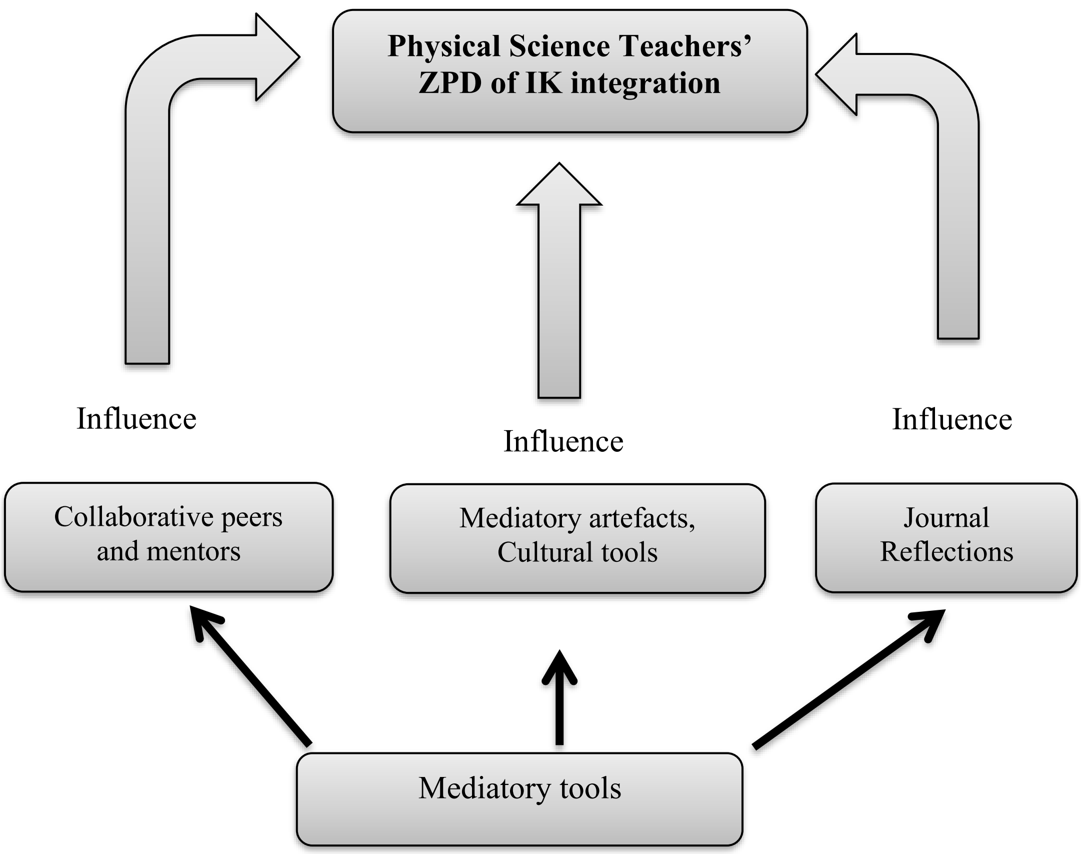


**Figure 2.3: Influential factors in teachers' ZPD (adapted from Shabani et al., 2010, p. 242)**

In this model, Shabani et al. (2010) illustrate that mediatory tools – mentors, artefacts, and journal writing – have an influence on teachers' ZPD, which in turn shapes their teaching approach to specific topics. In this way, the concepts of mediation of learning, social interactions, and the ZPD became central to my analysis of the effectiveness of the indigenous technology of dyeing and weaving baskets, chosen as a mediatory tool. I also realised that the local language (psychological tool) used by the expert community member during her practical (demonstration of dyeing and weaving) enhanced the mediation process. In her study, Mika (2018) explains that without a language, it would be impossible to socialise and interact. As a result, she classifies language as a vital cultural tool for both learning and shaping thoughts. The model of influential factors in teachers' ZPD (Shabani et al., 2010) assisted me to see the connection between Vygotsky's (1978) socio-cultural theory and Mavhunga and Rollnick's (2013) topic specific pedagogical content knowledge appropriateness as analytical theories or frameworks in my study. The theories were used to establish how the grade 8 Physical Science teachers (co-researchers) learned (or not) from the mentors (the expert community member) and from each other (colleagues or peers) during the intervention on how to integrate indigenous knowledge into teach concepts of the science curriculum.

### 2.7.2 Analytical framework: Topic specific pedagogical content knowledge

Shulman's (1986) Pedagogical Content Knowledge (PCK) is a teaching framework focused on how teachers transform the subject matter knowledge into teachable units of knowledge accessible to the diverse interest of the learners. Shulman (1986) identifies seven knowledge bases which teachers ought to have, in order to teach effectively and successfully. These are: (i) content knowledge; (ii) general pedagogical knowledge; (iii) curriculum knowledge; (iv) pedagogical content knowledge; (v) knowledge of learners and their characteristics; (vi) knowledge of educational contexts; and (vii) knowledge of educational ends, purposes and values (Shulman, 1986). The concept represents the knowledge base that teachers use in the teaching process (Kind, 2009). In support, Mothwa (2011) explains that PCK focuses on the knowledge of what method or teaching strategy would be most suitable to ensure learners understand a certain topic

Building on Shulman's seminal work, Shing, Saat, and Loke (2015) define PCK as the integration of pedagogy and content which covers the 'what' and 'how' of teaching. This implies that in order to teach, teachers should be skillful enough to blend together the content knowledge, instructional strategies and student knowledge in order to teach (Shing, et al., 2015). Some scholars have leveled a number of criticisms against PCK as a theory, among them Kind (2009), who says Shulman's (1986) PCK lacks a theoretical background. She maintains, though, that PCK is a useful construct in education to elevate teaching to the professional status. Finding out exactly what it comprises and using this knowledge to support good practice in teacher education is not easy. She further contends that PCK is not yet an explicit tool to be used by teachers (Kind, 2009). Another critique is that when we define PCK as an instructional strategy, it lessens the influence of other mediating factors in teaching and learning (Bromme, 1995). In addition, Kind (2009) maintains that PCK is regarded as being difficult to measure because it is tacit in nature and not easy to document.

PCK differs from topic to topic (Mavhunga & Rollnick, 2013). In other words, different teaching strategies are required for different topics. In the case of this study, I focused on PCK within the topic of chemical and physical changes in Grade 8 Physical Science. To implement this, I adopted Mavhunga and Rollnick's (2013) Topic Specific Pedagogical Knowledge (TSPCK) analytical framework. Shown in Figure 2.4, there are the five aspects to TSPCK developed by Mavhunga and Rollnick (2013, p. 115).

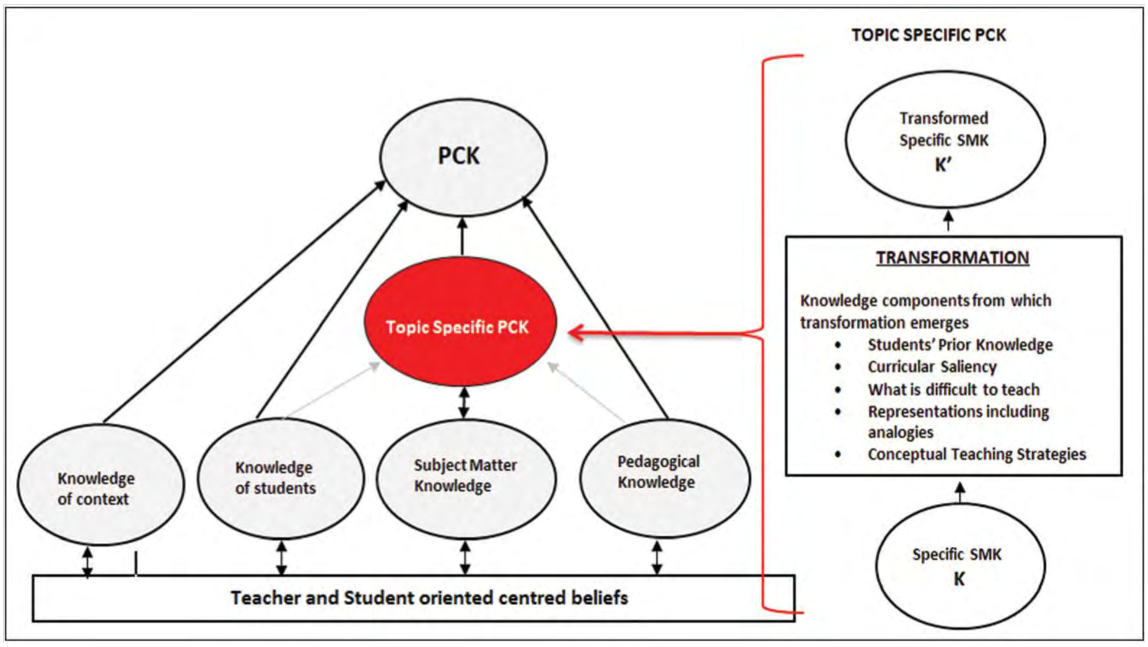


**Figure 2.4: Model for Topic-Specific PCK (Adapted from Mavhunga & Rollnick, 2013, p. 115)**

On the right hand side of the model (Figure 2.4) are the five knowledge components: students' prior knowledge, curricular saliency, what is difficult to teach, representations including analogies, and conceptual teaching strategies (Mavhunga & Rollnick, 2013). All five components were used to analyse data gathered during the semi-structured interviews, workshop discussions and data from co-analysing of curriculum documents as well as the co-development of an exemplar lesson integrating IK. Below I discuss each component and how it was used in this study.

**(i) Learners' prior knowledge**

According to Mavhunga and Rollnick (2013), this component emphasises a teacher's ability to elicit learners' prior learning experiences. Teachers are required to have specialised skills and knowledge of dealing with learners' preconceptions and misconceptions (Mavhunga et al., 2013). In this study, the semi-structured interviews captured qualitative data on how the grade 8 Physical Science teachers (co-researchers) elicit and make use of their learners' prior knowledge, especially of indigenous knowledge. Furthermore, this component was used to analyse the teachers' perspectives, understanding and pedagogical insights into the integration of IK into science lessons.

**(ii) Curriculum saliency**

To Mavhunga and Rollnick (2013), curriculum saliency is about teachers' awareness of major concepts around a topic which learners need to understand, without which, understanding of such a topic would be difficult for learners. To promote awareness Shinana ( 2019) and Magwentshu (2020) suggest that before a new topic is presented to the learners, the pre-requisite concept should be learned or elicited. In this study, curriculum saliency was used to analyse qualitative data pertaining to research question one:

> *RQ 1: Based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation?*

**(iii) What is difficult to teach?**

In this component, the emphasis is on how the teachers deal with those concepts that are difficult for the learners to understand (Mavhunga & Rollnick, 2013). What is the teacher's knowledge of his or her learners' learning difficulties in specific topic, including identification of misconceptions? In the case of this study, mediating learning of chemical and physical changes has been difficult for many science teachers, as revealed in the context of this study.

This component was used to critically analyse the teachers' responses in the semi structured interviews.

**(iv) Representations and (v) Conceptual teaching strategies**

According to Mavhunga and Rollnick (2013), these two components are concerned with how the learning content should be presented, such that it gives meaning to the learners. With these knowledge bases, teachers are able to select teaching and learning aids to mediate learning of science concepts in a manner that would enhance deep learning. One advantage of representation is that learners themselves can easily attach meaning of the content being taught (Shinana, 2019). Mavhunga and Rollnick (2013) refer to these forms of representations as mediatory tools which can be in the form of models, simulations, or cultural artefacts, which are used to ease learners' understanding of school science concepts. In the case of this study, African basketry (dyeing and weaving) was purposively chosen for its ability to offer learners an opportunity to visualise chemical and physical changes. The components of representation and conceptual teaching strategies were used to analyse data in order to answer research questions two and three, which are:

> RQ 2*: During the workshop interactions with the expert community member, what opportunities emerged for the grade 8 Physical Science teachers to bridge the gap between curriculum formulation and implementation of IK?*
>
> *RQ 3: How can the grade 8 Physical Science teachers be supported in co-developing exemplar lessons on chemical and physical changes that integrate concepts from the indigenous technology of dyeing and weaving of African baskets?*

**2.8 Chapter Summary**

In this chapter, I discussed literature relevant to the integration of IK into a science curriculum. The literature reviewed on chemical and physical changes suggests that this topic has been under-researched. I also reviewed literature around the concept of indigenous knowledge (IK) and its implication for teaching science. Furthermore, I discussed challenges relating to IK integration in science teaching. The chapter ends with a discussion on the 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 mobilise the indigenous technology of dyeing and weaving African baskets to mediate learning of chemical and physical changes in grade 8 Physical science lessons in rural schools in the Zambezi region in Namibia. In the previous chapter, I discussed the literature relevant to chemical and physical changes as well as indigenous knowledge (IK) and its implication in contextualising school science. I also discussed teachers' continuing professional development as well the theoretical and analytical frameworks.

In this chapter, I thus discuss the research methodology underpinning this study. I start by discussing the research paradigm followed by the research design employed in this study. Within the research design, I discuss the research goal, research questions, site, positionality, participants and sampling. Furthermore, I outline the research process showing how the data was gathered and analysed. Lastly, issues of validity and trustworthiness are explained and ethical issues are considered and then discussed. The chapter concludes with a chapter summary.

## 3.2 Research Paradigm

Creswell (2016) explains a research paradigm as a lens through which a researcher discerns worldviews. The lens refers to the researcher's underpinning philosophical belief on ontology, epistemology, as well as axiology. Ontology refers to belief about the nature of reality, while epistemology has to do with the acceptable knowledge, and axiology informs the role of values and ethics in research, data collection, and techniques (Al-Ababneh, 2020). This study explored the nature and reality of integrating indigenous knowledge in school science, amid the ongoing debates regarding the choice between Eurocentric over Afrocentric school science.

Oviawe (2016) holds the view that researchers in Africa need to include alternative paradigms in education that are less positivistic, Eurocentric, and individualistic, as is currently the norm.

In light of this, my study was underpinned by two paradigms, namely, the interpretive and Ubuntu paradigms.

### 3.2.1 Interpretive paradigm

According to Bertram and Christiansen (2015), interpretivists seek to describe and understand human agency, behaviour, attitudes, beliefs, and perceptions. Concurring, Cohen, Manion, and Morrison (2018) explain that interpretive research studies are aimed at providing a rich description of the phenomenon under study as well as providing the answer to the research question. I found this paradigm appropriate in this study that sought to mobilise ways of integrating indigenous knowledge such as African basketry to contextualise science lessons.

The interpretive paradigm was employed in this study as a lens to ascertain the grade 8 Physical Science teachers' pedagogical insights, attitudes, and experiences before and after their engagement in an indigenous technology of dyeing and weaving African basketry. Additionally, the interpretive paradigm was considered relevant because the data generating techniques such as interviews, workshops, observations as well as journal reflections employed in this study, are associated with the interpretive paradigm. However, one of the criticisms of the interpretive paradigm is that it focuses on descriptions at the expense of explanations. To address this limitation, I therefore complemented the interpretive paradigm with the Ubuntu paradigm.

### 3.2.2 Ubuntu paradigm

According to Mkabela (2015), the Ubuntu paradigm focuses on indigenous African cultures and is appropriate as a paradigm underpinning research that seeks explanations and solutions to mitigate problems faced by Africans. This resonates well with the purpose and goal of this study, mobilising an alternative teaching approach (IK integration) to afford the indigenous learners an opportunity to access school science. Scholars like Ali and Shishigu (2020) and Mabingo (2020) accentuate that the philosophical idea of incorporating culturally based knowledge should not only be about the content that learners learn but should be relevant to leaners' everyday life and be fitting to the values of the community in which they live. My intention in this study was not only to describe the teachers' social interactions and experiences during their engagements in the intervention workshops, but also to observe a shift in their zone of proximal development towards valuing IK as espoused by Vygotsky (1978).

The Ubuntu shown by my participants (the expert, my critical friend, and the four Physical Science teachers) during the study was beyond my expectations. I personally felt the true meaning of the expression "I am, because we are" during this study (Oviawe, 2016). The Ubuntu paradigm is contrary to individualism as it holds the view that through collaboration a lot can be accomplished. This paradigm was the underlying force behind bringing in the grade 8 Physical Science teachers to form a community of practice with the expert community member. The learning intervention workshops were opportunities created for active collaboration between the Physical Science teachers, to improve their content knowledge as well as pedagogical skills. The expert community member's willingness, as a "more knowledgeable other" (Vygotsky, 1978), to share her knowledge by facilitating the practical demonstration on dyeing and weaving, is central to her Ubuntu. In the section that follows, I discuss the research design for this study.

### 3.3 Research Design

Bertram and Christiansen (2015) describe a research design as a plan showing exactly how the researcher will systematically collect and analyse the data needed to answer the research questions. Similarly, Cohen et al. (2018) also explain a research design as a plan or a strategy drawn up by a researcher organising the research, such that the research questions are answered based on empirical evidence. A case study was adopted in this study, as discussed in the section bellow.

#### 3.3.1 Case study

Cohen et al. (2018) describe a case study as a detailed phenomenon under close consideration, focused on practice, intervention and interpretation, with the aim of improving a situation. A case study allows a researcher to examine a particular issue in a great deal of depth, rather than looking at multiple instances superficially. Complementing the interpretive and Ubuntu paradigms, a case study was deemed appropriate to seek an in-depth understanding of how IK can be integrated. This study is framed as an exploratory qualitative case study. The case in this study was the four grade 8 Physical Science teachers and my critical friend exploring ways of integrating indigenous knowledge using the indigenous technology of dyeing and weaving of African baskets to mediate learning of chemical and physical changes.

One of the goals of this study was to co-develop an exemplar lesson, so as to integrate such indigenous knowledge. My unit of analysis was based on the social interactions, teachers' participation, and learning incidents throughout the workshops. I also focused on how the practical demonstration on dyeing and weaving processes enabled and/or constrained the teachers' perceptions of IK integration into science, as well their understanding of the concepts of chemical and physical changes. This resonated well with my two complementary theories employed to analyse the data in this study, Vygotsky's (1978) socio-cultural theory and Mavhunga and Rollnick's (2013) TSPCK.

### 3.3.2 Research goal and questions

What a researcher aims to accomplish through a study is always outlined in the goal of the study. The research questions are formulated such that the goal of the study is achieved. Below are my research goal and questions for this study.

#### *3.3.2.1 Research goal*

The main goal of this study was to mobilise the indigenous knowledge practice of dyeing and weaving African baskets with the aim of co-developing an exemplar lesson that would serve to mediate the learning of chemical and physical changes in grade 8 Physical Science lessons. To achieve this goal, the following research questions needed to be addressed:

#### *3.3.2.2 Research questions*

1. Based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation?
2. During the workshop interactions with the expert community member, what opportunities emerged for the grade 8 Physical Science teachers to bridge the gap between curriculum formulation and implementation of IK?
3. How can the grade 8 Physical Science teachers be supported in co-developing exemplar lessons on chemical and physical changes that integrate concepts from the indigenous technology of dyeing and weaving of African baskets?

### 3.3.3 Research site, participants and sampling

The study was carried out in the Zambezi region in Namibia, where four grade 8 Physical Science teachers from three schools in the Katima Mulilo circuit as well as my critical friend and I were participants. One expert community member in African basketry facilitated two practical demonstrations: one on dyeing the palm leaves' strips, and another on weaving African baskets. Due to the nature of the study it was conducted at two different sites according to the demands of the research phases. The study had three phases: phase 1 and 3 were carried out at AKA combined school (pseudonym). Phase 2 was conducted at the expert community member's home village, where she was closer to the supply of raw materials.


**Figure 3.1: Location of the Zambezi region in Namibia**
*(https://en.wikipedia.org/wiki/Zambezi_Region)*

A purposive sampling method of research participants was used in this study (Cohen et al., 2018). The target participants were grade 8 Physical science teachers and who had more than six years teaching experience within Katima Mulilo circuit. They were approached and served with invitation letters to voluntarily participate in my study. Only three responded positively to be co-researchers with me on IK integration. However, in the study there were four Physical Science teachers who eventually participated. After giving permission to conduct my study at AKA combined school the principal of AKA seemed to have persuaded his teachers to participate in this study. As a result, I was approached by the fourth Physical Science teacher, who requested to become a participant, I could not refuse her since she was the only female participant teacher. The sample size of four and a critical friend was more than enough; even if one or two teachers withdrew, two participants would still allow me to generate enough quality data. However, all four teachers were willing to participate, thus I could not refuse them, as this was a learning experience aimed at teachers' continuing professional development. The team consisted of one head of department (Head of Department of Mathematics and Science), a subject head for Physical Science, and two Physical Science teachers.

Initially, I had invited two expert community members to do the presentations. Both basket weavers were sampled purposively as they both had vast knowledge and experience in basketry and had been weaving for more than 35 years. They were also close to the schools at which I was to conduct my study. This was very convenient in terms of transport costs for teachers going to and from the expert community members' homes. However, only one expert community member managed to do the presentations and she was assisted by her granddaughter who was doing grade 7 at the time of the study. The other expert community member could not come because she had lost a family member during the first week of data collection. She informed me that she was going to the village for funeral arrangements. A critical friend was invited (see Appendix E), but was also selected purposively based on the fact that he is knowledgeable about indigenous knowledge. As result, he assumed the role of a co-researcher and willingly participated in all our workshop discussions.

My sample size in this study was somewhat small, but sufficient in terms of data captured. Moreover, the study was not intended to generalise the research findings to the whole region or country. Instead, it was aimed at describing and understanding the grade 8 Physical Science teachers' experiences, perspectives, and pedagogical insights on the integration of indigenous knowledge into science teaching. Additionally, we intended to co-develop exemplar lessons that integrated the local knowledge of dyeing and weaving baskets.

### 3.3.4 Teacher profiles

All four of the grade 8 Physical Science teachers participated in the semi-structured interviews. Instead of using pseudonyms, the teachers preferred to be identified by means of codes. The codes used were T1 to T4 which represent teacher 1 to 4. Table 3.1 shows the teachers' profiles.

**Table 3.1: Teachers' profiles**

| Biographical information | Category | Number of teachers |
|---|---|---|
| Gender | Male | 3 |
| | Female | 1 |
| Teaching experience | 1-10 | 1 |
| | 11-20 | 3 |
| Qualification | BETD | 4 |
| | ACE | 4 |
| Age | 33-38 | 4 |
| Ethnicity | *Totela* | 1 |
| | *Subia* | 1 |
| | *Lozi* | 1 |
| | *Mbalangwe* | 1 |

In terms of teaching experience, all four teachers were fully qualified to teach Physical Science in grade 8. Moreover, all four teachers had a Basic Education Teacher Diploma (BETD) and an Advanced Certificate in Education (ACE). My critical friend holds a PhD in Science Education and his widespread work in IK has been published in different journals. The participants were aged between 32 and 40 years. Ethnically, the group was diverse, representing four different ethnic groups from the Zambezi region of Namibia, Totela, Subia, Lozi, and Mbalangwe. Totela was the language used by the expert community member during her presentation, and there was no need for translation as the language was understood by all four teachers.

### 3.3.5 Researcher positionality

The position of a researcher requires attention in any study as it can negatively affect how observations are conducted as well as how data is interpreted (Thomas, 2013). In this study, I was aware of the challenge of my position and power with respect to the co-researchers. As a master's student at Rhodes University, my participants, especially the four Physical Science teachers, might have thought that I was more knowledgeable, while I was a learner as well. My role in the study alternated; to the Physical Science teachers I was more of an initiator and facilitator, especially in the workshop discussions. During the expert community member's presentations, I positioned myself as a co-learner; a position that allowed me to gain more trust from the participants. In the section that follows, I discuss the research process interwoven within the data generating methods.

### 3.4 Research Process and Data Generating Methods

The research process according to Creswell (2016) is a detailed plan and procedure that the researcher will use to gather data. Three data gathering techniques were employed to generate qualitative data, to answer my three research questions. These were: semi-structured interviews, participatory observation, and journal reflections. These data gathering techniques were employed to collect data within three different phases.

This study was carried out during a very difficult time of the outbreak of the world's deadly SARS-CoV-2 virus. As a result, I had to ensure that the COVID-19 protocols were observed. During the orientation stage, I reminded my participants to put on their face masks. Social distancing of at least 1,5m was maintained. We scanned our body temperature and kept a record of it in a hardcover exercise book. We also sanitised our hands before we proceeded with any activity.

In Phase 1, I conducted two orientation workshops which were not intended to generate data to answer any of my research questions. After the two orientation workshops, I administered the semi-structured interviews, which generated qualitative data to answer my research question one. Phases 2 to 3 were exclusively workshop discussions, and were deemed appropriate in this study for they created space for collegial conversations in a learning spirit (Brodie, 2013; Chauraya & Brodie, 2018; Vygotsky, 1978). Moreover, Sedlacek and Sedova (2017) claim that participation in social interactions in the form of workshops is one way of enhancing learning. This resonates well with Vygotsky's (1978) socio-cultural theory and the TSPCK model (Mavhunga & Rollnick, 2013) adopted as analytical frameworks in this study. I now discuss each phase and how data generating techniques were employed.

### 3.4.1 Phase One

#### *3.4.1.1 Orientation workshops*

Two separate orientation workshops were held in Phase 1. The orientation workshops were aimed at relationship building – relationships between myself, the participant teachers, and expert community member. The orientation workshop with the expert community member occurred at her village some 800 meters from AKA combined school. After ensuring that COVID-19 protocols were met, the expert community member welcomed me and said that I must feel at home. During this meeting I requested the expert community member to sign the consent form for her voluntary participation in the study. I asked her to indicate her most convenient time she would like to do her workshop presentation to the teachers. I discussed with her regarding her primary task in the study and during our discussion she realised she had a shortage of one of the dyeing agents. After attending the teacher's orientation workshop, we went to collect this dyeing agent together with one teacher who located a nearby *Munzinzila* tree where the dye is obtained.

The second orientation workshop was held with the teachers. During this orientation workshop I invited the expert community member as well as my critical friend to join the Physical Science teachers. In the first place, the COVID-19 protocols were followed, I scanned and recorded our body temperatures with a thermo gun. We sanitised our hands and sat down maintaining a social distance of about 1,5m. This workshop was meant for us to get to know each other and the teachers introduced themselves one by one. They all met our expert community member, and they exchanged greetings with one another. During this workshop, I gave my participants an overview of the study. I stated the title, outlined the context of the study, the problem statement as well as the purpose of the study. This was followed by a discussion on ethical issues such as voluntary participation, autonomy, confidentiality, and their roles. Apart from creating and building personal relationships and getting to know each other, the workshops were also helpful in creating a sense of ownership of this study among the participating teachers as opposed to just being objects in this study. At the teachers' orientation workshop, I also explained to the teachers their role and rights in participating in the research project. I used this workshop to receive the signed consent letters from the teachers. Although the two orientation workshops were not aimed at generating data to answer any of my research questions per se, I was able to extract the teacher's bibliographies from these discussions.

#### *3.4.1.2 Semi-structured interviews*

Interviews are commonly used to capture qualitative data and at the same time can provide a richer and more reliable understanding of the phenomenon under investigation (Cohen et al., 2018). The fact that the interviews are not structured provides the researcher with a chance to ask follow-up questions based on the interviewee's responses. At the second workshop, individual interviews were held with each of the four grade 8 physical science teachers. Using the codes T1SSI, T2SSI, T3SSI and T4SSI, the interviews were audio recorded and then later transcribed. This technique ensured that all the qualitative data from participants were captured so as to answer research question one, which looked at the grade 8 Physical Science teachers' experiences and pedagogical insights regarding mediating learning of chemical and physical changes (see Appendix G(a)) for the teachers collated semi-structured interview responses.

### 3.4.2 Phase Two

#### *3.4.2.1 Workshop 2: Presentation by the expert community member*

The willingness of the expert community member to share her indigenous knowledge with the teachers was central in this study. Presentations in this phase were envisioned to expose the science teachers to examples of IK relevant to school science for integration. Moreover, the phase was a lesson to the science teachers on how to work with the community members (indigenous elders). The intervention is supported by Mandikonza (2007) who advocates that community members possess knowledge of their cultural practices and such practices can be used in science teaching. It is also suggested in Namibia's MEAC (2016. p. 52) that, "in the community there maybe **persons with expertise** in for instance language and **cultural traditions, crafts,** sport, health, entrepreneurship or agriculture, who may be **approached** to support teaching or co-curricular activities" (my emphasis). In the case of this study, we had an opportunity to work with an expert community member in dyeing and weaving African baskets. This is commended by Seehawer (2018), that in the case where teachers themselves do not have IK, or they do not have the right IK, the teachers should collaborate with expert community members to present lessons in their classes.

The engagement of the teachers in the expert community member's presentations was envisioned at strengthening the teachers' understanding of indigenous knowledge integration in science lessons. These workshops served as a platform for teachers' continuing professional development. This position is supported by Shabani (2016) who posits that teachers should be engaged in activities that help them improve their professional knowledge of pedagogy. In this phase, two workshops were held. In the first workshop, the teachers watched or observed a practical demonstration of dyeing the palm leaf strips using different natural dyes. In the second presentation, the teachers watched or observed a practical demonstration on the weaving process.

All the participating teachers' interactions with the expert community member, the cultural artefacts, tools, and products which the expert community member was using, were videotaped. Apart from the videos captured, data were also gathered through observations. The teachers also wrote individual reflections on their engagement. Data gathered in this phase were analysed using concepts from Vygotsky's socio-cultural theory (1978) to answer research question two: In what ways do grade 8 Physical Science teachers interact, participate, and learn (or not) during the presentations by the expert community member?

Figure 3.2 illustrates the science teachers (while social distancing due to COVID-19) taking notes using participatory observation data sheets, during the presentation by the expert community member (see Appendix I).

**Figure 3.2: Teachers taking notes during the presentation of dyeing palm leaf strips**

### 3.4.3 Phase Three

#### *3.4.3.1 Workshop 3: Co-development of exemplar lessons*

The third workshop was envisioned for teacher continuing professional development. After exposing the teachers to the local knowledge or IK during the presentation by the expert community member, workshop 3 was initiated. This workshop was divided into two parts. Part A was a brainstorming session based on the two practical demonstrations by the expert community member (basket weaver). We listed all school science concepts that emerged from the indigenous technology of dyeing and weaving. Part B was co-designing an exemplar lesson, to mediate learning of chemical and physical changes based on the indigenous technology presented. As a measure of their development, each science teacher was tasked to plan a science lesson on their topic of choice integrating IK of their choice, using the exemplar lesson.

The activities engaging teachers in this phase resonate well with Ngcoza and Southwood's (2015) proposed ethical way of doing research with participants, which is with them rather than on them. According to Pollen (2009), allowing participants to fully participate in an activity affords them an opportunity to understand the nature of the activity in which they are involved. The teachers' engagements during the workshop discussion as well as the development of a model lesson, were videotaped by my critical friend.

The research process for my study was informed by Chikamori, Tanimura, and Ueno's (2019) Transformative Model of Education for Sustainable Development (TIMESD). This model resonates well with indigenous knowledge instruction design (lesson planning) and involvement of community members as custodians of IK. The model explains the processes involved on how indigenous knowledge could be integrated and enacted in science lessons (Hashondili, 2020; Magwentshu, 2020). The Chikamori et al. (2019) TMESD framework consists of three learning sub-processes: 'knowing the present', 'past-present relationships' (focusing on the dependence of the present on the past) and the 'future-present' (see Figure 3.3). These scholars refer to the process of studying the past-present relationships as retroduction and future-present relationships as retrodiction.

In this study, the first sub-process (knowing the present) was achieved through the use of semi-structured interviews. Data were collected on the experiences and pedagogical insights of the Physical Science teachers of integrating IK when mediating learning of chemical and physical changes in their classrooms. In the second sub-process (past-present relationships), the learners (teachers) were engaged in intervention workshops in which the expert community member shared indigenous practices of dyeing and weaving baskets. Teachers were afforded an opportunity to link the observed scientific concepts, embedded in dyeing and weaving baskets, with the concepts of chemical and physical changes. The third sub-process (future-present) in this study was achieved through reflections on the science embedded in the indigenous technology of basketry and its place in mediating the learning of chemical and physical changes. Lastly, the workshop discussion on the co-development of an exemplar lesson aimed at capacitating the science teachers to integrate the science concepts embedded in the indigenous technology of dyeing and weaving baskets was framed within the future-present idea. Figure 3.3 below summarises my research process as framed in TIMESD (Chikamori et al., 2019).

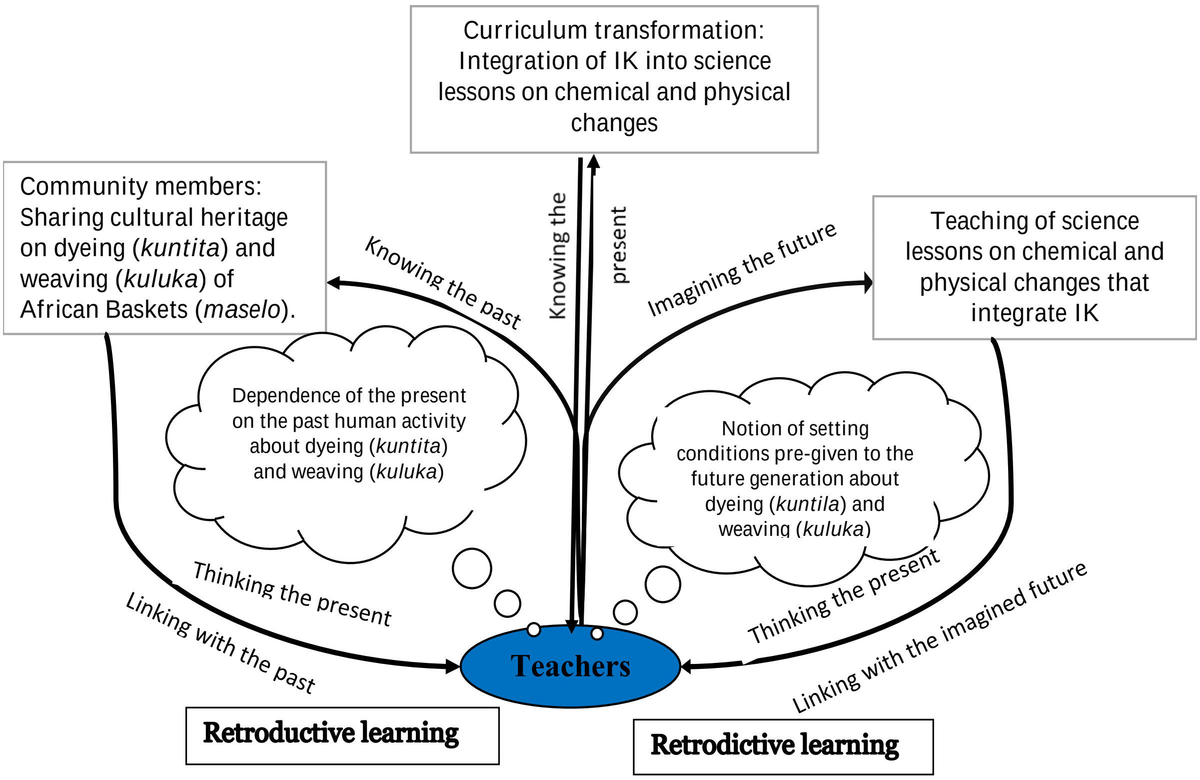


**Figure 3.3: The IK integration framework for instructional design used in this study (adapted from Chikamori et al., 2019, p. 9)**

### *3.4.3.2 Participatory observation*

Observations allow a researcher to have first-hand information by visiting the site of the study to see or watch carefully for oneself the way things happen or events unfold (Bertram &

Christiansen, 2015). According to Ivankova (2015), observation is a process of recording events, situations, behaviours, and interactions of people in their natural settings, aimed at exploring the individuals' learning experiences. Maxwell (2012) specifically proposes that for one to understand a study better, one should be a participant in their own study. Other scholars (Cohen et al., 2018; Thomas, 2013) find observations to be a powerful way in which a researcher can learn about people's behaviours. This method can give the researcher an advantage to collect data directly from the real-life lived experiences.

As a co-learner as well as researcher (observer), my observations were focused on how the grade 8 Physical Science teachers interacted and participated during the expert community member's presentations. I participated by asking questions for clarity and directions, while evaluating the science embedded in the indigenous technology. One disadvantage, I realised, of being both a participant and being a researcher or observer, is divided attention or concentration. For instance, it was hard to concentrate on a specific teacher's body language or specific interactions during the presentation. Fortunately, I had the opportunity of reviewing the videos during the time of transcribing. Also, my critical friend participated during the presentations. This technique was used during phase 2, to answer research question two: In what ways do grade 8 Physical Science teachers interact, participate, and learn (or not) during the presentations by the expert community member?

#### *3.4.3.3 Journal reflections*

According to McMillan and Schumacher (2014), journals are personal accounts of how a person has experienced a learning opportunity. In teacher development, journal reflections can be used as important tools to create self-awareness, evaluation of teaching methods used, problems encountered in teaching, and change of teaching practice when necessary (Göker, 2016). Keeping reflective notes in a study helps a researcher and participants to remain abreast of the developments around a topic under study. In this study, the four Physical Science teachers were asked to complete individual general reflections guided by a few questions (see Appendix H) on the two presentations made by the expert community member. The teachers' reflections served to inform me about the effectiveness of the workshop activities and/or establish any shift in the ZPD of the teachers after their engagement in the indigenous technology. The data were analysed using constructs from Vygotsky's (1978) socio-cultural theory.

**Table 3.2: A summary of the data gathering methods used in this study**

| Method | Purpose | Research Question |
|---|---|---|
| Semi-structured interviews | To find out, based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation? | 1 |
| Participatory observations | During the workshop interactions with expert community member, what opportunities emerged for the grade 8 Physical Science teachers to bridge the gap between curriculum formulation and implementation of IK?<br><br>Scientific concepts that emerged from the community members' presentations on dyeing and weaving. | 2 |
| Journal reflection | Teachers' insights on the use of indigenous knowledge presented by the community member to mediate learning of chemical and physical changes in their classrooms.<br><br>How to use the local knowledge presented by the community member to develop an exemplar lesson that integrated local knowledge. | 3 |

### 3.4.5 Data analysis

Data analysis is the process of making sense of data gathered from the different instruments to provide answers to the research questions. According to Cohen et al. (2018, p. 315), "data analysis involves organising, accounting for and explaining the data. It is about making sense of data in terms of participants' definitions of the situation, noting patterns, themes and categories" (Cohen et al., 2018). In this study, data are presented and analysed in Chapter Four, Five and Six. These chapters are organised according to the different data generating techniques in relation to a specific research question. The data generated were analysed using an inductive approach; sub-themes were allowed to emerge from the data (inductively). From the sub-themes, themes were formed, and the themes formed were discussed in relation to the literature as well as the two theories, namely, socio-cultural theory and TSPCK.

In Chapter Four, the data from semi-structured interviews are presented and analysed using constructs from Mavhunga and Rollnick's (2013) TSPCK to address research question one. In Chapter Five I present results from the audio and videotaped teachers' interactions during the expert community member's presentations. The interactions were analysed using constructs from Vygotsky's (1978) socio-cultural theory to address research questions two and three. The focus of the analysis was mainly on the social interactions, the influence of the mediatory tools, and any shift in teachers' ZPD. Chapter Six presents data analysis from videotaped interactions during the workshop of co-development of an exemplar lesson. Both Vygotsky's socio-cultural theory together with the five TSPCK components were employed to analyse the data. In a nutshell, the constructs from Vygotsky's (1978) socio-cultural theory were used to find out how the teachers' engagement in various workshop discussions enabled (or not) a shift in their ZPD, such as promoting improved understanding of chemical and physical changes as well as IK and how to integrate it. The presentation influenced the teachers' pedagogical content knowledge, and teachers were enabled to plan lessons integrating IK.

### 3.4.6 Validity, trustworthiness and reliability

Validity is one crucial aspect of research that looks at how accurate and credible the research findings are (Creswell, 2016). The use of multiple methods of data generation techniques in the study was aimed at strengthening the validity of the data, also called triangulation (Cohen et al., 2018; Maree, 2016).

To ensure that the information collected in the study was valid and trustworthy, data were triangulated to determine agreements or contradictions (Bertram & Christiansen, 2015). The semi-structured interviews were audiotaped, which I replayed and transcribed. A critical friend validated my transcribed data by replaying the audio recorded interviews. During the workshop discussions, I captured the data using both audio (cellphone recording) and video (video camera). Audio recordings are good as data gathering techniques when it comes to trustworthiness and reliability. According to Cohen et al. (2018), using audio recording devices to record verbal interviews is more accurate compared to taking notes. Using such devices, the researcher can return to these recordings during data analysis or at any other stage for validation purposes. Moreover, the audiotaped and videoed teachers' interactions during the intervention learning workshops were triangulated with the teachers' reflections for validation purposes.

### 3.5 Ethical Considerations

Murray (2006) points out that the ethical considerations are an important aspect of all research. According to Bertram and Christiansen (2015) ethics in research is concerned with acceptable behaviour that is considered right when conducting research. I now discuss how I addressed the ethical considerations in this study.

#### 3.5.1 Respect and dignity

After identifying the expert community member in basket weaving and the four grade 8 Physical Science teachers, I started building personal relationships with them. I personally visited the expert community member and the four grade 8 Physical Science teachers for the purposes of familiarisation. I used this chance to discuss the nature of my study, its benefits to the participants, especially the four grade 8 Physical Science teachers (co-researchers). During these visits, I did inform my participants that I would return when the study was approved by the ethics committee, with written consent forms for them to sign. Before the informed consent letters were signed, I again explained to the participants that their participation was voluntary and that they had the right to withdraw from the study any time they wished to do so. Repeatedly, at each stage of my data collection I respectfully asked my participants to give their consent allowing me either to audio record discussions or take photographs in which they were involved.

In this study I was aware and respectful of the schedule of the participants, thus, I ensured that the research activities took place without causing inconvenience to the participants' schedules. During the orientation workshop, the participants (teachers) helped in drawing up a schedule for the different workshops that best suited their personal activities and school work. This was done after consulting the expert community member. The identities of the participants were treated with a high degree of anonymity and confidentiality; pseudonyms and codes were used instead of their real names. Lastly, I assured my participants that the information (data) collected in this study would not be shared with a third party without their permission. Further, I assured them that the data collected from the study would be safely stored on an external hard drive in my personal safe as well as the university established storage system.

### 3.5.2 Transparency and honesty

I explained the purpose, nature, and the entire research process including the benefits and role of the research participants before they signed the consent forms. To ensure that participants understood the magnitude of the task before them, consent letters were written both in English and Isilozi for the expert community member. Permission to conduct this study was obtained from all gatekeepers (see Appendix B): the regional director of education in the Zambezi region, down to the circuit inspector, school principal (see Appendix C), the teachers (see Appendix D), and expert community member (see Appendix F).

### 3.5.3 Accountability and responsibility

I was accountable for conducting a research study within the guiding principles of conducting educational research. My responsibility in this study included creating a conducive environment for social interactions and learning to occur. Moreover, I took full responsibility for the safe keeping and storage of research data (semi-structured interview responses, teachers' reflection journals, video and audio recordings), and equipment in a secure place.

### 3.5.4 Integrity and academic professionalism

I declared from the beginning that this thesis is my own original work and has not been previously submitted in any form for assessment or for a degree in any other higher education institution. Where I have used work from other scholars, such ideas have been acknowledged by means of quotations and references according to Rhodes University Education Department Guidelines. Through the whole process of data collection my professional conduct was evidence to the four Physical Science teachers that I was conducting this research *with* them rather than on them (Ngcoza & Southwood, 2015). This was also evident in my inclusive writing, where I recognised them using *we.*

## 3.6 Chapter Summary

In this chapter I described the research design and methodological orientations used in this study. Furthermore, I outlined the research goal and questions for the study. The research site, participants, sampling, and positionality were also discussed. I explained how the data were gathered and analysed. The issues of validity and trustworthiness were explained and ethical issues were considered and then discussed.

# CHAPTER FOUR: ANALYSIS OF SEMI-STRUCTURED INTERVIEWS

## 4.1 Introduction

The main goal of this study was to mobilise the indigenous knowledge practice of dyeing and weaving African baskets to mediate learning of chemical and physical changes in grade 8 Physical Science classrooms. In the methodology chapter, I discussed the research methodology used in this study. In this chapter, I thus present, analyse, and discuss the qualitative data I generated from the semi-structured interviews to answer my research question one:

> *Based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation?*

The study began with some orientation workshops prior to the semi-structured interviews. I, therefore, start by presenting what unfolded during the orientation workshops.

## 4.2 Orientation Workshops

Two separate orientation workshops were conducted in Phase 1. Before meeting up with the teachers, I first visited the expert community member at her village to let her know that I had received approval to commence with the study. I used this meeting for her to officially sign the consent form, showing her voluntary participation. However, before signing the consent form, she indicated that there was no need for her to sign any papers since we already had a *verbal agreement* and this is what she said:

> *Inzi zintu zenu zencikuwa, mbwita kusaina saina. Mane muntu nalisiinele efu, kapa cifumu cakwee enzi muhinde!* (Your modern ways of doing things, everything you want people to sign. One day someone will sign for his death or even giving his or her wealth to be taken).

The expert community member's response suggests a critical element that calls for urgent attention when it comes to ethics issues for scholars doing research with indigenous people. Smith (2013) shows that ethics are currently framed in Western ways, such as the requirements of individual participants to give informed consent. The expert community member made the comment in a form of a joke but considering our cultural norms, I felt as if I had offended her when I asked her to sign the consent form. The expert community member's response suggested that the verbal agreements we made were equally valid and as legally binding as a consent letter would be. Although I concurred with her, I had to explain to her that signing the consent letter was a requirement by the university, for it serves as proof that she was not coerced to participate in the study. These sentiments suggest that ethical standards formulation should recognise the cultures of the indigenous people for the protection of their rights.

The orientation workshops took place at AKA combined school (pseudonym). Since this was the commencement of this study, I welcomed the participant teachers, thereafter, I introduced myself as a Physical Science teacher at a local senior secondary school. I further explained that I had been teaching Mathematics and Physical Science grade 8-12 for about 10 years. Lastly, I indicated that I was a student from Rhodes University pursuing a master's degree in Science Education in order to improve my practice. I then gave the teachers an opportunity to introduce themselves by giving their names, schools, subjects they were teaching, and for how long they had been teaching.

To give my participant teachers an overview of what the study was all about, I explained it briefly. I stated the title, outlined the context of the study, the problem statement as well as the purpose of the study. This was followed by a discussion on ethical issues such as voluntary participation, autonomy and confidentiality, and their role in the research. Apart from creating and building personal relationships and getting to know each other, the workshops were also helpful in creating a sense of ownership of this study among the participating teachers. This resonates well with Ngcoza and Southwood (2015) who aver that when participants are treated as data informants we are doing research *on* them. Thus, these scholars (Smith, 2013; Ngcoza & Southwood, 2015) suggest doing research *with* participants, instead of treating participants as objects. Thus, to create a sense of ownership of this study, the teachers were empowered by participating in the drawing up of the weekly meeting schedule for the two week period of data collection. For our weekly meetings, the teachers agreed to a minimum duration of one hour to a maximum of one hour thirty minutes, scheduled from 15: 30 to 17: 00 for the duration of the study. I now present data from the semi-structured interviews.

## 4.3 Qualitative Data from Phase 1: Semi-structured Interviews

After the orientation workshops with the four Physical Science teachers, I began with the individual semi-structured interviews. In the next section, I present the qualitative data from the semi-structured interviews.

### 4.3.1 Qualitative data from semi-structured interviews

The teachers were interviewed individually and with their permission I audio recorded the interviews. Thereafter, I transcribed the interviews verbatim so that no information was lost (see Appendix G). SSI is the code used for the semi-structured interview and the teachers were coded (T1SSI) to mean: teacher 1 semi-structured interview.

The qualitative data from the semi-structured interviews (SSI) were collated according to the questions they answered and the teachers' responses were colour-coded based on similarity. This is where the sub-themes were generated and later developed into themes (see Appendix G (b). The themes that emerged from the data were then linked to the relevant literature as shown in Table 4.1 below.

**Table 4.1: Themes from the semi-structured interviews**

| **Research question 1:** Based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation? | |
|---|---|
| **Themes** | **Literature/Theory** |
| Teacher's views about Physical Science as a subject | Stein et al. (2008) |
| Teachers' experiences and pedagogical insights teaching chemical and physical changes | Kuhlane (2011); Kozulin (2004); Shulman (1986) |
| Teachers' understanding of prior knowledge | Kuhlane (2011); Roschelle (1995); Kibirige & Van Rooyen (2006); Hashondili (2020); Mukwambo et al. (2014) |
| Teachers' knowledge of their learners' learning difficulties and misconceptions | Mavhunga & Rollnick (2013) |

As it can be seen in Table 4.1, four themes emerged from the semi-structured interviews and these are: teacher's views about Physical Science as a subject; teachers' experiences and pedagogical insights teaching chemical and physical changes; teachers' understanding of prior knowledge as well as teachers' knowledge of their learners' learning difficulties and misconceptions. I now discuss each theme below.

#### *4.3.1.1 Teachers' views about Physical Science as a subject*

Understanding how the grade 8 Physical Science teachers perceived or viewed the subject Physical Science was an important point of departure in my quest to understand how these teachers mediate learning of these science concepts in their classes. Below are some of the teacher's responses:

> *Physical science is a more practical subject and our schools do not have laboratories (TISSI).*
>
> *Topics involving chemical reactions cannot be taught without chemicals (T3SSI).*
>
> *Our schools do not have laboratories (TISSI).*
>
> *Science has many aspects that many people do not understand. You find that there is a part we call Physics, which has to do with physical things and Chemistry how they react together (T2SSI).*
>
> *Physical Science here in our region is one of the regarded difficult subjects by learners due to culture (T4SSI).*

The science teachers' responses suggest their acknowledgement of Physical Science as a difficult subject, not only for learners but for teachers as well. The teachers here show some form of defense for their learner's lack of understanding of science concepts, leading to poor performance in science. For instance, T2SSI revealed that: "*Science has many aspects that many people do not understand".* This response alludes to the nature of science concepts.

Multi representation-based teaching materials could be used as an alternative to understanding the abstract nature of chemical materials and adding knowledge related to chemical concepts in various forms of representation.

The claims by T1SSI and T3SSI for instance are that:

> *Physical Science is a more practical subject and our schools do not have laboratories TISSI).*

*Topics involving chemical reactions cannot be taught without chemicals (T3SSI).*

From their claims, the teachers seemed to suggest that mediation of learning of science concepts is impeded by the lack of chemicals and apparatus within school laboratories. As a result, they gave the impression that science results could be improved if each school had a fully stocked and operational laboratory to expose the science learners to hands-on practical activities (Asheela et al., 2021). Concurring, Makgato's (2007) study on factors that contribute to learners' poor performance, reveals that lack of practical work is one of the potential contributors to learners' poor performance in Physical Science.

The response from T4 was that: "*Physical Science here in our region is one of the regarded difficult subjects by learners due to culture",* is an important revelation about their learners' attitudes towards learning Physical Science. Seemingly, learners have developed negative attitudes towards Physical Science learning by labelling it as difficult. This perception is echoed in Aikenhead's (2006) observation that learners view school science as a foreign culture. This scholar believes that the integration of indigenous knowledge in science teaching, where teachers help learners associate school science with daily life practices, can create a positive attitude towards learning science. Baquete et al. (2016) hold a similar view that the incorporation of indigenous knowledge into school curricula could have a positive effect on learners' interest in science, as well as help them value and keep alive their grandparents' indigenous knowledge.

To Benson, Nwagbo, Ugwuanyi, and Okeke (2020), attitude is very important in school science because anyone who wishes to achieve higher marks in science, should display a positive attitude towards science. For this reason Physical Science teachers are faced with challenges when instructing learners with negative attitudes and lower self-motivation in learning science. Similar to T4's assumption, Aslan (2017) notes that learners' attitudes towards Chemistry negatively influences their academic performance in the subject.

#### *4.3.1.2 Teachers' experiences and pedagogical insights teaching chemical and physical changes*

Findings from the semi-structured interviews showed that teachers are aware of the importance of conducting practical work in Physical Science to concretise those abstract concepts so that they are accessible to the learners (Asheela et al., 2021). These teachers' responses suggested that dissemination of theoretical facts and knowledge is the common teaching method employed by the science teachers. For example, T1 and T3 reflected that:

> *Physical Science is more practical subject, but we teach science using theories (T1SS1).*

> *Teachers tend to teach science topics using theory ... but, experiments can be done through improvisation (T3SS1).*

In these excerpts, these teachers acknowledged that they do not conduct hands-on practical activities. Yet, it has been found that practical work in science teaching and learning is critical, in terms of facilitating learners' knowledge and understanding of science by concretising those abstract concepts (Asheela et al., 2021). The teachers' responses revealed the unavailability of chemicals and laboratory equipment as the greatest impediment to conducting practical work in the schools. However, T3SSI's suggestion of improvisation to conduct science practical work is an important alternative pedagogical approach to mitigate the shortage of laboratories supplies in schools. Namibia's national curriculum for basic education encourages science teachers to improvise by finding teaching and learning materials that are easily available and inexpensive in the immediate environment (Namibia. MEAC, 2016). This resonates well with the rationale for this study which focused on how to integrate the learners' indigenous knowledge into the science lessons. It was hoped that dyeing offered opportunities for teachers to conduct hands-on practical activities with little to no financial cost, as the materials are sustainably sourced from the local environment (Asheela et al., 2021).

Another important revelation from the teachers' semi-structured interviews pertained to the teachers' attitudes towards the topic of chemical and physical changes. These teachers seemed to not take the topic seriously compared to other science topics. That is, they assumed that the topic is very easy and that learners should not have difficulties understanding it.

In their responses, for instance, T1, T3 and T2 hinted at the following experiences:

> *I do not find the topic to be very difficult too. Everything, difference between chemical and physical as required in the syllabus is nicely found in the textbook (T1SSI).*

> *Chemical and physical changes; being a teacher the topic supposed to be an easy topic because they just have to master the characteristics of chemical say it is permanent and physical changes is temporal (T3SSI).*

> *It is good or best to differentiate [chemical and physical changes] in terms of a table, such that each point under physical change will have its opposite for chemical change (T2SSI).*

The excerpts above showed the teachers' perceptions and pedagogical approaches. T1, T3 and T2 mentioned how the learning of chemical and physical changes is presented in their classroom. This is what Mavhunga and Rollnick (2013) refer to as representations and conceptual teaching strategies. The above excerpts suggested that the interviewed teachers do not use any form of representation to help learners build conceptual understanding. Since the teachers perceived the topic as easy or not difficult, it has negatively influenced their teaching methods.

According to Benson et al. (2020), pedagogy is a decision-making process in which a teacher makes decisions regarding what and how to teach the subject matter knowledge. From the teachers' responses it could be hypothesised that in their classes, they have employed teaching methods that seem to only disseminate theoretical knowledge or knowledge transfer (Susilaningsih, Fatimah, & Nuswowati, 2019). Science teachers in Namibia are required to use different teaching techniques in a learner-centred manner (Nyambe, 2008; Nyambe & Wilmot, 2012) in an attempt to promote knowledge with understanding.

To minimise these challenges, teachers are called to employ different representations to illustrate the chemical and physical changes through the use of analogues (Mavhunga & Rollnick, 2013). According to Shinana (2019), when representations or mediatory tools such as cultural artefacts are used, learners themselves can attach meaning to the content they are learning or being taught. In the case of this study, African basketry (dyeing and weaving) was purposively chosen for its ability to offer learners an opportunity to visualise chemical and physical changes.

#### *4.3.1.3 Teachers' understanding of learners' prior knowledge*

The semi-structured interviews also revealed an important aspect of prior knowledge. Knowing the source of learners' prior knowledge will help teachers to be able to elicit the relevant prior knowledge and experiences (Mavhunga & Rollnick, 2013). The teachers' responses highlighted two sources of learners' prior knowledge. The first source is everyday knowledge experience, and the second source is previous grade subject content knowledge or curriculum exposure. During the semi-structured interviews, T2 and T4 highlighted the following to illustrate the everyday knowledge experience:

> *My learners have been cooking or seen someone cooking; when something is cooked it undergoes a change (T2).*

> *I believe in their homes they are having knowledge of things even though they don't label them as physical or chemical change in their daily lives (T4).*

The responses from T2 and T4 showed their awareness of learners' everyday knowledge and traditional practices, as possible sources of prior knowledge to mediate learning of chemical and physical changes. Though these teachers seem to possess this knowledge, as can be seen in T2's response above, they hardly refer to it during their teaching. Moreover, it can be deduced from T2's response what prior knowledge her learners bring to class about chemical and physical changes: "*I do not know exactly [what prior knowledge they bring".* Based on this it could be argued that these teachers seem to be neglecting this knowledge, although the actual reason could be that they lack the pedagogical skills.

Baquete et al. (2016) show that when incorporating IK, teachers need to employ appropriate conceptual change strategies, for instance, discussing and explaining some of the IK practices and beliefs that may seem contradictory to scientific knowledge. David (2017) warns that inaccurate prior knowledge learnt from cultural backgrounds may impede the learning of scientific concepts from T2 and T4 showed their awareness of learners' everyday knowledge and traditional practices, as possible sources of prior knowledge to mediate learning of chemical and physical changes In other words, teachers should initiate and facilitate debates among learners about cultural beliefs and practices that may be unscientific to minimise the misconceptions and myths learners may have (Mukwambo et al., 2014).

During the semi-structured interviews, the teachers were asked to share what prior knowledge they expect their grade 8 Physical Science learners to possess about chemical and physical changes. T1 and T2 revealed that:

> *I expect them to know examples of the two [chemical and physical changes], including their properties as from grade 7… I expect them to give the definition, this I expect them to know from their previous grades (T1SSI).*

*I do not know exactly [what prior knowledge they bring] because these learners come from primary (grade 7); I do not know about grade 7 content or what they learnt in grade 7, whether it was chemical or physical changes (T2SSI).*

From these excerpts, it could be deduced that both teachers T1 and T2 seem to relate prior knowledge as the subject content knowledge covered in the previous grade (Mavhunga & Rollnick, 2013). In hindsight, however, both T1's and T2's responses seem to signal that teachers are not aware of or possess inadequate knowledge of the previous grade's curriculum content knowledge for the subject they are teaching. Since some of the teachers' responses referred to grade 7, I decided to look into the grade 7 Natural Science and Health Education syllabus to establish the extent to which the grade 8 leaners have been exposed to chemical and physical changes. What I found was that the topic of chemical and physical changes is not taught in grade 7, but is only introduced in grade 8 through to grade 12.

What could be learnt from T1's and T2's responses is that without knowledge of the content knowledge from the previous grade, grade 8 Physical Science teachers will be challenged to elicit their learners' prior knowledge. This suggests that science teachers should acquaint themselves with the previous curriculum (syllabi) for the current grade they are teaching. Mavhunga and Rollnick (2013) refer to this as curriculum saliency, that is, sequencing and continuity in the curriculum.

It can also be concluded from these teachers' responses from the semi-structured interviews that although they seemed to be aware of what prior knowledge is, they lacked pedagogical insights on how to elicit and integrate it in their science lessons. Instead, their pedagogical insights revealed an overreliance on the learners' previous grade learning experiences as the source of their prior knowledge. This was observed in T1's and T2's responses on how they elicit learners' prior knowledge on chemical and physical changes:

*I ask questions like what is a chemical change (T1SSI).*

*If I taught them this topic in the previous grade which is 7, now I was going to ask questions on the topic. Then I will go deeper within the topic (T2SSI).*

If we take T1's approach, for instance, and note that chemical and physical changes are presented as new knowledge in grade 8, when such a question is posed to learners they are likely to be quiet. This does not mean that learners do not have relevant experience about chemical changes, but it points to the fact that learners' experience has not been considered as a starting point in the lesson. This finding seems to resonate with Kibirige and Van Rooyen's (2006) position who suggest that we normally make our teaching tasks more difficult by not starting where the learners are and building on what they know. For T2, since she did not teach grade 7, nor is the topic chemical and physical changes taught in grade 7, she would then not attempt to elicit what prior knowledge learners came to class with about chemical and physical changes.

#### *4.3.1.4 Teachers' knowledge of their learners' learning difficulties and misconceptions*

The participant teachers were asked to share some of the challenges they face when mediating learning of chemical and physical changes. Teacher 1 shared the following during their semi-structured interviews:

> *The main challenge that I have faced with chemical and physical changes, my learners always confuse the two … properties of chemical changes will be given to a physical change and those of physical change to chemical changes (T1).*

As can be seen from the teacher's response, they show awareness of learners' challenges. The challenge of mixing of confusing concepts results from learners' lack of conceptual understanding. Poor concept understanding could be a result of the teacher's poor conceptual teaching strategies (Mavhunga & Rollnick, 2013). If the teachers help learners form or grasp a concept they are learning, they may not resort to memorisation. None of the teachers interviewed highlighted how they investigate and deal with the challenges relating to learners confusing the differences between chemical and physical changes. As a result of participating in this study the teachers learned culturally responsive teaching strategies which draw teaching and learning resources from the natural environment to concretise school science concepts.

Another challenge in her science class was highlighted by T2 as follows:

> *Challenges are there, I do not know if I should say one of them is English. They don't really understand what it means that a physical change temporarily and a chemical change is permanent or when we say energy is always involved here and so on those things (T2).*

From this excerpt, it seems that English as a second language is a challenge to some learners. In this regard, Msimanga and Lelliott (2014) confirm the challenge experienced by English second language speakers as they face a double challenge: learning the language of teaching and learning (English second language) and developing a register for science language.

Teachers may opt for code switching or translanguaging (Denuga, 2015). Code switching is the change by a speaker from one language to another or the use of more than one language in order to contextualise communication (Msimanga & Lelliott, 2014).

The data obtained from the semi-structured interviews showed that the teachers are aware of their learners' challenges and misconceptions. The following were highlighted by T1 and T2 respectively:

> *When assessing them (learners) you will find out they confuse the two. Properties of chemical changes will be given to a physical change and those of physical change to chemical change (T1SSI).*
>
> *I should say one of them (referring to challenges) is English. Learners do not really understand those concepts (T2SSI).*

These teachers' knowledge and awareness of their learners learning difficulties in this study resonates with Mavhunga and Rollnick's (2013) TSPCK component of teachers' knowledge of what is difficult to teach. The medium of instruction (English second language) is salient in the teachers' responses as a chief source of the learners' learning difficulties and misconceptions. In her teaching experiences, for instance, T2 further highlighted that: "*If you ask for example burning is it physical or chemical change? Some will say physical just like guess work; they don't think deeper"*.

It is not enough for teachers to know the difficulties learners experience with chemical and physical changes, but rather, teachers need to employ alternative teaching strategies. Teachers' knowledge and skills on how to use the easily accessible resources from the local environment could reduce teachers' dependence on laboratory chemicals to conduct experiments that could demonstrate the difference between chemical and physical changes. It is against this backdrop that in this study, together with the teachers, we explored the indigenous technology of dyeing and weaving baskets to mediate teaching of chemical and physical changes. IK scholars like Msimanga and Lelliott (2014), propose indigenous languages as a legitimate resource for science teachers to mediate difficult concepts, as it also enhances learners' conceptual understanding. This can be achieved through code switching and translanguaging teaching strategies, without undermining the learners' acquisition of the correct scientific terminologies or their English language proficiency access.

## 4.4 Chapter Summary

In this chapter, I presented qualitative data from the semi-structured interviews with the participating teachers. Findings from the semi-structured interviews show that the interviewed teachers have some understanding of prior knowledge and indigenous knowledge practices. It emerged that the interviewed teachers have no experience on the integration of IK from their school tertiary education and hence lack the pedagogical skills of integrating it into their teaching. Furthermore, the data revealed limited teachers' knowledge and awareness of learners' learning difficulties, and they thus lack pedagogical knowledge to mitigate such learning difficulties. In the next chapter, I present, analyse, and discuss data generated from the presentations by an expert community member, through participatory observation and teachers' reflections.

# CHAPTER FIVE: PARTICIPATORY OBSERVATIONS AND REFLECTIONS

## 5.1 Introduction

The main goal of this study was to mobilise the indigenous knowledge practice of dyeing and weaving African baskets to mediate learning of chemical and physical changes in grade 8 Physical Science lessons. In the previous chapter, I presented, analysed, and discussed data generated from teachers' semi-structured interviews. In this chapter, I thus present, analyse, and discuss the data from the participatory observations, reflections, and discussions on the expert community member's presentations. The data generated were aimed at addressing my research question three:

> *During the workshop interactions with the expert community member, what opportunities emerged for the grade 8 Physical Science teachers to bridge the gap between curriculum formulation and implementation of IK?*

The invitation of the expert community member to share her indigenous knowledge and wisdom on dyeing (*Kuloba mikwaipo*) and weaving baskets (*Kuluha Maselo*) with the teachers was central in this study. This resonates with Mandikonza (2007) who conveys that community members have knowledge of cultural practices and that such practices can be used in teaching science. Moreover, it addresses the call by the NCBE that "in the community there are persons with expertise in … cultural traditions, crafts, sports … who can be approached to support teaching". (Namibia. MEAC, 2016. p. 53) As a result, I regarded the presentations as the main platform to enhance the teachers' understanding of the place of indigenous knowledge in science lessons. Importantly, the data from the presentations by the expert community member was subsequently used to co-develop exemplar lessons on chemical and physical changes integrating the IK.

## 5.2 Expert Community Member's Presentations

All four teachers were observers in the presentations made by the expert community member. In this session my critical friend assumed two roles; that of videotaping the interactions as well as a participant observer. In the first place I present the community member's biography.

### 5.2.1 Biographical information of the expert community member

The expert community member who presented and demonstrated the indigenous technology of dyeing and weaving baskets was a 65 year old female. To identify her in this study the code ECM which stands for expert community member was used. Ethnically she comes from the *Mafwe* tribe, which is the largest ethnic group in the Zambezi region of Namibia, followed by the *baSubia*. However, within the *Mafwe* ethnic group there are several dialects and she speaks the *Totela* language. As a result, her presentations were in *Totela.* Academically the ECM only possessed standard 5. What impressed us the most was her eloquence when speaking English; thus she did not require someone to translate between English and *Totela* during her presentation. The ECM has been making baskets since she was 15 years old; by the early age of eight, she had already started learning the craft. She received no formal lessons on dyeing and weaving but learnt the craft by observing older women in her family weaving the baskets. She now earns a living from the sale of her baskets, in addition to her old age pension fund. Two practical sessions by the ECM were held, preparation of dyes and another one on basket weaving.

### 5.2.2 Preparation of dyes and the dyeing process of the palm leaf strips

The workshop began with the ECM welcoming us to her home as well as to her presentation, followed by each one of us introducing ourselves to her. The ECM used this opportunity to show her appreciation and the honour granted to her in this study, to share her knowledge and wisdom on dyeing and weaving baskets with us. She said "*Eme njinilitumele, nisiini kubona amaluti, kukeza mumizi abuna, kwiza kulituta kwetu tusalitutite! Kulotu mitulitute hamoho za maselo* (I am so delighted to host teachers in my home, this is happening for the first time in my lifetime. I have never seen teachers coming into villages in search of knowledge! However, let us learn together about African basketry).

The ECM's expression highlights the uniqueness of what we were trying to accomplish, bringing science from the classroom to the community and the community to the classroom (Hashondili, 2020). After the ECM's opening remarks, Cf thanked the ECM because he was the eldest among us and he said:

> *Mama, thank you very much for agreeing to come teach us dyeing and weaving African basketry, someone would have charged us a lot of money for this knowledge you are about to give us. I would like to let you know that you are an expert, a custodian of this indigenous knowledge, I would also request you not to close your door to us as we will be returning for more knowledge on indigenous practices*.

The ECM smiled and assured to support us: *"Kappa masiku nekukeze, kamuniwane, nilitumela kwi chiseho yenu"* (Whether you come at night or during the day, I will be waiting for your return; I am very humbled by your interest to learn from me).

The ECM called her granddaughter to help her set up the materials they had already prepared before our arrival. The materials and apparatus were lined up before us and she challenged us to identify some of the materials. She said *"Zumwi nazumwi a niyambile cenzi henzi nzitu zitwa tula aha"* (I want each one of you to identify by name any of these things we have put here). The teachers were able to name most of the materials, except a few plant extracts (leaves and dead bark) which they failed to identify. Thereafter, she acknowledged those we got right and asked TIM to tell the rest of the group the name of the tree from which the bark was taken. Actually, the bark was collected by T1 and the ECM a day before the presentation after learning that she was in short supply of this dyeing agent.

The ECM used the pedagogical skill known as 'set induction' which "acts as an attention inducer, directs learners towards the learning process and helps the learner to be psychologically and mentally alert for the learning to take off' (Benson et al., 2020, p. 14702). In this introduction, the science teachers also learnt the importance of anchoring new knowledge to what the learner already knows, thus they learnt the skill of how to elicit prior knowledge (Mavhunga & Rollnick, 2013; Roschelle, 1995). Successfully in her approach, the ECM drew our attention to her lesson. It was an interesting and engaging introduction, each and every one, including the Cf, were observed to have said something in the workshop introduction. The ECM explained her choice of introducing her lesson the way she did in a teasing manner and said: *"Kamba kana namibuza inzizintu ninafwa kutoloka zintu zemwizi* *kale, kunyonana kumoz* (If did not ask you to identify these materials, I would still be talking and explaining things you already know, this was going be boring).

Notably, although she is not trained as a teacher, I observed great attributes of being a teacher in her. For instance, to our surprise, she echoed an important component of TSPCK, knowledge of leaners' prior knowledge, as emphasised by Mavhunga and Rollnick (2013). These scholars accentuate that as designers of teaching instructions we are required to have specialised skills and knowledge to be able to deal with learners' preconceptions and misconceptions. What we learnt here also resonates well with the constructivist theory of learning, emphasising that learners are not empty vessels to be filled with knowledge. We moved to the collection of the *Makalani* palm leaves.

### 5.2.3 Collection and preparation of *Makalani* palm leaf fronds

The *Makalani* palm tree species is at the heart of the weaving industry. About 90% of weaved baskets in the Zambezi region of Namibia are woven using the *Makalani* palm leaf strips, either plain or dyed with natural dyes. The ECM pulled a bundle of freshly cut *Makalani* palm fronds and began her presentation: *"Motutangile mukulwani utuswanela kusandula. Uwu cwale njo mukulwani tuusupa kuti Batumbwani, mubakauhanya abuna"* (We will start with the *Makalani* palm leaves. Before dyeing it or using it for weaving, we have to split it like this). While she was busy showing us how to split the fronds, T1 asked her; "*Why do you split the fronds into strips*?" ECM replied while showing us a frond from the pile of fronds and said, *"Mubwene aha, ku unzanika abuna kakuwihiha womukanti kaubuzwi kamapili kapa kuzuma, uhind nang fibi dezi neusazumi* (Do you see this frond it is closed, if I were to cook them closed like this inside, they will not turn a colour or if I try to leave it in the sun to dry like this, they will take about five days to dry) (see Figure 5.1 below). The teachers were attentive, such that in unison Cf and T4 shouted: "*That is surface area effect on rate of reactions"*. Cf explained further: *"You see when the palm leaves are split and are been boiled more strips are exposed to what 'heat and dye'*.

T4 added that, when the split strips *"are left to dry in the sun the strips provide more surface area, that the water molecules inside the fronds quickly heats up and evaporates, this leaves the strips dry"*.

**Figure 5.1: The fronds are split into thin strips before they are dried or dyed**

The Cf and T4 responses showed a positive start in terms of the learning intervention, especially their sense making of school science embedded in the practices. Thus, from the conversation, science concepts started emerging and this was the main aim of the workshop presentation – that teachers are enabled to link or point out science in the practices. As a participant observer, I asked the teachers "*What is the nature of the change that takes place when the water molecules in the palm leaves evaporate*"? T1 answered that: *"When the water evaporates the physical properties of the palm leaf strips change, thus this should be a physical change"*. The teachers were able to compare the properties of the fresh palm leaf strips and the dried ones and link these to physical and chemical changes.

The splitting of the fronds involves removing the midrib of the *Makalani* palm leaf and the ECM explained that the removal of the midrib can be done with a fingernail but is a time consuming exercise and can also cause injuries. Hence, she used a sharp metal hook to easily pierce through the fronds. This is what the ECM said about the awl: (an awl is a sharpened metal tool to make or poke holes around a basket, where the palm leaf strips are woven) "*Haiba intungo kai shengentwe nenza, kaitululu kapili, cwale tuishenga a hulu intungo ihweela kutulula"* (You see, if the awl is blunt, it is difficult to puncture the fronds, thus we make it very sharp to easily pierce through). Immediately after the ECM's explanation Cf asked: "*Colleagues can we not use this in class to teach the concept of pressure?"* Although the expert community member did not mention the concept of pressure, the concept was apparent from the ECM's explanations: easy to pierce when sharpened and difficult when blunt.

The ECM was also probed by T3 who asked: "How do you know the size of the Makalani palm leaf strips to make?" ECM replied and said "Hanu nikwesi feela kunataula, hani luka nji natule isainzi enisaka" (Currently I am just splitting the palm leaves into strips, when I am weaving that is when I split them into thinner strips). On this point, I deliberately asked the teachers: "What changes occur, chemical or physical, when the fronds are split and split further into thin strips during weaving?" In unison all the teachers mentioned and agreed that a physical change would occur. Cf further emphasised that the chemical composition of the palm leaf strips remains the same; only the physical outlook will change (size).

Furthermore, the expert community member briefly explained that the palm leaves can be dyed either fresh or after drying them. During the practical demonstrations, together with the participants we observed the dyeing of both the fresh and the dried leaves. In Figure 5.2: (**A)** shows the freshly cut palm leaf frond, **(B**) the freshly split palm leaf frond in strips and dried and **(C**) the expert community member with dried palm leaves ready to be dyed.

**A** **B** **C**

**Figure 5.2: The preparation of palm leaves used for weaving the baskets**

After explaining how the palm leaves are treated before dyeing them, the ECM took us to the next stage. She said "*Hanu mukulwani wetu ciwaluka cwale cetu ya kuzo ku doyolisa, moni misondenze zeni balukisi feela. Kumana, kulushanauna kapa nikuluzanika. Tuluhinda no kulwihiike feeal"* (Now that our palm leaf strips are ready, we are moving to dyeing agents and the dyeing process itself, I will show you just some few dyes).

Dye materials are collected from a wide variety of local indigenous plants. The split fresh or dried palm leaf strips (Figure 5.1) are either boiled or soaked in crushed plant material to dye them. Table 5.1 shows common dyes used and the desired colour for the palm leaf strips.

**Table 5.1: Common dyes and their colours**

| Dyes used | Plant name (where available) | Latin name (where available) | Colour |
|---|---|---|---|
| *Muzinzila* | Bird plum | Berchemia discolour | Deep red brown |
| *Makapa (rusty cans)* | - | - | Charcoal |
| *Mabele/Mahera* | Sorghum | Sorghum bicolour | Salmon pink |
| *Mukokoshi* | Na | Diospyrus chamaeth | Yellow |
| *Muhatula* | Na | Indigofera cinctoria | Lilac |
| *Litati (Icheka)* | Aloe | Aloe ebrine | Lemon yellow |
| *Mutakula* | Magic guarrie bush | Euclea divinorum | Olive brown |
| *Musweti* | Blue bush | Diospyrus lyciodes | Mustard |
| *Muzauli* | False mopane | Guibourtia coleosperma | Bark = beige; leaves = charcoal |
| *Muhonono* | Silverspring | - | Dark = charcoal |

(Source: Suich and Murphy (2002, p. 14)

The expert community member began her presentation on dye preparation and dyeing with the *Munzinzila* tree (*Berchemia)* whose bark produces a deep red brown colour. The *Munzinzila* is regarded as the chief dye and is used in every basket. She said: *"Echi chisamu cho Munzinzila cina mubukabu, baluka kaba cichempaulanga mahande a hala, bunata bwezi zikuni niza zimana kufwa*" (This tree *Berchemia* is in danger, previously the weavers used to cut the fresh bark of its trunk and that has left the tree trunk being damaged and as a result some trees have dried up). Further, "*Baba kaboni bamwinya, kuhinda feela mahande a fwile kale nga keinza kusebeliswe, kachifwi chikuni*" (Among you some witnessed how we sustainably collect the dye from the tree without damaging it. This is by collecting the dead bark; we ensure we do not injure the tree). We were privileged to witness the sustainable way of harvesting bark from the *Munzizila* tree. Together with T1, we drove to a nearby place where we found this tree and we learnt that the tree was recovering from damage caused by basket weavers (see Figure 5.3 below).

**Figure 5.3: ECM collecting dead bark from the *Munzinzila* tree for making dyes**

The ECM brought the dead bark collected from the *Munzinzila* tree and showed everyone how it looks. She then explained that: "*Aya mahande tuyatwa mukwina pili, nga ne tu a bilisa nomukulani"* (The bark will be ground to powder in a mortar and then boiled with the palm leaf strips). The teachers assisted with the grinding of the bark in a mortar and pestle. While grinding the teachers discussed the changes they observed and T1 commented that: "*This is a physical change also, the larger (lumps are turning into powder (smaller pieces), but this is still Munzinzila tree content"*.

T3 needed some clarity regarding reversibility and asked:

> *We say a physical change can be easily reversed right? And a chemical change is difficult to reverse. Now, after we have pounded the larger lump of those bark is it not difficult to change the powder of Munzinzila bark back to those large lumps we started with?*

TIM responded and said:

> *This is a good question precisely this is how our learners reason when using those summaries contrasting chemical and physical changes. I think we need first to*

*understand the chemical composition of matter before and after it has undergone a change, we know that physical changes do not affect the chemical composition, while a chemical change does.*

Interjecting T1, Cf added that: "*What we are seeing is only a change in its form from lumps to powder. Its composition have not changed of Munzinzila bark and contains no foreign matter, but that which we started with in the beginning"*. He further gave an illustration: *"Take another example, let us say in the process of making maize meal from maize, we grind the maize seeds is i?"* We chorused: "*Yes, well when the maize is loaded and pounded in the mortar, does it cease to be maize?"* All the teachers agreed and acknowledged that the finest powder as a product was still maize and would never cease to be maize. During the discussion, the *Munzinzila* dye was successfully used as a mediatory tool (Vygotsky, 1978), and shifted the teachers' comprehension of physical and chemical changes to a cognitive level. In Figure 5.4 below the whole process of how the *Munzinzila* dye was prepared and used to dye the palm leaf strips as observed during the ECM's presentation are illustrated below from A-D.

**A: *Munzinzila* bark being pounded in a mortar**

**B: Ground *Munzinzila* bark**

**C: Dye into a boiling pot**

**D: Palm leaf strips dyed**

**Figure 5.4: Different changes observed presentation by the expert community member**

Photograph A illustrates larger lumps of *Munzinzila* bark being ground to a powder form as shown in photograph B. The change was observed to be a physical change, as there was no change in the chemical composition of the *Munzinzila* bark that took place. In photograph C, the content (palm leaf strips and pounded Munzinzila bark) is being boiled to change colour, as shown in photograph D. The change taking place from C to D was observed to be a chemical change as lots of heat energy was involved.

The ECM was not happy with the outcome (colour) of the dyed palm leave and commented that:

> *Kana wasanduka hande mukulani wetu. Ibaka lyaleta so, munzinzila wa niniha namezi engiha mucidimpi, munzinzila wapanga feela mulyungulyungu.* (This is not a very positive result as our expected colour was deep red. There are a few reasons why this could have happened, for instance, our dye *Munzinzila* was not enough. Also, the amount of water we poured into the mixture was too much resulting in our dyeing agent formed becoming diluted)

With excitement T3 shouted that: "*Ooh Mulyungulyungu kanti nje dilute?* (Ooh Mulyungulyungu means dilute!) From the ECM's explanations it dawned on T3 that the Chemistry concept 'dilute' is the equivalent of *"mulyungulyungu".* T2 argued with T3 saying that: *"You mean to tell us you have been teaching this concept on acids and bases, you do not understand it?"* T3 responded that: *"No, I understand it, it means containing more water, what happened is that I never thought about it in our local language".*

The ECM was asked to explain the concept *mulyungulyo* and she said:*"Mulyungulyungu njahana haiba mainzi a ngiha, chikondoliso nechichehete, mata a chilungiso kaasuwahsli"* (A dilute: a mixture of a solute and a solution in which the solution contains more water and little amount of solute dissolved). These conversations revealed that indigenous African languages have a potential to mediate science concepts, contrary to current perceptions that indigenous languages cannot deal with science concepts. Scholars like Msimanga and Lelliot (2014), Mavuru and Ramnarain (2020) and Nhase (2019) believe that using the learners' home language for engagement with difficult concepts is a real resource for science teachers to create opportunities for learners' conceptual understanding. In the next paragraph I discuss the dyeing agent *Muhonono*.

### 5.2.4 *Muhonono* (Silver Spring tree) leaves as dyeing agent

While the chief dye *(Munzinzila*) was boiling, the ECM proceeded to present the preparation of *Muhonono* leaves and *Makapa* (Rusty cans). Both these dyeing agents turn the palm leaf strips dark or charcoal and are prepared almost the same way. The ECM explained:

> *Makoba oMuhonono mutual sebeliseza njihecina. Tuhinda a aya makoba ni lukulwani kuzi ombeka. Ziswanela kuhinda ezuba, nga netuzihika. Kumana kuzi bilisa kokuzi ombombala nokuzizanika pili. Hazizuma hana cwale nje tuwoola kuzi sebelisa kukuluka.* (The Silver Spring tree /Muhonono leaves are first soaked in water together

with the palm leaf strips to be dyed. After a day, the content is boiled and the strips turn from nature green to dark black. The dyed palm leaf strips are rinsed and allowed to dry before they are used)

In Figure 5.5 the expert community member's granddaughter is seen rinsing the dyed palm leaf strips which were soaked and boiled in Muhonono leaves.

**Figure 5.5: Makalani palm leaves strips soaked in Muhonono leaves**

The young girl in Figure 5.5 assisted her grandmother from the beginning of the study. In her story the ECM narrated that she learnt the art of African basketry by observing and assisting her parents, family members, and other weavers during her time. The fact that the ECM was working with her granddaughter as her personal assistant in this study is an example of how indigenous people pass on their cultural heritage and wisdom from generation to generation (Kibirige & Van Rooyen, 2006; Seehawer, 2018).

What is more important in this study is that this young girl is completing her primary phase at school (currently in grade 7), meaning the following year she will be taking all these experiences of dyeing and weaving into her science class. Should her grade 8 science teacher, when mediating learning of chemical and physical changes refer to this indigenous technology, she would easily make the connection, refine the science in the practice based on the classroom conversations, and understanding of the concept of physical and chemical changes will be realised.

More natural dye demonstrations had been planned, but unfortunately, this study was interrupted by the coronavirus pandemic. Many restrictions were imposed which negatively impacted this study. For instance, the number of dyes presented was reduced to two, yet we had hoped to observe the following dyeing agents: *Makapa* (rusty can), *Mabele/Mahera*, *Mukokoshi, Muhatula, Litati (Icheka), Mutakula, Musweti* and *Muzauli.* However, the ECM had time to explain theoretically how *Makapa* (Rusty cans) and *Mukokoshi* dyes are prepared.

### 5.2.5 Presentation on dye from *Makapa* (rusty cans)

The ECM indicated that:

> *Makapa moya sebeleza kuswana feela no Muhonono, cwale makapa katu ehiki. Tubika makapa kunsi, nokubika mukulani, ngane tubika amwi hewulu. Ku asia a ombeketwe mazuba otatwe kappa kuhitililila. Hamusia oambole asandula lukulwani kuzwisa mwa nature green (luteke) to grey, no luzumite kuluzwisa mwa cream white kuya mwa grey.* (Rusty cans are used and prepared in a similar manner to *Muhonono leaves*. The arrangement inside the soaking container is that; at the bottom we put rusty cans, then the palm leaves strips in the middle and more rusty cans are added on top of the palm leaves. The difference with *Muhonono* is that the rusty can take a longer period of soaking about three or more days than *Muhonono*. After three or four days, the content is not boiled, the palm leaves strips will have changed to grey from nature green (for fresh palm leaves strips) or from creamy white (dried palm leaf strips)).

As the ECM was explaining about the rusty cans the Cf asked the ECM: "*Sorry to take you back, as you were explaining about the rusty cans I want to know or someone here to learn why you do put rusty cans at the bottom and some on top*?"

The ECM responded: "*Makapa a chimbauka kua siya hewulu? Tubika mukulwani hakati, kupangila zizwa kumakap, ziole kuzwakunsi ni hewulumukulwani uhwele kusanduka"* (The rusty cans will float if not forced at the bottom. Also there is a chemical substances coming out of the rusty cans, it will soak away if not arranged this way. Those at the top as the chemical is permeating out of the can it is absorbed by the palm leaf strips in the middle. So, we want that substance to leach from the top and bottom towards the palm leaf strips). Immediately after the ECM finished explaining, T1 reflected that:

> *I can clearly see both Physics and Chemistry in this practice of dyeing. We can see the community member's understanding of density, so they worked out a way how to make the rusty cans sink! In the second part I see a chemical reaction between a metal oxide or hydroxide (rusty cans) and the Carbon fibres in the palm leaves strips. Can this be the reaction responsible for turning the palm leave grey?*

T3 replied and said:

> *Oh yes, that could be true, since the rusty cans are mainly metal oxide, when soaked in water, the solution become alkaline it is this alkaline substance formed is responsible in turning the palm leaf strips.*

The teachers' discussions showed new scientific perspectives and understanding of the indigenous technology of dyeing.

While presenting this, teachers were now interested in knowing how the weavers learnt about the use of rusty cans. T4 asked: "*How did you come to know about the use of rusty cans*?" The ECM responded that:

> *Tubalituti kubamwi. Motupangilanga, kulika lika zitu zincinchana cichana musi bona kuti ekala yateni endondu peto muyambila kwateni bamwinya. Eme nina mukatengo kecinzo kayendise e art centre, kubalentanga maselo abo ba luki tuba uliseza. Cwale basitwala maselo abo batu tusibona feela e kala yetuseni kubona. Zuna muluki a kuiwa tuka lituta twense, mo twizibilanga.* (We learnt from each other, what we do as weavers across the Zambezi region, we use trial and error! We try out different dyeing agents. In the process of trial and error when one comes with a nice color, that particular person's discovery will be shared. Especially the name of the dyeing agent and how to prepare that dye)

Here is the Ubuntu of the people of Zambezi region. The weavers do not claim ownership of certain dyes. What can be learnt from their success stories is their focus on decorating their baskets with the best dyes. The teachers here were learning the importance of sharing best teaching practices, as a community of practice.

### 5.2.6 Presentation of *Mukokoshi* dye

*Mukokoshi* is one of the shrub species together with the *Munzinzilz* tree whose quantity is declining at an alarming rate. In the case of the *Mukokoshi* shrub, the weavers destroy the whole shrub to access the roots which are required for the dye. The ECM explained that there is no alternative way of protecting the *Mukokoshi* shrub species apart from minimising or stopping its use. Narrating how Mukokoshi dye is prepared she said:

> *Aya machachani katusi asebelisi a hulu. Ciya wanika kulule. Uku tusebelisa mibishi. Chichachani chose kuchi nyukula nikuhinda kwateni mibishi. Tukai ndamandama nokuizanika, isizuma tuitwa busu buna mbotukopanya ni lukulwani kubilisa. Mukokoshi usandula lukulwani kuzwisa mwa nature green (luteke) kutwala mwa Yellow, ka (luzumite) kuluzwisa mwa cream white kuya mwa yellow.* (We are reducing

> the use of this shrub as a dyeing agent. It has become difficult to find good *Mukokoshi,* you have to walk long distances. This is because of how we use it; from this shrub we use its roots, this means we uproot the whole bush to access the root, which is total damage. The roots are dried and crushed to powder, that is then mixed with the palms leaves strips and boiled. It turns the palms leaf strips to yellow from nature green (fresh palm leaves strips) or from creamy white (dried palm leaf strips).

During the ECM's presentation, the teachers seemed to have mixed feelings; some looked as if they had received some bad news. They were not as happy as they were in the previous presentations. There was a shift in their zone of proximal development and sensitivity to environmental sustainability. They deduced that the use of this dye is causing environmental damage. With compassion T2 asked: "*Does this mean you will no longer have the yellow strips on your baskets in the near future? "*The ECM responded and said: *"Oh neeh, ubo kana bukabu. nkolinaee Icheka, nelyo lisandula yeloow. Bulotu bulyo, libyaliwa"* (No, that is not a problem to us, as we have an alternative dye, the *Aloe vera plant.* The aloe vera also gives the same yellow colour, but the advantage of using the Aloe vera plant is that it can be planted which is good for future generations). The next day we moved to the weaving process, as presented below.

### 5.2.7 Basket weaving presentation

All four Physical Science teachers, Cf, and I participated in the presentation on weaving. Using a similar introduction approach the ECM challenged us to name a few utensils which she was going to use during weaving. She said:

> *Baluka maselo bonse, zinu zisebeliso haiba kazikweina kaluki iselo, kabemba kangu asikakalola zuna. Cwale izizinaha mbuti muzikuwa. Muwoola kuzikuwa mumushobo wenu.* (All basket weavers need these tools and materials, for these materials here can you identify their names please, and you can use the names from your languages)

Figure 5.6 below shows some of the expert community member's utensils and materials needed and used during weaving process.

**Weaving grass** **Awl**

**Dyed palm leaf strips** **Soaking palm leaf strips**

**Figure 5.6: Utensils and materials for weaving**

The ECM appreciated our contributions and moved on to explain the use of each. The weaving grass is coiled around to give the basket its shape. The dyed palm leaf strips are used to decorate the baskets. Lastly, a container of water is needed to soak the dyed palm leaf strips; the water is also used to moisten the weaving grass to increase their flexibility.

Next, the ECM demonstrated how to make a knot and she said, "*Kaselo kathungiwa kokusebelisa kakulwani konke, muka nsumina abuna"* (When we start weaving, we start with a single palm strip, out of it we make a knot which is the centre and this is how we do it) – with ease she overlapped the palm leaf strips, and she had her knot! The Cf asked a question immediately after the ECM's demonstration: "*After tying this knot we can see that the palm strip has changed? Is this change on the overlapped palm leaf strip an example of chemical or physical change?"* T3 responded: *"This is a very clear physical change, it is very easy to untie it"*. Cf came back emphasised that: "C*olleagues if we are to adopt this kind of teaching into our classes, our learners would probably be afforded an opportunity like this to visualise these* *changes. This means they will no longer depend on memorising facts about chemical and physical changes".* Figure 5.7 shows the knot made by the ECM.

**Figure 5.7: Demonstrating knot making**

As a participant observer, I posed a question to the participant teachers to focus their attention on chemical and physical changes: *"To make a basket the ECM will be putting together the grass woven with dyed palm leaf strips to make a basket, is this process illustrating a chemical or physical change?"* Without hesitation T2 responded saying: *"Since the basket is a new substance, we can say the process illustrates a chemical change".* T1 disagreed saying: *"To me it is a physical change for there is no chemical reaction that took place. Both the palm leaf strips and the weaving grass have not changed on the woven basket".* T2 commented: *"Oh, I overlooked that, I understand indeed for a chemical change, the products (basket) characteristics should not be the same as reactant, and by the way palm leaves and grass are not reacting".*

Initially T2 had a misconception about the characteristics of chemical changes, that they form new substances. Thus, the teacher may also have some misconceptions of other science concepts. In this vein, Kimberlin and Yezierski (2016) support the use of multiple representations in chemistry to dispel learner misconceptions. During the presentation, the indigenous technology helped T2 to dispel her misconceptions and improve her conceptual understanding of chemical and physical changes.

During the presentation T2 wanted to know why the ECM had to soak the palm leaf strips and she asked: *"Can you tell us why are you soaking the palm leaf strips in a container of water?"* The ECM did not answer T2, but, instead, she gave each one of us a palm leaf strip and told us to try and tie a knot. She said: "*Mwa bona muna ntendela line ekoto? Mwense mulisumine*! (You saw how I made the knot; I would like each one to make a similar knot using these dry palm leaf strips). This activity guided us to discover that one cannot make a knot using the dried palm leaf strips. The strips were hard and broke easily (brittle), as we tried to make knots. The teachers learnt that soaking the palm leaf strips was a way of softening them. This change in the property of the palm leaf strips was an opportunity to teach the concept of physical change. For instance, soaking the dried palm leaf strips involved rehydrating or restoring their moisture or water potential (Tuned-Akintunde, 2008). Figure 5.8 below shows the ECM soaking the palm leaf strips.

**Figure 5.8: Softening the palm leaf strips by soaking**

From my observations, I learnt that the flexibility of the fibres contained in the palm leaf strips allows them to be woven into tight coils and small holes made using an awl. However, the palm leaf strip's flexibility is easily lost when exposed to the sun once again – this is the concept of reversibility. According to T1, the flexibility of the palm leaf strips is attained due to the movement of water molecules into the palm leaf strips. He said: "*Colleagues I can see biology in this activity, we can teach osmosis using these palm leaf strips".* Since the dried palm leaves have low water potential, during soaking, water molecules move into the palm leaf strips which make the strips flexible and suitable during weaving.

After making the knot, the ECM began weaving. She started with a base and added a little grass and the basket kept growing and she kept on adding more grass carefully. The process entailed a constant feed of grass, continuously coiled and woven with the palm leaf strips. The ECM reminded us and said:

> *Kuluka maselo musebezi, usaka pilu telele, kakulwani nakakulwani hakaselo mutwilwilo hape kaselo konke uhinda 3-4 mazuba njikakamana, kahena kumatamata feela kuti ciwa mana.* (The process of weaving is an activity that needs patience, because every palm leaf strip on the basket is stitched skilfully and an average basket can take three to four days before it is complete)

T3 asked: "*What are the reasons that you cannot complete a basket in a day or two?*" The ECM responded:

> *Kaniticuti mwndi muntu kawooli kumana kuluka kaselo mwizuba lyonke kappa muobile. Ibakalya mpili lilyehisa kuluka chobukwala nenzanenza. Muntu heena alukahana a swanela kubika muhupulo kumikabiso iyendelele. Chobubeli, kukotama, tufwanga mabote musihali onse ukotamite kukalala abuna, kuteleza musana namakosi.* (I am not saying someone cannot weave a basket in one day or in two. The thing that can delay someone, the first thing is the quality of the baskets. The symbolic and geometric patterns woven into a basket need quality time and focus of mind. However, the chief reason is that we endure lots of pain in the back and neck, as we spend long hours bending)

Observing the ECM's seating posture during her practical demonstration of weaving, we could see why weavers complain of neck and back pain. They sit with their head and neck bent downwards as they focus on the basket they are weaving on their laps. It is the weight of the head and shoulders that strain the neck and back, a pressure they cannot sustain for a long period as the ECM stated. From a physics perspective, this indigenous practice can be used to mediate the learners' conceptual understanding of concepts such as force or movement.

**Figure 5.9: ECM weaving the base of a basket weaving and T2 observing**

Observing how the ECM joined and wrapped the weaving grass to make it longer, T2 said: "*I see this as another good illustration of a physical change"*. T1 added: *"Definitely this is a good one and to reverse it you just untangle the weaving grass"*. The ECM was also asked by T4, *"When you have weaved a few lines and then you detected an omission in your pattern and it does not follow so well. What do you do?"* The ECM responded and said: *"Kutatulula feela kanini hateni no ku luka hande nde moi yeyendelele deco yateni"* (I simply undo the pattern, and then weave it again). T1 reflected that: "*This is about reversibility"*.

T4 asked the ECM an interesting question saying: "*How do you know when to add weaving grass?"* The ECM said: "*Kubonahala, muline utanga kuba munini cwale ni bika twani tobile kappa totatwe. Nisibika ahulu mulaine uneneha hape mane buhuba kwiziba* (I use observations, this line you see, once it starts to become small, and then I add some straws. If you add too many straws the line becomes too big again, so it is easy to adjust to the right size). It is evident from the ECM's explanation that she was using a scientific skill of observing in her indigenous practice (Haimbangu, Poulton & Rehder, 2017; Van Niekerk, 2016); this also confirms school science concepts embedded in local knowledge.

As the ECM started weaving, there was almost total silence; seemingly the process of weaving requires the undivided attention of the weaver. For instance, the weaver attentively observes when to add the weaving grass, when to begin a pattern with which colour, and when to end a particular colour. As a participant observer, I reminded the teachers that our next workshop back at school involved coming up with school science concepts emerging from these two presentations by the expert community member. Immediately after that message, the teachers began discussing school science concepts which were coming out while the ECM was weaving. For instance, T1 contributed that: *"Oh there are many science concepts as here. Apart from chemical and physical changes, I see forces in action, pushing the awl to make a hole, pushing* *and pulling the palm leaf strip through the hole made".* T2 added: *"There is also pressure here; she is applying a force on an area".* It could be argued that the teachers' conversations here showed their greater understanding of the link between school science and the science in the indigenous technology of weaving.

The ECM wove one flat basket for demonstration purposes and she used the easiest weaving technique (skill) that allowed her to complete this basket in two days. In her storeroom, she had many ready to be taken to the market for selling. She allowed the teachers to view her artistic work (see Figure 5.10).

**Figure 5.10: Shows the ECM's collection of baskets**

Through participatory observations and from the conversations exchanged during the expert community member's presentations I came up with three themes as shown in Table 5.2.

**Table 5.2: Themes that emerged from the data and supporting theory or literature**

| **Themes** | **Theory/ literature** |
|---|---|
| Teachers' conceptual understanding of chemical and physical changes enhanced | Mavhunga & Rollnick (2013); Susilaningsih, Fatimah, & Nuswowati (2019) |
| Teacher's understanding of the link between IK and school sciences enhanced | Kasanda et al., (2005); Çepni, Ülger, & Ormanci (2017); Chikamori, Tanimura, & Ueno (2019) |
| Zone of proximal development | Southwood & Ngcoza (2015); Stott (2016) |

I now discuss each of these below.

## 5.3 Teachers' Conceptual Understanding of Chemical and Physical Changes Enhanced

During the presentations, I observed that the teachers were afforded an opportunity in which their understanding of the concept of chemical and physical changes was enhanced. It emerged during the discussions that even teachers themselves held misconceptions on chemical and physical changes. This was noticed in T3's responses during the expert community member's presentation:

> *We say a physical change can be easily reversed right? And a chemical change is difficult to reverse. Now, after we have pounded the larger lump of those bark is it not difficult to change the powder of Munzinzila bark back to those large lumps we started with? (T3)*

From this excerpt, it seems that T3 thought that grinding *Munzinzila* bark is a chemical change and he incorrectly applied reversibility of changes. Apparently, he knows that a chemical change is difficult to reverse once it occurs. Notwithstanding, the quality of participation, interactions, and responses among the teachers themselves enhanced their understanding of the concept of chemical and physical changes. For instance, TI responded that:

*I think we need first to understand the chemical composition of matter before and after it has undergone a change, we know that physical changes do not affect the chemical composition, while a chemical change does (TI).*

*What we are seeing is only a change in state, the powdered of Munzinzila bark, contains no foreign matter, but that which we started with in the beginning (Cf).*

The teacher's conceptual understanding of the concept of chemical and physical changes increased as can be seen in the conversations. According to Susilaningsih, Fatimah, and Nuswowati (2019), conceptual understanding is one aspect that needs to be considered in teaching and learning. The conversations moved from an abstract to concrete level. Within the teachers' responses two important topic specific pedagogical content knowledge were salient; what is 'difficult to teach' and 'conceptual teaching strategies' **(**Mavhunga & Rollnick, 2013). What is difficult to teach requires teachers to spot misconceptions as in T1's and Cf's responses, which showed their awareness of the fact that if learners do not attain conceptual understanding of a concept it will be difficult for the learners to understand that concept. With conceptual teaching strategies, teachers seek to adopt teaching methods which will enable learners to understand the concept.

### 5.4 Teachers' Understanding of the Link Between IK and School Science

To help the grade 8 Physical Science teachers integrate IK in their science lessons, there was a need for the teachers to first explore the relevant IK they are familiar with. After participating in the two presentations by the ECM the teachers made this reflections:

*Both chemical and physical changes were observed e.g. soaking and boiling. White (nature as they call it) palm leaves in Muhonono leaves turn black, while grinding Munzinzila barks was physical change (TI).*

*Both chemical and physical changes were observed; grinding Munzinzila barks is physical change, while palm leaves changing to different colours is chemical change (T3).*

*On chemical change the palm leaves changed colour when heated in different plant extracts. And colour could not be reversed. In physical change, in weaving when a mistake is done you re-do (T4).*

The above quotes were responses to a question that was asked about what they had observed in the presentation by the expert community member. They also had to reflect on whether the observed changes were chemical or physical. Notably, before the science teachers were engaged in the two presentations they appeared to be familiar with the traditional practice of dyeing and weaving baskets. As it can be seen in the teachers' responses, the discussions from the presentation by the ECM gave the science teachers an opportunity to explore and understand the link between the dyeing and weaving of baskets with school science (chemical and physical changes). The teachers were enabled to see beyond the simple traditional practice of dyeing and weaving. However, they did not seem to have any knowledge of how this IK could be used to mediate the learning of chemical and physical changes.

The following excerpts are teachers' responses during the two ECM's presentations and they show the opportunities for science topics which could be mediated by the indigenous technology of dyeing and weaving baskets:

> *That is surface area effect on rate of reactions. When the split strips are left to dry in the sun the strips provides more surface area, that the water molecules inside the fronds quickly heats up and evaporates, this leaves the strips dry (T4).*

> *Oh they are many science concepts as here. Apart from chemical and physical changes, I see forces in action, pushing the awl to make a hole, pushing and pulling the palm leaf strip through the hole made (T1).*

> *There is also pressure here; she is applying a force on an area (T2).*

After the ECM's presentations the teachers met to brainstorm science concepts embedded in the indigenous technology of dyeing and weaving African basketry. As a result of their improved understanding of IK and the school science link, the teachers were enabled to come up with science concepts or topics that emerged and could be mediated by the indigenous technology of dyeing and weaving baskets from the ECM's presentation. From these concepts we subsequently co-developed an exemplar lesson that integrated the science concepts that emerged from dyeing and weaving of baskets to mediate learning of chemical and physical changes. The concepts that emerged from the expert community member's presentations are shown in Figure 5.11 below.

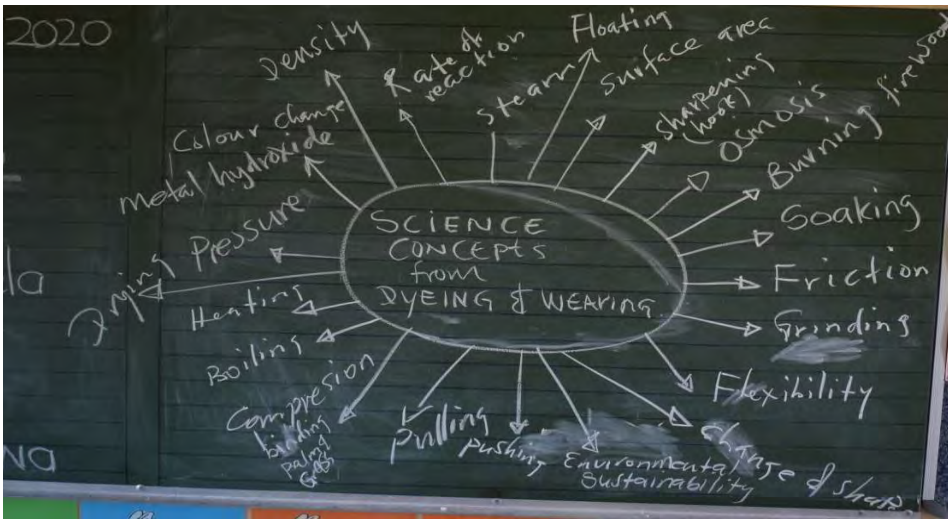


**Figure 5.11: School science concepts that emerged from the ECM's presentations**

## 5.5 Observed Shifts in Teachers' ZPD and Pedagogy

After the ECM's presentations, teachers were asked to reflect on the presentations. An improved understanding was not only observed in the teachers' subject matter knowledge but also in their pedagogical content knowledge (Shulman, 1986). This was evident in their reflections presented in Table 5.3 below.

**Table 5.3: Teachers' reflections**

| |
|---|
| *It is much helpful because learners could see for themselves the different changes like grinding the barks remain the same barks, only shape changes. But the dyed palm leaves looks/seem to have something in it that makes it different (T4).* |
| *Some of the practices used in the presentation would be very useful in my future teaching not only in the topic chemical and physical changes but in other topics too (T1).* |
| *I will not depend on examples given in the textbook anymore, I will try to give at least 50% of example in the local community (T3).* |
| *In my selection of teaching aids I have learned to include some from the local environment. Moreover inviting community members so that they can share the knowledge e.g. traditional way of preserving food (T4).* |

The extracts from these teachers' reflections suggest that the expert community member's presentations assisted them to visualise chemical and physical changes. By reflecting on their previous teaching practices, and as alluded to earlier, these teachers showed a significant increase in both their subject matter knowledge and pedagogical content knowledge. Moreover, they also exhibited understanding of IK and its implication in science lessons. The reflections also show that these teachers learnt how to integrate IK in science lessons. They thus reflected with confidence that they would use the knowledge in their future teaching. More importantly, this suggests that these teachers would be able to fulfil the curriculum requirements.

## 5.6 Chapter Summary

In this chapter, I presented the data from the participatory observations and discussions on the expert community member's presentations as well as the data from the teachers' reflections. Findings show that all the teachers found the indigenous technology of dyeing and weaving appropriate and useful to mediate the conceptual understanding of chemical and physical changes. The teachers' participation was very high, they interacted both with the expert community member and her mediatory tools. In the next chapter I present data gathered from the workshop on co-designing exemplar lessons that integrated IK.

# CHAPTER SIX: CO-DEVELOPMENT OF EXEMPLAR LESSONS

## 6.1 Introduction

The main goal of this study was to mobilise the indigenous knowledge practice of dyeing and weaving African baskets with the aim of co-developing an exemplar lesson to mediate learning of chemical and physical changes in grade 8 Physical Science lessons. In this chapter I present data gathered from the workshop on co-development of an exemplar lesson that integrated IK. The data generated was aimed at addressing my research questions three:

> *How can the grade 8 Physical Science teachers be supported in co-developing exemplar lessons on chemical and physical changes that integrate concepts from the indigenous technology of dyeing and weaving of African baskets?*

## 6.2 The Co-development of an Exemplar Lesson

The co-development of an exemplar lesson on chemical and physical changes that integrated IK science concepts embedded in the traditional practice of dyeing and weaving baskets was one of the objectives of this study. Essentially, engaging the four Physical Science teachers in the expert community member's presentations on dyeing and weaving baskets was meant for the teachers to explore and understand IK. The co-development of an exemplar lesson was thought as a form of support to the science teachers from which we could plan our own lessons that integrated IK. The session began with a discussion on what we thought were the key components to be considered when designing a lesson that integrated IK. Table 6.1 below shows the themes that emerged from our conversations in the session.

**Table 6.1: Themes from workshop discussion on lesson planning**

| Theme | Literature |
|---|---|
| Curriculum saliency | Shulman (1986); Mavhunga & Rollnick (2013); Shinana (2019); Magwentshu (2020) |
| Choosing relevant IK | Ali & Shishigu (2020); Magwentshu (2020); Mavuru & Ramnarain (2020) |
| Lesson structure | Namibia. MEAC (2016) |

I now discuss each of these below.

### 6.2.1 Curriculum saliency

During the session, the teachers suggested that our model lesson could follow the general format of lesson planning. Below are some of the aspects teachers felt needed to be included:

> *No, every lesson has name of subject, date, grade, lesson topic (T2).*
>
> *We also need lesson objectives and basic competencies from the syllabus (T1).*
>
> *For our lesson to stand out, we can then add another sub-heading relevant IK to those aspects (Researcher).*
>
> *Why don't we include a section titled prior knowledge? (T3).*

These excerpts show that there teachers' in-depth curriculum knowledge is a prerequisite for lesson planning and delivery (Shulman, 1986; Mavhunga & Rollnick, 2013). These teachers indicated and emphasised that every teacher should plan their own lesson according to the syllabus requirements. A syllabus is a detailed course document with a variety of topics. Each topic in the syllabus has objectives and basic competencies, which directs the teachers regarding *what to teach* or the subject content knowledge requirements. For our exemplar lesson we had already decided on the topic: chemical and physical changes. We then moved to our next phase in the discussion choosing relevant IK.

### 6.2.2 Choosing relevant IK

After choosing a science topic we discussed the need to choose IK that was relevant to both the chosen topic and the learners. In other words, the teachers were to use examples of IK practices that learners knew, or were familiar with, from home or community. This component of the lesson required the teachers' awareness of their learners' prior knowledge of indigenous knowledge combined with knowledge of multiple representations (Mavhunga & Rollnick, 2013).

During this session, the essence of planning dawned on us. For instance, we came to understand that we do not plan to teach a subject (we already possess subject content knowledge), but to teach unique learners (understanding what learners bring to the topic). The learners bring cultural knowledge, language, and beliefs and our target through planning is how to meet and use their cultural capital as a foundation to anchor new knowledge. The discussions allowed us to also allude to cultural beliefs as possible sources of IK. We encouraged ourselves to welcome such ideas by allowing learners to debate to minimise misconceptions (Kibirige & Van Rooyen, 2006). Apart from relying on the learners or on our limited IK, teachers resolved that they would invite expert community members to school to present some lessons to their classes or take their learners to the expert community members' places. This is taking science from home to school and also taking science from school to the environment.

Before discussing how the knowledge we learnt from the expert community member's presentation of dyeing and weaving could be integrated in the exemplar lesson, we first discussed its relevancy and appropriateness to mediate learning of chemical and physical changes. Below are some of the quotes from the teachers on how they felt about this:

> *For me, I think dyeing and weaving is very much relevant. I say this because, the changes observed like palm leaves changing colour from cream white to dark (charcoal) when soaked and boiled in Muhonono leaves were typically chemical changes (T2).*

> *It is true from those presentation learners can see for themselves when changes are taking place and can classify them as chemical or physical change (T4).*

The indigenous technology of dyeing and weaving passed the test of relevancy both on the topic of chemical and physical changes, as well as familiarity to the learners.

As far as the discussion on how dyeing and weaving could be used in the exemplar lesson was concerned, TI had this observation:

> *I think we need to decide on the nature of our lesson, when I look at these basic competencies in the syllabus, I see that we can have a normal lesson or a practical lesson. For me I see a very good practical investigation lesson here that illustrates examples of chemical and physical changes (T1).*

A careful examination of T1's suggestion shows a positive disposition towards practical activities that use resources that are easily accessed (Asheela et al., 2021). Such interest could be a result of being engaged in the expert community member's presentation. After a thorough discussion on the nature of the lesson we were going to prepare, the teachers decided against a practical lesson. This was arrived at considering the fact that our aim was to ultimately come up with an exemplar lesson that integrated IK, subsequent to which each teacher was to plan their own lesson. In the next section I discuss components or lesson structure.

### 6.2.3 Lesson structure

During the workshop on co-designing a lesson plan that integrated IK, the teachers settled on a format. It was agreed that teachers could still modify it to suit their situations or needs if necessary, however, the following nine components of a lesson that integrated IK were proposed to be compulsory:

- **Topic:** *(from the syllabus);*
- **Learning objectives:** *(from the syllabus);*
- **Basic competencies:** *(from the syllabus);*
- **Relevant IK:** (*chosen according to the topic with careful consideration of the learning and basic competencies. Its relevancy to be determined by its familiarity to the learners);*
- **Teaching/Learning Aid:** *(special resources from the learners' local environment);*
- **Introduction:** *(possibly position for narrating a relevant story to the topic);*
- **Presentation of subject matter:** *(teachers vs. learners activities: this is the possible portion for analogues, exploration hands-on IK, cultural artefacts, debating cultural beliefs, all expected questions and answers) creating links between abstract science concepts and IK;*
- **Conclusion:** *(recap: show learners link between IK and new subject content knowledge); and*
- **Assessment:** *(appropriate).*

The above format was followed to develop the exemplar lesson on chemical and physical changes using dyeing and weaving of African baskets. The exemplar lesson is shown in Appendix J. This workshop encouraged collaborative learning causing a shift in the teachers' ZPD in terms of their pedagogical content knowledge. Such positive shifts in learning were evident in the teachers' ability to come up with their own lesson plans; for example T1's lesson plan in Appendix J(a). T1's exemplar lesson impressed me, especially his selection of the indigenous knowledge practices of fermentation of milk. The practice is common in most homes in the village. As a result, learners can easily associate with it, and it is relevant to the topic of acids. For instance, the lactic acid causes the fermented milk to taste sour.

### 6.3 Chapter Summary

In this chapter, I presented, analysed, and discussed the data gathered from the workshop on co-development of an exemplar lesson. Findings from this study show that the teachers did not only participate in co-developing the model lesson but were successfully enabled to plan their own lessons using the exemplar lesson designed collectively. In the next chapter I present the summary of the findings, recommendations, and conclusion.

# CHAPTER SEVEN: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

## 7.1 Introduction

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

## 7.2 Overview of the Study

The main goal of this study was to mobilise grade 8 Physical Science teachers through the indigenous technology of dyeing and weaving of African basket with the aim to co-develop a model lesson that integrated IK, to mediate learning of chemical and physical changes. To generate data I employed four data gathering techniques: semi-structured interviews, workshop discussions, participatory observation, and teacher's reflections. The data generated were analysed inductively, sub-themes were allowed to emerge from the data and the common sub-themes were grouped together to form themes which I discussed in relation to the literature. Vygotsky's (1978) socio-cultural theory and Shulman's (1986) pedagogical content knowledge (PCK), together with Mavhunga and Rollnick's (2013) topic specific pedagogical content knowledge (TSPCK) were employed as theoretical and analytical frameworks.

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

1. Based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation?

2. During the workshop interactions with the expert community member, what opportunities emerged for the grade 8 Physical Science teachers to bridge the gap between curriculum formulation and implementation of IK?
3. How can the grade 8 Physical Science teachers be supported in co-developing exemplar lessons on chemical and physical changes that integrate concepts from the indigenous technology of dyeing and weaving of African baskets?

### 7.3 Summary of Findings

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

#### 7.3.1 Research question one

> *Based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation?*

Understanding the teachers' previous experiences, pedagogical insights and challenges they face when teaching Physical science was deemed critical in order to evaluate the effect of the intended workshop intervention on their pedagogical insights. The qualitative data from the teachers' semi-structured interview responses revealed Physical Science as a challenging and difficult subject for both learners and teachers. Because of the teachers' and learners' attitudes towards science teaching and learning, learners' performance in science has been poor. This conclusion is supported by Benson, Nwagbo, Ugwuanyi, and Okeke (2020) who state that attitude is very important in school science because for someone to achieve good marks in science they must display a positive attitude towards it. However, in this study the challenges according to the teachers are aggravated by the fact that they are forced to teach the theory part of science. One of the teachers highlighted that: "*Science is a more practical subject and our schools do not have laboratories" (T1SSI).*

Furthermore, the science teachers' claim that due to the serious shortage of school laboratories and equipment and chemicals, hands-on practical activities are not conducted. It seems that these teachers are aware of the importance of conducting hands-on practical activities; for instance they help to concretise abstract concepts and make them accessible to learners (Asheela et al., 2021). However, their responses revealed they seem to depend on the government to provide laboratory facilities, equipment and chemicals to conduct practical activities to fulfil the curriculum requirements. This is contrary to the national curriculum that calls for teachers to improvise by finding and using teaching and learning materials that are easily available and inexpensive resources found in the immediate environment (Namibia. MEAC, 2016).

Another finding in this study is that the participating teachers have some understanding of what prior knowledge is. The Namibian national broad curriculum calls for teaching to build on learners' existing knowledge and ideas (Namibia. MEAC, 2016). Notably, T3 for instance, positioned prior knowledge as everyday knowledge or experiences from home and this includes local indigenous knowledge. This finding is congruent with literature (Hashondili, 2020; Kibirige & Van Rooyen 2006; Kuhlane, 2011; Roschelle, 1995). In contrast, T2's and T4's responses suggested that prior knowledge is restricted to the content knowledge covered in the previous grade. The interviews revealed that the teachers could find out what their learners have learnt in previous grades or in topics that overlap, however, the teachers have not adequately elicited and used prior knowledge such as indigenous knowledge.

Lastly, data from the semi-structured interviews revealed that all the participating teachers are aware of the difficulties learners experience when studying chemical and physical changes.

### 7.3.2 Research question two

> *During the workshop interactions with the expert community member, what opportunities emerged for the grade 8 Physical Science teachers to bridge the gap between curriculum formulation and implementation of IK?*

Most significantly, in this study, the participating teachers found the indigenous technology relevant and useful in the teaching of chemical and physical changes. This was revealed in the teachers' reflections on their previous teaching practices. The teachers also confirmed a significant increase both in SMK and PCK. For instance, T1 and T3 reflected that:

> *Some of the practices used in the presentation would be very useful in my future teaching not only in the topic chemical and physical changes but in other topics too (T1).*
>
> *I will not depend on examples given in the textbook anymore; I will try to give at least 50% of example in the local community (T3).*

During the presentations by the expert community member the teachers were also observed showing their skill on how to use the mortar and a pestle, assisting the ECM and her daughter to pound the bark of *Munzinzila* during the ECM's presentations. All the teachers participated in asking and answering questions during the ECM's presentation. The teachers initiated discussions and evaluated the science embedded in the activities the ECM demonstrated. Collaboratively, the teachers were able point out concepts associated with chemical and physical changes in the presentations. The collegial conversations (Chauraya & Brodie, 2018) promoted learning and the improvement of teachers' understanding of chemical and physical changes were observed as a result of the ECM's presentation. Moreover, teachers' understanding of the link between IK and school science was enhanced (Aikenhead & Jegede, 1999).

### 7.3.3 Research question three

> *How can the grade 8 Physical Science teachers be supported in co-developing exemplar lessons on chemical and physical changes that integrate concepts from the indigenous technology of dyeing and weaving of African baskets?*

The activity of co-developing an exemplar lesson on chemical and physical changes integrating the indigenous technology of dyeing and weaving baskets was the chief goal of this study. In the first place, the teachers exhibited extensive knowledge when it comes to lesson planning. They also exhibited knowledge of the use of a syllabus in lesson planning. The crucial lesson teachers learnt in this section of the study, was the selection of the indigenous knowledge or practice – the teachers set a relevancy criteria. The teachers found that, to be used as a mediatory tool, the IK should be relevant to the topic chosen. Secondly, the IK must be relevant or familiar to the learners; it serves no purpose if learners do not know or cannot associate themselves with the chosen IK.

The teachers did not only participate in co-developing the lesson but were successfully enabled to plan their own lessons using the exemplar lesson see Appendix J(a). It can be said that the workshops in which the teachers were involved were successful ones as they met the goal of the study. This coheres with scholars in continuing professional development who advocate for educational workshops and training to be geared towards advancing teachers' professional development (Eun, 2008; Ngcoza & Southwood, 2019), to help change the teachers' teaching practices. The most salient lesson in this study was that we learnt how to work together as teachers in a community of practice with the expert community member to improve our pedagogical skills (Chauraya & Brodie, 2018).

### 7.4 Recommendations and Areas for Future Research

None of the participating teachers in this study had been exposed to IK and its integration in science learning, as it was not part of their teacher training programme at their university or college. As a result, teachers have inadequately utilised their learners' prior everyday knowledge (Kibirige & Van Rooyen, 2006; Roschelle, 1995). I thus recommend that all teachers' training institutions should consider revising and integrating IK in their curricula for teachers' courses as this will accommodate and empower graduating and younger teachers with IK.

For in-service teachers, I recommend school-based teachers' continuing professional development to enhance both the teachers' subject content knowledge and pedagogical content knowledge (Mavhunga & Rollnick, 2013) on IK integration. This may take the form of workshops organised at school level and could empower teachers at departmental level. The head of department for science, for instance, could designate a week in which they explore science topics and identify relevant IK that could be used to contextualise such topics. During these workshops, they may invite an expert community member or they could visit an expert community member on the identified IK.

This study has opened opportunities for possible further research. I would like to see a study conducted on the same topic exploring how the Physical Science teachers mediated the co-developed lessons in their science classrooms.

### 7.5 Limitations of the Study

Two limiting factors that hindered the amount and quality of data in this study are now discussed. The study only involved four teachers – given the population of the grade 8 Physical Science teachers in the Zambezi region and the country at large, it is impossible to generalise the findings as the sample size is too small. However, the data generated from the sample remains insightful on grade 8 Physical Science teachers' understanding of IK and how they mediate learning of chemical and physical changes.

The data generation process was conducted after school hours, with a time limit set for one hour. This time limit constrained the amount of data I could obtain. If I were to conduct this study again, I would extend the duration of the data collection process.

I had planned to spend more time with the expert community member so that the participants could see how the raw materials for the indigenous technology are collected (weaving grass and natural dyes). In addition, I had planned to collect my data in a minimum time frame of three consecutive weeks. However, the outbreak of COVID-19 restricted the time spent on the project.

### 7.6 Personal Reflections

I became a student at Rhodes University in 2017 doing my BEd Honours in Science Education. As a part-time student with numerous responsibilities such as being a full time senior secondary school teacher, a husband, a father of three young children aged one to seven and a breadwinner in the family, I can say completing this project was not easy. Finding a balance between my studies, schoolwork, and family responsibilities was a challenging task. As an ordinary teacher I was financially burdened as I was paying for the BEd Honours myself. Thus, thoughts of proceeding with the masters' programme after completing my BEd Honours were not there due to financial constraints. However, I came to find hope after learning that some of my colleagues were being funded by NASFAF. My colleagues motivated me to apply for a loan so that I could proceed with my master's studies.

My confidence in getting a loan was high, my financial fears were gone, and I was just looking forward to applying for admission into the master's programme. I am deeply indebted to my BEd-Honours colleagues for this enlightenment; I seriously did not know that postgraduates could also apply for funding with NASFAF. Thus, I dedicate this master's degree to all my friends who played a part in my being able to continue with this qualification.

It was in my second year during my BEd-Honours programme when I was introduced to the concept of indigenous knowledge and prior knowledge by Professor Ngcoza and Doctor Nhase. Choosing a research topic was not that difficult for me. Having been raised in a village and growing up learning about adulthood from family members and other elders in our community gave me an advantage as I could associate school science concepts with numerous cultural practices. I settled on the indigenous technology of dyeing and weaving African basketry to mediate learning chemical and physical changes. I also encountered some challenges, especially coming up with the research questions, the theory to be used in the study as well as coming up with a theory to analyse the data which was quite challenging. Even so, with the support of my two supervisors Professor Ngcoza and Mrs Joyce Sewry, together with our team spirited MEd and PhD scholars, I overcame these challenges.

Writing my research proposal and having it approved was the most exciting moment in my MEd journey – I thought I was moving closer to getting started. However, this period was shadowed by the most stressful period of getting the ethical clearance certificate. It was stressful indeed waiting and counting the months – one, two, three, four, and five. I remember re-uploading it and after another two months our supervisor enquired on my behalf from the ethics committee and I was so annoyed to learn that it showed that I had not attended to the reviewers' comments, while I had done so. I remember complaining to Prof Ken who advised: "*William do whatever they ask you to do".* I re-uploaded and after the six month I finally got the ethical clearance letter (see appendix A). The ethical clearance process should be revisited because my colleagues and I spent more months waiting to be given a go-ahead letter, than we spent on doing the research itself.

This study was conducted during the unprecedented outbreak of the world's deadly SARS-CoV-2 virus (COVID-19). As mentioned in the limitations of the study the Coronavirus pandemic negatively impacted this study, especially on the quality of data collected as well as the quality of social interactions and learning that took place. Initially, I thought I would not conduct the study as immediately when two cases were confirmed in Namibia, a state of emergency was declared and the country was on lockdown. Everything came to a standstill. In short, all the health regulations that were put in place to combat the spread of the deadly virus from spreading, impeded my research processes. For instance, the declared lockdown was accompanied by messages such as "stay at home" (when I was supposed to go and collect my data). Movement of persons were prohibited as well as gatherings of more than 10 persons. Though the number of participants was less than 10, everyone feared for their lives. COVID-19 instilled fear in people but Ubuntu overcame fear and brought hope and life to my study. I count myself lucky to have a supervisor like Professor Ken, who during this difficult period constantly reminded and encouraged us to remain focused on our studies. I realised the value of emails and Whatsapp messages. No week passed without: "how is life with you"? How is your study shaping"? He is advanced in age, but he makes good use of the social platform for his students. Very importantly he cultivated a spirit of teamwork amongst us master's scholars, using the phrase: *"If you want to go faster, walk alone! But, if you want to go far, walk together".* As a team of masters' students we are still holding hands and thinking of how much joy will fill our hearts if we all make it and graduate with these master's degrees.

I will remain indebted to the expert community member and the science teachers. In biblical terms, we will say they were 'laying down their lives for their brother's sake'. The programmes of many scholars around the world were put on hold amid the outbreak. My participants could not be stopped by this deadly virus, and this is the true meaning of Ubuntu: *"*I am because you are". There were supposed to be three participant teachers in this study. With the outbreak of COVID-19, the sample size was expected to drop, but it increased to four plus a senior science lecturer (Dr) from the local campus of the University of Namibia bringing the number to five. The COVID-19 period taught me to be resilient and remain focused in such times.

### 7.7 Conclusion

This study sought to mobilise the indigenous technology of dyeing and weaving baskets with the aim of co-developing an exemplar lesson to mediate learning of chemical and physical changes. Three research questions were answered using data collected from the semi-structured interviews, workshop discussions through participatory observation, and teachers' journal reflections. The findings revealed that the participating teachers learnt many lessons from the workshop discussions: among the lessons is that all teachers found the indigenous technology of dyeing and weaving relevant useful in the teaching and learning of chemical and physical changes. From the analysis of documents, it dawned on the teachers that the national curriculum for basic education and the national subject policy guide for Physical Science call on them to integrate IK.

During the presentations by the expert community member, teachers seemingly possessed poor SMK, when some misconceptions surfaced during the presentations. Further, data in this study revealed that the teachers' subject content knowledge of chemical and physical changes improved. Moreover, the teachers also showed significant increases in pedagogical content knowledge, showing improved understanding of IK and its implication for integration. The teachers were enabled to plan a lesson that integrated IK. The most important lesson teachers learnt was that the expert community member's indigenous technology of dyeing and weaving was more than just a source of income, but she was a more knowledgeable other (Vygotsky,

1978) in terms of indigenous knowledge that could be tapped into and used in the classroom. Lastly, the knowledge gaps found in this study have been presented as areas for further research.

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# Appendices

## Appendix A: Ethical Clearance

RHODES UNIVERSITY
*Where leaders learn*

**Human Ethics subcommittee**
**Rhodes University Ethical Standards Committee**
PO Box 94, Grahamstown, 6140, South Africa
t: +27 (0) 46 603 8055
f: +27 (0) 46 603 8822
e: ethics-committee@ru.ac.za

www.ru.ac.za/research/research/ethics
**NHREC Registration no. REC-241114-045**

24 June 2020

William Kakambi

Email: g17k8175@campus.ru.ac.za

Review Reference: 2020-1151-3551

Dear Prof Ngcoza

**Title:** Mobilising the indigenous practise of dyeing and weaving African basket to mediate learning of chemical and physical changes

Principal Investigator: Prof Kenneth Mlungisi Ngcoza

Collaborators: Mr William Kakambi, Mrs Joyce Sewry

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

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

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

Sincerely,

Arthur Webb

**Prof Arthur Webb**

**Chair: Human Ethics Sub-Committee, RUESC- HE**

## Appendix B: Directorate Letter of Consent

**REPUBLIC OF NAMIBIA**
**ZAMBEZI REGIONAL COUNCIL**


| | | |
|---|---|---|
| *Tel: +26466261962* | *Ngoma Road* | *Private Bag 5006* |
| *Fax: +26466253187* | *Govt Building* | *Katima Mulilo, Namib* |
| *Enquiries: Ms Adrenah K Mukela* | *Our Ref:* 13/2/9/1 | |


PO Box 2665
Ngweze
Namibia

Dear Mr William Kakambi

**REQUEST FOR PERMISSION TO CONDUCT AN EDUCATIONAL RESEARCH IN ZAMBEZI REGION WITH 3 GRADE 8 PHYSICAL SCIENCE TEACHERS IN KATIMA MULILO CIRCUIT**

Your letter to the office of the Regional Director: Zambezi Region dated 19 June 2020 with caption request for permission to conduct an Educational Research in Zambezi Region with 3 grade 8 Physical Science teachers in Katima Mulilo Circuit was received.

Kindly be informed that approval is granted to you to conduct a research as per your request, but let me draw your attention to the following aspects: **NOTE!**

- The granted approval should not disrupt the normal teaching and learning at the schools.
- Kindly share your findings with the Ministry.

**By copy of this letter Inspector of Education concerned is notified accordingly of your presence to these schools.**

I trust and hope you will find this in order.

MINISTRY OF EDUCATION, ARTS & CULTURE
Zambezi Regional Directorate
2020 -06- 23
Office of the Director
Private Bag 5006 - Katima Mulilo

**MS JOY ZAMBO MAMILI**
**REGIONAL DIRECTOR: EDUCATION, ARTS AND CULTURE**

## Appendix C: Principal letter of Consent

**Ministry of Education**
**Zambezi Regional Council**

[redacted]

[redacted]

**Dear Sir/Madam**

**Re : Permission granted to Mr Kakambi William to conduct his research study at [redacted]ct School.**

This communique affirms that permision has been granted for Mr Kakambi William to conduct his research study at our school.

Thanking you in advance

Yours sincerely

..........................................................
Mr. Mowa Shadrack
**PRINCIPAL**

[redacted]
10 JUL 2020
KATIMA MULILO
REPUBLIC OF NAMIBIA

## Appendix D: Teachers' Consent Letter

Dear Sir/ Madam

**Re: Invitation to participate in an educational research study**

I, William KakambiMafelelezo (student number 17K8175) a part-time student doing Masters in Science Education at Rhodes University, South Africa and a Mathematics and Science teacher at Mavuluma Senior Secondary school. I am kindly inviting you to be one of the participant in my study for a duration of two /three weeks in July 2020.

My research is an intervention on the integration of local, indigenous knowledge of dyeing and weaving of African Baskets to mediate learning of chemical and physical changes in grade 8 physical science class. In this study, you will be a co-researchers and your main roles among others includes: (a) share current teaching methods; (b) participate in semi-structured interviews, (c) visit two expert community members; who will present and you observe the cultural practice of dyeing and the weaving process so, as to visualize chemical and physical changes, (d) you will then reflect on your engagement in each of the presentation of the expert community members and lastly (e) will participate in developing a model lesson that integrate IK. The study will not disrupt the normal teaching as, all the activities (including planned workshops) shall occur between 15:00 -17:00 after school hours.

Kindly be informed that you are voluntary participating in this study thus you can withdraw at any time if you wish. If you agree to participate in this study you will be asked to sign a consent form that you understand and agree to the conditions, before engaging in any activity. We shall have a minimum of 5 visits to the expert basket weavers in the community to observe the science in the indigenous practices of African basketry. Be assured, your name or identity and views will be treated with the most anonymity and highest confidentiality, your name will not be used in descriptive text nor commentary, it shall be kept anonymously. The, data that will be gathered will not be used for other purposes apart from this study. Please note that you have the right to withdraw at any given time during the study

Should you need more information contact me at wmkakambi@gmail.com
My supervisor is Prof K.M Ngcoza at Rhodes University, email address (k.ngcoza@ru.ac.za)
My co-supervisor is Mrs Joyce Sewry at Rhodes University, email address (j.sewry@ru.ac.za)
The Rhodes University Ethic coordinator is Mr Siyanda Manqele, email address (s.manqele@ru.ac.za)

Would you indicate your choice by ticking [√] in the appropriate box below?
Agree ☐ Not agree ☐ Signature: ...................................
Your cooperation will be highly appreciated
Yours Sincerely
William Kakambi

**DECLARATION BY PARTICIPANT**

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

I hope my request receive your consideration looking forward to your prompt response.

Yours Sincerely
**William Kakambi** (MEd in science student @ Rhodes University)

## Appendix E: Critical Friend's Consent Letter

Dear Research Participant

**Re: Invitation to participate in an educational research study as a Critical friend**

I, Willian Kakambi Mafelelezo (student number 17K8175) a part-time student doing Masters in Science Education at Rhodes University, South Africa and a Mathematics and Science teacher at Mavuluma Senior Secondary school. I am kindly request you to participate in my study as a critical friend for a duration of one or two weeks in February/March 2020.

My research is an intervention on the integration of local, indigenous knowledge of dyeing and weaving of African Baskets to support grade 8 Physical science teachers in mediating learning of chemical and physical changes. I am not doing research on you, but we are going to do the research together. In this study, you will be a co-researchers and you will participate in asking probing questions to both the expert community member and the participating teachers. I will also request you some time to critically reflect on the data I capture in this study. Together with the teachers, you will participate in developing an exemplar lesson that integrates IK. The study will be taking place between 15:00 -17:00 after school hours.

Kindly be informed that you are voluntarily participating in this study thus you can withdraw at any time if you wish. Your name and identity will not be used in the descriptive text nor commentary it shall be kept anonymously. Nonetheless, data that will be gathered will not be used for other purposes apart from this study.

Should you need more information contact me at wmkakambi@gmail.com

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

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

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

Would you indicate your choice by ticking [√] in the appropriate box below?

Agree ☐ Not agree ☐ Signature: ....................................

Your cooperation will be highly appreciated

Yours Sincerely

William Kakambi

**DECLARATION BY PARTICIPANT**

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

Name.........................................................................................

Signature....................................................................................

Contact number...........................................................................

I hope my request receive your consideration looking forward to your prompt response.

Yours Sincerely

**William Kakambi** (MEd in science student @ Rhodes University)

**Appendix F: Letter to the Expert Community Member [English]**

**Dear Madam**

**<u>Re: Request to voluntarily present dyeing and weaving African Basketry to grade 8 Physical Science teachers</u>**

I, William Kakambi Mafelelezo a part-time student (17K8175) studying for a master's degree in Science Education at Rhodes University, South Africa and a Mathematics and Science teacher at Mavuluma Senior Secondary school. I hereby humbly request your willingness to be a research participant in my research project with three other Physical science teachers. I will conduct the study for about one or two weeks in February/March 2020.

My research is an intervention on the integration of local, indigenous knowledge of dyeing and weaving of African Baskets to support grade 8 Physical science teachers in mediating learning of chemical and physical changes. Since our focus is on African basketry, your main roles will be: prepare all materials used to make the lovely African baskets, the dyeing of the palm leaves and be ready to coil sample baskets for the participating teachers to learn your cultural heritage.

Kindly be informed that you are voluntarily participating in this study as there will be no remuneration of any kind, thus you can withdraw at any time if you wish. I must ensure you that your name and identity will not be used in descriptive text nor commentary it shall be kept anonymously. As for the data that will be generated will only be used for the purpose of this study.

Should you need more information contact me at wmkakambi@gmail.com

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

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

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

I would you indicate your choice by ticking [√] in the appropriate box below?

Agree ☐ Not agree ☐ Signature:…………………

Your cooperation will be highly appreciated

Yours Sincerely

William Kakambi

**DECLARATION BY PARTICIPANT**

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

Name……………………………………………………………………………….

Signature………………………………………………………………………...

Contact number…………………………………………………………………

**Letter to the Community Members [*Silozi* translation]**

**Kumu salimuhulu…………………………**

**<u>Re: Kupo yakutoikabela hamoho zibo ya mina ya kutintula mubala ni kuluha Maselo.</u>**

Kina William Kakambi Mafelelezo, muituti kwa sikolo sesi pahami sa Rhodes Mwa naha ya South Africa. Ticele fa sikolo sa Mavuluma senkondali, Nimiñolela kumikupa kuba yomuñwi wabaipapapi mwa Tuto yaka ye, nimaticele babsitopa sa 8 Sayansi babalalu. Tuto ye etaeetaezahala mwahala viki iliñwi kapa zepeli mwakweli ya Sope kapa Yowa 2020.

Tuto ye kikuikabela, ku zibisa maticele kuama ni sebeliso ya zibo ye mwa mipilelo nilipangaliko za sizo. Musebezi tuna wamina, kikupankanya kulukisa lisebeliso zemusebelisa hamuluha maselo, sihulu kutintula mubala wa mukulwani omuluhisanga. Maticele bata mipotela kwa sibaka samina. Muitukiseze kutoikabela niluna zibo ya sizo samina. Mutomo was tuto yee, kikuongaonga sebeliso yazibo yasizo kuluta tuto ya Sayansi. Butungi bwa tuto lubata kutalima kalulo yakuntintula in kuluha maselo ili kufa banabasikolo sikuka habanze baituta lichincheho zeinelenzi ni za swalelele. Kalulo tuna yamina kikulutusa, kutoluetelela momupangela mukwaipo mane cwalo ni kuluha Maselo, mo lubata kufumana kutwisiso yalinchincheho.

Kukena kwamina mwatuto ye hakikapelezo kondo kibuitomboli, kacwalo mulukuluhile kuzwa mwa tuto ye nako kaufela yemukali hamusatabela kuzwelapili. Libizo niku zibahala kwamina itaba kunutu, hanina kumipatulula mwa kuñola litaba zatuto ye. Haiba kuna nifomusautwisisi muniswale fa emele ye wmkakambi@gmail.com kapa baeteleli baka bo Prof K.M Ngcoza kwa Rhodes University, emela yabona ki (k.ngcoza@ru.ac.za) ni mubakweli mufumahali Joyce Sewry kwa Rhodes University, mi elmele ki (j.sewry@ru.ac.za)

Ya muongaongi wa Ethic Mr Siyanda Manqele, email address (s.manqele@ru.ac.za)

Nikupa kuli mubonise kakuketa mwaka box kubonisa maikuto amina

Agree [Kulumela] ☐ Not agree [Kuhana] ☐ Signature: [Siino] …………………

Na wamina

William Kakambi

**DECLARATION BY PARTICIPANT**

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

Name…………………………………………………………………………………….

Signature…………………………………Contact number……………………………………

**Appendix G: Semi-structured Interview Schedule**

RHODES UNIVERSITY

***Where leaders learn***

**Semi-structured interviews protocol for Teachers**

***Proposed research Title:*** Using the indigenous technology of dyeing and weaving African baskets as a cultural tool to mediate learning of chemical and physical changes

**Preamble**: Thank you Sir/Madam. The purpose of this interview is for us to discuss the teaching and integration of indigenous knowledge in Physical Science in the topic of Chemical and Physical changes. Feel free to share with me your experiences through the following questions. I may have some follow ups questions along the line.

1. Could you please tell me for how long have you been teaching Physical Science in grade 8?
2. Could you please tell me what are your views about teaching Physical Science in your grade 8 science class?
3. Could you please tell me what are your experiences of teaching the topic of Chemical and Physical changes in your grade 8 science class?
4. What prior knowledge do you expect your grade 8 learners to have about Chemical and Physical changes?
5. Could you please tell me how do you find out your learners' prior knowledge when teaching the topic on Chemical and Physical changes?
6. Could you please tell me your challenges you have been faced with your grade 8 learners when teaching this topic on Chemical and Physical changes?

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

| | |
|---|---|
| **Question 1: Could you please tell me for how long have you been teaching Physical Science in grade 8?** | |
| T1SSI | I have been teaching for 11 years now. |
| T2SSI | in grade 8. Oh thank for the question. Eeeh I started teaching that was in 2004. I taught physical science and mathematics. I will say for the rest of my- 15 years.<br><br>Me: 15 years, you have been teaching physical science for fifteen years. |
| T3SSI | aaaaahh physical science I taught it now for oooo because I started teaching 2009. Aaaaah that is almost 10 years now. |
| T4SSI | aoooh for now its aaa... approximately six years because the other year I was teaching mathematics |
| **Question 2: Could you please tell me what are your views about teaching Physical Science in your grade 8 science class?** | |
| T1SSI | Science has many aspects that many people do not understand. It is more of a practical subject. But most of our schools do not have laboratories, so we teach science using theories. |
| T2SSI | How do I teach it? Ohoo.. What is involved? That is you let learners, teach them share with them what is happening in the world around us. And why do things happen like that, in the environment, the things reacts together, interact eeeeh like that. You find that there is a part we call Physics - has to do with physical things and Chemistry how they react together. |

| | |
|---|---|
| | Me: you are saying there is Chemistry in grade 8.<br><br>T2SSI: Yes. The reaction part. |
| T3SSI | okey physical science aaaah is taught let say physical science is a practical subject, but then aaaaah. Teachers tend to it theory because of lack of chemicals and apparatus or equipment.<br><br>Me: So it involves practical but you teach it more theoretical than conducting experiment?<br><br>T3SSI (Joy): yes because of lack of chemicals and apparatus<br><br>Me: With the lack of chemicals and apparatus. What do you think can be done? Say how do you conduct your experiments in class<br><br>T3SSI (Joy): aaaah experiments can be done aaah through improvisation, yaaah you can improvise. For instance, you are teaching about reflection you can take mirrors for use in your lesson. |
| T4SSI | T4SSI: okey, aooh science, aaa eee, especially here at home it is one, physical science is one of the of the aaaa regarded to be a difficulty by learners due to culture. They believe everything that is there it is aa much of technology. Traditionally aaaeee kids find it and take it to be very difficult.<br><br>Me: How do you take it yourself?<br><br>T4SSI: aaah aaahh to me I enjoy it. Aaaahh basically from my eeee schooling time I enjoyed science that why I furthered it at college level and eee yaah I enjoy doing new thing subject by<br><br>Me: thank you very much. |
| **Question 3: Could you please tell me what are your experiences of teaching the topic of Chemical and Physical changes in your grade 8 science class?** | |

| | |
|---|---|
| T1SSI | T1SSI: learners on this topic chemical change when you introduce the lesson. The lesson seems to be very easy and very simple to leaners and very enjoyable to learners. As a physical science teacher, I do not find the topic to be very difficult too. Everything, difference between chemical and physical as required in the syllabus is nicely found in the textbook. |
| T2SSI | T2SSI: How do I approach it? Okey, when I first teach it. Though learners are aware of the changes. I can't say much about grade 7 content I have not been exposed to it. But from home there changes. I suppose in natural science grade 7 there are changes I do not know specifically if there chemical or physical changes but there changes there. Emmhuuu so I find out, and I will tell them noo, in the world around us even at school. Substances change, have experienced any change, there will be mentioning the changes they think and they know. Its prior knowledge, I do not know if they will be correct of wrong and they do not know whether that what I am looking for or not but changes are there they will be mentioning these changes then you go on and eeeeh ask them if they can differentiate them.<br><br>Me: what does the syllabus says about chemical and physical changes in grade 8. When you are teaching chemical and physical changes what does the syllabus requires you to do as a teacher or what they should know.<br><br>T2SSI: you state those basic competencies before you actually introduce it you have to find out what they know about that, so that when you introduce it they will be able to understand it. |
| T3SSI | chemical and physical change. Aaah being a teacher, the topic suppose to be easy topic, because they just have to master the characteristics of chemical say it is permanent and physical changes is temporal. Learners due to lack of experimental exposure they tend to mix up the questions. They don't really understand. |

| | |
|---|---|
| T4SSI | Aahm there are some challenges that comes inn, aaaaa it is on, especially on chemical. Chemicals aaaah aaammmm ahmhhh but I am saying that in terms of aaammm daily life examples aaammm aaamm some of the things they aree aaa are quite difficult to to..t..o for learners to state whether these are physical changes or chemical changes especially with chemicals. But then in our daily lives you can see simple life, like ice to water these they can tell whether new substance are formed but in terms of chemical we have a challenges of a aaamamm aaaa of getting those it's just theoretical. |
| **Question 4: What prior knowledge do you expect your grade 8 learners to have about Chemical and Physical changes?** | |
| T1SSI | I expect them to know the definition of chemical and physical changes. I also expect them to know examples of the two, including the [redacted] |
| T2SSI | I will not know exactly because I have not yet taught them. [redacted]. |
| T3SSI | aaaah the prior knowledge that I expert my learners to have is aaaah let say aaah my learners have been cooking, seen someone cooking. When something is cooked, aaaaah it will undergo what we call aaaah change chemical change. |
| T4SSI | Okey eeeaaah aam with that one it is sometimes difficult [redacted]. But, I believe in their homes eeeaaaam they are having that knowledge of thing even though they dot label them as physical or chemical change in their daily lives but the things they do that produces new substances and they are things that they do that there are no changes happening in their lives, so I believe they have that little knowledge |

| **Question 5: Could you please tell me how do you find out your learners' prior knowledge when teaching the topic on Chemical and Physical changes?** | |
|---|---|
| T1SSI | T1SSI: okay by simply introducing the lesson and ask oral questions and then going in details. I ask questions like what is a chemical change. What do you know about chemical and physical change? How do you understand what a chemical change is? That how I will know if the learners have any idea of what a chemical of physical change is?<br><br>Me: in other words you expect the grade 8 to be able to define chemical and physical changes. Where will they get the definition of chemical and physical changes, as you are teaching this for the first time.<br><br>I expect them to give me the definition this I expect them to know from their previous grades. |
| T2SSI | T2SSI: Just like in the previous question, if I taught them topic in the previous grade which is 7, now I ask learners questions on the topic. Then I will go deeper within the topic. |
| T3SSI | Uuuuuh the best way I use is to ask them random questions and pinpoint to some situation that when this happens is it physical or chemical. |
| T4SSI | Ok aaam eee especially in grade 8 we ask learners always to introduce, like when I am introducing the topic to say: aaaee we are going to learn about chemical and physical change. So I will always state the difference to say what are the difference between eeem chemical and physical chances. Now can you state examples. Now this is where, now learners could see that learners give that simple example like as I stated, yaah like you water, when you boil it will just remain water. |

| Question 6: Could you please tell me your challenges you have been faced with your grade 8 learners when teaching this topic on Chemical and Physical changes? | |
|---|---|
| T1SSI | The main challenge that I have faced with chemical and physical changes aaah, my learners always confuse the two. During the lesson learners may seem to understand what a chemical or physical change is? But when assessing them you will find out they now confuse the two. Properties of chemical changes will be given to a physical change and those of physical change to chemical changes. Even the examples that they give they might give a physical change to a chemical change. Those are the challenged that I face.<br><br>Me: why do learners confuse the two?<br><br>Ooh it is the fact that from the beginning of the lesson both me and the learners we take this topic as a very simple topic and we just used the knowledge that is given in the textbooks or syllabus. |
| T2SSI | T2SSI: challenges are there. I do not know if I should say one of them is English. They don't really understand what means is if this is physical change the change is temporally and this is chemical the change is permanent and energy is always involved and so on those things. It is like they don't really understand those concepts because when you give then a question or in a test for them to answer. Instead of thing of those about those differences and match them to the question. They will just think whichever comes which ever they think about. For example if you ask them burning wood is that chemical or physical? Some will still say physical, just like guess work they don't think deeper they do not like understand the table that these are characteristics of chemical and these are for physical changes and then now they match with that for burning wood. Can burnt wood be reversed? Is it permanent, is energy involved or not? Some but some they can able to match. |

| | |
|---|---|
| | Me: What do you mean by match, does it mean you will have something like a list of chemical changes and a list of physical changes?<br><br>TFSSI: Of cause before the learners know that this is a chemical and physical change it is good or best for to differentiate in terms of a table like for each point under physical change. If we say it is temporally, then it the opposite for chemical will be permanent change. If for physical change we say no new substance formed then for chemical a new substance is formed. |
| T3SSI | T3SSI: the challenges aaaah for instance if we say a candle is burning. Now you ask a learner is that a physical or chemical change. The two changes are there; the burning itself that is a chemical change, but then wax melt that in itself is a physical change. It is just the wax that melts, turns into liquids and afterwards it turns into solid. Learners do not understand this. |
| T4SSI | T4SSI: This topic needs time, I think most of the time, because it has to work with experiments whereby you have to see whether a substance is changing or not changing. Sometimes in the 40 period and due to other conditions especially aaaam in situation, you will find out you are not given that much time in terms of laboratory on observing these aaaam changes so that there are new substance formed or not.<br><br>Me: in terms of your learners during tests and examinations what are the challenges?<br><br>T4SSI: With my learners to those examples I have given them they do not have much problems yaah they can tell especially with the simple definitions eeem a chemical change: new substance are formed, now physical change no new substances are formed, they do not have a problem.<br><br>Me: where is the problem; specifically or where do they lose marks?<br><br>T4SSI: aaaam the only part is with the chemicals as I started first. When you give the equation of aaaa mixing chemicals when you say there is this chemical |

| | |
|---|---|
| | A and B when you mix them now what will be the result because sometimes we do not carry or under these experiment, this is the problem with chemicals. Otherwise with the examples of daily lives they are doing well. |

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

| Research question 1: **Based on the grade 8 Physical Science teachers' previous experiences and pedagogical insights, within this study context, what challenges do they face in bridging the gap between curriculum formulation and implementation?** | | |
|---|---|---|
| **Sub-themes** | **Themes** | **Literature/Theory** |
| -Has many aspects that many people do not understand.<br>-Physical science is a practical subject.<br>-There is a part we call Physics - that has to do with physical things and Chemistry; how they react together.<br>-Physical science is regarded to be difficulty by learners due to culture.<br>-Everything that is there it is much of technology. | **Teacher's views about Physical Science as a subject** | Stein et al. (2008) |
| -Lesson/topic seems to be very easy and very simple to leaners<br>-The topic supposed to be easy topic<br>-We take this topic as a very simple topic and we just used the knowledge that is given in the textbooks or syllabus.<br>-Teach them share with them what is happening in the world around us.<br>-We teach science using theories.<br>-Teachers tend to it theory. | **Teachers' experiences and pedagogical insights teaching chemical and physical changes** | Kuhlane (2011)<br>Kozulin (2004)<br>Shulman (1986) |

| | | |
|---|---|---|
| -They just have to master the characteristics of chemical and physical changes<br><br>-Improvisation, you can improvise<br><br>-Lack of chemicals and apparatus or equipment.<br><br>-Our schools do not have laboratories<br><br>-Some challenges that comes inn, it is on especially on chemical | | |
| -Difference between chemical and physical as required in the syllabus is nicely found in the textbook.<br><br>-I cannot say much about grade 7 content I have not been exposed to it<br><br>-I believe in their homes they are having that knowledge of thing even though they dot label them as physical or chemical change in their daily lives<br><br>-Properties of chemical and physical changes from grade 7<br><br>-I said I do not know about grade 7 content<br><br>-If I do not know what they learnt on the topic already.<br><br>-My learners have been cooking, seen someone cooking.<br><br>-I ask questions like what is a chemical change.<br><br>-How do you understand what a chemical change is? | **Teachers' understanding of prior-knowledge.** | Kuhlane (2011)<br><br>Roschelle (1995)<br><br>Kibirige & Van Rooyen (2006)<br><br>Hashondili (2020)<br><br>Mukwambo et al. (2014) |

| | | |
|---|---|---|
| -Pin point to some situation that when this happens is it physical or chemical.<br><br>-You boil water it will just remain water. | | |
| -They tend to mix up the questions.<br><br>-One of them (challenge) is English.<br><br>- A candle is burning**,** two changes are there; the burning itself that is a chemical change, but then wax melt that in itself is a physical change**.**<br><br>-But when assessing them you will find out they now confuse the two.<br><br>-Properties of chemical changes will be given to a physical change and those of physical change to chemical changes | **Teachers' knowledge of their learners learning difficulties and misconceptions.** | Mavhunga and Rollnick (2013) |

**Appendix H: Reflection by Teachers**

## TEACHER'S REFLECTION ON PRACTICAL DEMONSTRATION DYEING AND WEAVING.

***During the workshop interactions with expert community member, what opportunities emerged for the grade 8 Physical science teachers to bridge curriculum formulation and implementation of IK?***

1. What have you learnt (or not) from the community members' presentation? anything that relates to physical science in the indigenous technology of dyeing and weaving African baskets?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

2. Which changes chemical or physical did you observe in the presentation by the expert community member? From your observations make you think that the observed changes are chemical or physical?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

3. How helpful or not, do you think this presentation could be to your learners' understanding of the difference between chemical and physical changes?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

4. How have your engagement in this indigenous technology of dyeing and weaving African baskets presentation by the expert community member going to change the way you teach chemical and physical changes?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

5. Is there a need to include indigenous knowledge/ practices such as dyeing and weaving African basket in science teaching? Explain

…………………………………………………………………………………………………

…………………………………………………………………………………………………

**Appendix H(a): Collated Teachers' Reflections Responses**

<table>
<tr><td colspan="2">1. What have you learnt (or not) from the community members' presentation? Anything that relates to physical science in the indigenous technology of dyeing and weaving African baskets?</td></tr>
<tr><td>T1</td><td>Science is there e.g. concept of pressure, changing substances and reactions were seen and explained</td></tr>
<tr><td>T3</td><td>Yes, the rate of reaction between the dye and palm leaves, depending on the surface area of palm leaves exposed to the dye and boiling water.</td></tr>
<tr><td>T4</td><td>Most of things that were done the were related to physical science like heating and making substances small.</td></tr>
<tr><td colspan="2">2. Which changes chemical or physical did you observe in the presentation by the expert community member? From your observations make you think that the observed changes are chemical or physical?</td></tr>
<tr><td>T1</td><td>Both chemical and physical changes were observed e.g. soaking and boiling white (nature as they call it) palm leaves in Muhonono leaves turns black while grinding Muzinzila bark was physical.</td></tr>
<tr><td>T3</td><td>Both chemical and physical changes were observed. Pounding Muzinzila bark is a physical change while palm leaves changing to different colour is chemical.</td></tr>
<tr><td>T4</td><td>In chemical, palm leaves changed colour when heated in different plant extract, and the colour could not be reversed. In physical change in weaving when a mistake is done you redo.</td></tr>
<tr><td colspan="2">3. How helpful or not, do you think this presentation could be to your learners' understanding of the difference between chemical and physical changes?</td></tr>
<tr><td>T1</td><td>Very helpful, now learners could observe for themselves what we mean by new substance formed or not e.g. the dyeing part could be seen that the composition of the palm leaves after dyeing changed while grinding bark which are used for dyeing just change shape.</td></tr>
<tr><td>T3</td><td>It will be helpful because learners are using local materials which are familiar to them and things that they do in their local communities.</td></tr>
</table>

| | |
|---|---|
| T4 | It's much helpful because learners could see for themselves the different changes like grinding the bark remain the same barks only shape changes. But the dyed palm leaves looks/seem to have something in it that makes it different. |
| **4. How has your engagement in this indigenous technology of dyeing and weaving African baskets presentation by the expert community member going to change the way you teach chemical and physical changes?** | |
| T1 | Some of the practices used in the presentation would be very useful in my future teaching not only in the topic chemical and physical changes but in other topics too. |
| T3 | I will not depend on examples given in the textbook anymore, I will try to give at least 50% of example in the local community. |
| T4 | In my selection of teaching aids I have learned to include some from the local environment. Moreover inviting community members so that they can share the knowledge e.g. traditional way of preserving food. |
| **5. Is there a need to include indigenous knowledge/ practices such as dyeing and weaving African basket in science teaching? Explain** | |
| T1 | Yes, of course, it's very important as learners are familiar with the knowledge presented. |
| T3 | Yes, because learners are familiar with the materials used during the lesson. |
| T4 | Yes, there is a need because learners are familiar to these knowledge practice and becomes easy for them to understand science concepts. |

## Appendix I: Participatory Observation Data Sheet

**Indigenous preparations of Natural dyes**

**Participatory observations data sheet**

TLM

| Name of Dye/ Source (made from) | Desired colour | Apparatus/materials needed and Preparation method |
|---|---|---|
| 1. Muzizila bark | from Gean white / Brown | Muzizila tree bark pounding stick, water, palm leaves (1) pound muzizila (2) add palm leave then (3) water (4) boil them. |
| 1. Mukokoshi | From Green white to orange. Natura colour | (1) Mukokoshi Roots (2) smash them (pounding) (3) water (4) Boil the leaves. |
| 2. Muhonono | From Green white to Black | (1) Muhonono leaves (2) Boil the leaves (3) For few minutes |
| 3. Tins lasted | To Grey | (1) Put them to gather with lasted Tins (2) leave them for a while. 3 days |
| 4. | | |
| 5. | | |

**Appendix J: Exemplar Lesson**

| | | |
|---|---|---|
| **Subject: Physical science** | **Grade: 8** | **Date: 22 July 2020** |
| **Theme: Matter** | | |
| **Topic:** Nature of matter: Physical and chemical changes | | |
| **Teaching/Learning:** Un dyed and dyed palm leaves strips; freshly collected palm fronds and dried palm leaves strips; ungrinded and grinded Munzinzila tree bark and a container of water. | | |
| **Learning objectives: Learners will:** know the nature and characteristics of physical change and chemical change, the three states of matter and the kinetic particle theory of matter | | |
| **Basic competencies: Learners should be able to:** Distinguish between a physical and a chemical change<br><br>Give examples of chemical changes or reactions in everyday life. | | |
| **Relevant IK:** Processes in the practice of dyeing and weaving baskets | | |
| **Short introduction:** The teacher display all the materials brought to class and ask the learners to identify the traditional practice where they are used. Learners will be asked to identify the names of the materials. | | |

**Presentation of subject matter**

| Teachers' activity | Learner's activity |
|---|---|
| • Facilitate the identification of the materials used in dyeing and weaving<br>• Engage learners in an activity (where possible demonstrate) to identify and discuss the changes that took place in the preparation of the different materials: for instance; freshly cut palm fronds and dried palm leaves strips: undyed and dyed palm leaves | • Identify the materials by local names and in which practices they are used at home.<br>• Observe and classify changes as chemical or physical changes |

| | |
|---|---|
| strips or between ungrinded *Munzinzila* tree bark to the powdered *Munzinzila* bark.<br>• The teacher helps learner make connection between the observed changes and the characteristics of physical and chemical changes. | • Take notes on the nature and characteristics of physical change and chemical changes and link them to what they observed. |

**Consolidation:** Emphasize on the changes learners identified and classified as chemical or physical changes.

**Assessment: Homework to give:**

There are many changes in everyday life for example: fresh milk turning to sour milk is a good example of a chemical change.

Write down at least 5 changes that take place in our everyday life and classify them as chemical or physical changes.

**Appendix J(a): T1 Lesson Plan**

**Appendix … LESSON PLAN**

**Subject: Physical science** **Grade:** 9. **Date:**

**Theme:** Acids, Alkalis (bases), Metals and non-metals

**Topic:** Acids

**Teaching/Learning** (Aid): Fermanted milk, fresh milk, Mundambi Mango fruit, Lemon fruit and Mutente (wild fruit). + Universal indicator Solution

**Learning objectives: Learners will:** Know the nature and effect of acids on indicators

**Basic competencies: Learners should be able to:** Identify and name examples of acids in everyday life, discuss that acids are common in food, particularly fruits and that they have a sour taste.

**Relevant IK:** Fermantation of milk

**Short introduction:** I will ask the learners to tell me the difference in taste between fresh (cow) milk and fermanted milk. Later, Learners will taste the two, to confirm or not the tast foretold

**Presentation of subject matter**

| Teachers' activity | Learner's activity |
| --- | --- |
| Ask learners to identify the teaching/learning aid brought to class. | → learners to correctly identify all the fruits including fresh and sour (fermanted milk) |
| Ask learners to state the taste difference between fresh (cow) milk and fermanted milk | → Learners first to share their experiences and then give the difference if there is any |
| → The teacher ask the learners to taste the all the fruits including sour milk and fresh milk. (all are safe to taste)! | → Learners to report results of the taste, which one have a sour taste, bitter/sweet |
| → All substances with sour taste are acids | |
| - using universal indicator learners to find out weak or strong acid from the tasted food staff. | → Use universal indicator solution to determine strong and weak acids |

**Consolidation:** Stress that acids have a sour taste and Summarise the lesson.

**Assessment: Home work to give:** Using universal indicator solution results, learners to classify tasted food/fruits are strong or weak acids.