

**Mobilising the indigenous technology of making soap to mediate  
learning of saponification in organic chemistry**

**A thesis submitted in fulfilment of the requirement for the degree**

**Of**

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**Education Department**

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**By**

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**June 2022**

## Declaration of Originality

I, Neporo Johannes (19N9570) hereby declare that this thesis is my own original work and has not, in its entirety or in part been submitted to an institution of higher learning for a degree assessment purpose. All ideas, citations, quotations, and other materials derived from other people are duly acknowledged using the APA referencing style as per Rhodes University's Education department guidelines.

Signature: 

Date: 14 June 2022

## **Dedication**

I dedicate this thesis to my late mother Erwina Neporo (1970-2014). Dear mom I know you would have been very proud to read this thesis and would have enjoyed the fruits of your labour. Continue resting in eternal peace.

## Acknowledgements

First and foremost, I would like to thank God almighty for giving me the gift of life, wisdom, and intelligence and for seeing me through this academic journey.

Secondly, I would like to thank my family, friends, MEd classmates and work colleagues for their unwavering love, care, support, patience, and inspiration during my academic journey. In the same vein, I would like to give thanks to the four Chemistry teachers, a critical friend and the two expert community members for participating in my research study. To the school principals and Ministry of Education officials, thank you for giving me the access I needed to conduct the research.

To Ms Nikki Watkins thank you very much for professionally editing and formatting both my research proposal and thesis.

Furthermore, this thesis is written from a place of deep respect for the work of all my academic predecessors both locally and globally, I salute you all and your truly intellectual giants.

Finally, and most importantly, I would like to say thank you very much (*pandu zonene*) Prof Kenneth Mlungisi Ngcoza for being my supervisor and mentor. You are the greatest star! God bless you!

## Abstract

Scholars across the world are advocating for culturally responsive pedagogies that allow for the integration of indigenous knowledge (IK) in science teaching. This is in the hope of making science accessible and relevant to learners from different social, economic and cultural backgrounds. Although the Namibian curriculum welcomes the integration of IK in teaching, it, however, does not stipulate how it should be implemented. It is against this backdrop that this interventionist study aimed to mobilise the indigenous technology of making soap to mediate the learning of saponification in organic chemistry.

This study is underpinned by the interpretive and indigenous research paradigms. Within these paradigms, it employed a qualitative case study research design. The study was conducted in Walvis Bay in Namibia with four Grade 11 chemistry teachers, two expert community members and a critical friend who were purposively and conveniently sampled. Data were gathered using semi-structured interviews, semi-structured questionnaires, workshop discussions, participatory observation, stimulated recall interviews and journal reflections. Vygotsky's Socio-Cultural Theory (SCT) and Shulman's Pedagogical Content Knowledge (PCK) were used as theoretical frameworks. Within PCK, Mavhunga and Rollnick's Topic-Specific Pedagogical Content Knowledge (TSPCK) served as an analytical framework. A thematic approach to data analysis was employed. That is, data were analysed inductively to come up with sub-themes. Thereafter, common sub-themes were combined to form themes.

The findings of the study revealed that the Grade 11 chemistry teachers demonstrated positive attitudes toward the integration of IK in their teaching. However, they seemed not to have pedagogical insights on how to do it. Despite this, they learnt, interacted and participated actively during the two expert community members' presentation workshops on making soap. That subsequently enabled them to co-develop an exemplar lesson plan on saponification that integrated IK. This study implies that there is a need for Chemistry teachers to be empowered on how to make science accessible and relevant to learners' socio-cultural backgrounds. The study thus recommends that higher education institutions and educational authorities reform and amend the curriculum to cater for the integration of IK. The study further recommends that Chemistry teachers should tap into the cultural heritage of expert community members in mediating the learning of science concepts. Lastly, Chemistry teachers are encouraged to form professional learning communities to develop themselves professionally.

**Keywords:** Organic chemistry; saponification; indigenous knowledge; indigenous technology; socio-cultural theory; Ubuntu; PCK and TSPCK.

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## Symbols Used in the Context of This Study

+ (Addition)

% (Percentage)

°C (Degree Celsius)

$\xrightarrow{\Delta}$

(Arrow with triangle showing enthalpy delta change / to produce or to make)

## **List of abbreviations and/or acronyms**

BEd - Bachelor of Education

BEd hon - Bachelor of Education honours

BETD - Basic Education Teacher Diploma

CAPS - Curriculum Assessment Policy Statement

CKP - Curriculum Knowledge Pedagogy

COVID-19 - Corona Virus Disease

DBE - Department Of Basic Education

DE – Diploma in Education

IK - Indigenous Knowledge

LCE - Learner-centred Education

MASTEP - Mathematics and Science Teachers' Extension Programme in Namibia

MEAC - Ministry of Education Arts and Culture

MEd - Master of Education

MKOs - More Knowledgeable Others

MOE - Ministry of Education

NCBE - National Curriculum for Basic Education

PCK - Pedagogical Content Knowledge

PEEOE - Predict Explain Explore Observe Explain

PLCs - Professional Learning Communities

SCT - Socio-cultural Theory

SCORE – Science Community Representing Education

SMK - Subject Matter Knowledge

TMESD - Transformative Model of Education for Sustainable Development

TSPCK - Topic-Specific Pedagogical Content Knowledge

WDU/T - What is Difficult to Understand/Teach?

WHO - World Health Organization

WS - Western Science

ZPD-ZoneofProximalDevelopment

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## CHAPTER ONE: SITUATING THE STUDY

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### 1.1 Introduction

The main goal of this study was to mobilise the indigenous technology of making soap to mediate learning on the topic of saponification in organic chemistry. Essentially, this study was triggered and inspired by the need to integrate indigenous knowledge (IK) with westernised science (WS) in Chemistry lessons. Furthermore, this study was motivated by the fact that teachers' subject matter content knowledge (SMK) and pedagogical content knowledge (PCK) seem to be limited in this topic. As a result, they tend to teach it in a decontextualised manner (Gwekwerere, 2016; Seehawer, 2018a). Additionally, learners also seem to struggle with this topic as reflected in the Chemistry examiners' reports (2016–2021).

In this chapter, I first describe the background of the study by providing the international and Namibian context, and then give my personal experience. Secondly, I discuss the statement of the problem, the purpose and the significance of the study. Thirdly, I provide the research goal, objectives and questions. From there I give an overview of the theoretical and analytical frameworks, data-gathering methods, keywords and thesis outline. Fourthly, I conclude with a summary of the chapter.

### 1.2 Background of the Study

Scholars such as Naidoo and Vithal (2014) and Ogunniyi (2008) have called for the IK of African learners to be integrated into the mainstream curriculum. These scholars believe that by integrating IK into the curriculum, learning will be meaningful and relevant to African learners. Agreeing with this school of thought is Erinosho (2013), who echoed that when learners' IK is not used in class, it results in learners not fully internalising the science concepts being taught making them abstract and foreign to them. In this regard, Klein (2011) posits that this feeling of alienation might ultimately result in learners dropping out of school. Kibirige and van Rooyen (2006) believe that IK has the potential to reduce the feeling of foreignness among learners. That is, it helps in closing the gap between their IK from home with that of WS at school (Aikenhead & Jegede, 1999).

In this regard, a large body of past colonial indigenous research advocates for a process of decolonising and indigenising Euro-western research methodologies. Chilisa (2012) defines indigenisation as a:

process that involves a critique and resistance to Euro-western methodological imperialism and hegemony, as well as a call for the adapting of conventional methodologies by including perspectives and methods that draw from indigenous knowledge, languages, metaphors, worldviews, experiences, and philosophies of former colonized, historically oppressed and marginalized social groups. (p.97)

Notably, most African countries were forced to use WS and hence adopted the western culture and ways of doing things as a result of colonialism (Shizha, 2013). This led to Africans neglecting their own cultures and IK. Such hegemony and supremacy were strengthened by the fact that the African education system placed the WS on a pedestal and regarded it as superior (Shizha, 2013). As a result, African learners were taught only WS with no mention of their IK.

As an attempt to address this problem, the South African government encourages the use of IK in their science curriculum and educational policies. For example, one of the aims of the Curriculum and Assessment Policy Statement [CAPS] (Department of Basic Education [DBE], 2011) is to value IK. This is reflected in outcome three which states that valuing the IK system is vital in acknowledging the rich history and heritage of South Africa (DBE, 2011).

However, even though this well-crafted policy document has good aims and objectives, it fails to specify how exactly such IK should be integrated and implemented in classrooms. This is worrisome in Ogunniyi's (2007a) view who warns that such failure could lead to different perspectives and interpretations of how this integration should be achieved. The situation is not any different in Namibia.

Namibia was a colony of Germany from 1884 to 1915 due to its rich natural and human resources which were exploited by the Germans. In the process of colonising Namibia, the German government introduced a religious gospel education system through its missionaries according to Nghiteeka and Oosthuysen (2016). Apparently, the Germans came to Namibia to set up missionary schools like St Joseph at Dobra close to Windhoek, and at that time Namibia was called South West Africa. The aim and purpose of such missionary schools were to teach

Namibians how to read and write religious literature; English and German were used as a medium of instruction (Nghiteeka & Oosthuysen, 2016).

After the colonisation by the Germans, Namibia was then colonised by South Africa, our neighbouring country, from 1915 to 1989 during which period Bantu Education was introduced. That education system was based on a racial segregation philosophy known as apartheid introduced by Dr Verwoerd in 1958. As a result, under the Bantu apartheid education system, schools were established along racial lines. For example, Black learners received inferior low standard education with inadequate infrastructures and resources. That resulted in many Black children not having good career opportunities. On the other hand, the White learners received the Cape Education system which was of a high standard with quality infrastructures and resources that enabled them to get well-paying jobs according to Katjavivi (2016).

These disparities in the education system in Namibia led to the formation of the Namibia National Student Organisation in 1984 and the Namibian National Teachers Union in 1989. The main aim of these organisations was to fight against the apartheid education system for the benefit of all learners and teachers in Namibia. Another aim was to introduce a Namibian education system which was eventually achieved. Despite the abolishment of the apartheid system upon Namibia's independence in 1990, racial inequalities in school systems are still in existence from my personal experience. For example, most private schools are still owned and controlled by the White minority, and they mostly enrol White learners.

Namibia finally got its independence from South Africa after many years of political diplomacy and military battles in 1990. From there, a new dawn in the reconstruction and reforming of the education system began as enshrined in the Namibian constitution article 20 which states that "all persons shall have the right to education" (p. 18). To implement this articulation and provisional mandate, in 1993, the government outlined its four major goals of education in its policy document titled *Towards Education for All* as discussed below:

- (i) *Access*—involves the ratio of learner's enrolment rate in schools. It also refers to ways in which schools and policies ensure that learners have equal opportunities for educational attainment. It further requires schools to provide services and remove barriers to schooling such as race, religion, gender, sexual orientation, disability,

perceived intellectual ability, past academic performance, special education status, English proficiency, family income, educational attainment levels, culture, geographical location and school facilities which might hinder learners from attending school.

- (ii) *Equity* –is the measure of the extent to which educational resources are distributed to all learners. It is a process of reforming practices, policies and procedures at schools to support academic fairness and inclusion. It further ensures that every learner has the resources, teachers, intervention and support they need to be successful, for instance, those that need more get more. Equity also entails giving specific resources and support to disadvantaged student targets and bringing them up to the same opportunity level as their peers. Equity is closely linked to equality, which is providing the same opportunities to all students.
- (iii) *Quality* –is characterised by many factors among others like teachers’ qualifications and experience, resource allocation, teaching materials and equipment. To tackle these issues the ministry of basic education embarked upon programmes of classrooms, laboratories and library provisions, in-service and professional development programmes tailored for teachers to improve and upgrade their knowledge, attitudes, values and skills in order to provide an education of high standard and,
- (iv) *Democracy* –this has to do with the full participation of the three stakeholders of education, namely teacher, learner and parent. Education also entails that teachers and learners work together as equals. It is based upon respect, tolerance and love. Democracy stems from a free and expressive dialogue with no rules and no conventions just honesty. It also encompasses allowing learners to decide individually how, when, what, where and with whom they learn and to have an equal share in the decision-making about their education.

The government further introduced Educational Act no 16 (2001) to lead the implementation of these directives. That was done in an effort to transform the education system. Such transformation is reflected in the Namibian National Curriculum for Basic Education (NCBE) (Ministry of Education, Arts and Culture [MEAC], 2010; 2016) which, similarly to South Africa, calls for knowledge that embraces IK amongst other things. This suggests that teachers are encouraged to use content and methods within the learners’ environment and communities.

This philosophy or ideology formed part of the Learner-Centred Education (LCE) that was introduced by the Namibian government in 1993 (Nyambe, 2008). The LCE approach places focus on building from the learners' prior knowledge (Mavhunga & Rollnick, 2013) in order to contextualise and harmonise their IK and WS knowledge (Emeagwali & Shizha, 2016; Gwekwerere, 2016).

Despite these curriculum ideals, however, the NCBE does not explicitly guide how the integration of IK should be done. Correspondingly, Nyambe (2008) in his study inferred that there was a disjuncture between teachers' understating of LCE and how it should be implemented. He additionally revealed that teachers seemed to lack self-confidence and professional competence. This was exacerbated in part by the fact that teachers did not receive the necessary support to fully carry out the objectives of the LCE pedagogical approach. For instance, Nyambe and Wilmot (2012) revealed in their study, that there was a mismatch between the description and implementation of LCE pedagogy in the Namibian education sector.

It is against this backdrop that this study sought to engage and mobilise Grade 11 chemistry teachers in an intervention on how to integrate IK during their teaching of Chemistry. In this interventionist study, I used the indigenous technology of making soap with the hope of enabling the mediation of learning of the concept of saponification in organic chemistry in particular. Certainly, this study is timely as one of the World Health Organization's (WHO, 2019) safety protocols require regular hand washing with soap and running water. This has also necessitated the call to make soap from easily assessable materials and use IK to help in reducing the spread of COVID-19, especially among learners and teachers in schools as well as community members.

### **1.3 My Personal Story – Situating Myself in This Study**

I was born in Ncaute, a village 60 km west of Rundu town in the northern part of Namibia, but I grew up in Windhoek the capital city of Namibia and there I was seldom exposed to IK. The only time I was exposed to some form of IK was when I went to visit my grandparents from my paternal side during school holidays in the village. It was during that time that I took part

in traditional activities such as herding cattle, milking cows and ploughing the Mahangu<sup>1</sup> fields. While doing such activities or chores, I learnt a lot of leadership qualities like patience, communication and assertiveness just to mention a few. But at that time, I did not realise the science embedded in such activities.

During my primary and secondary schooling, I was never really taught concepts that related to my socio-cultural background as reiterated by Mavuru and Ramnarain (2017). All I remember vividly is that we were taught WS epistemologies and ontologies with no mention of our IK. That resulted in me growing up thinking that WS was the only acceptable form of knowledge in society. Little did I know that it was not the only way of knowing back then.

When I enrolled at Rhodes University for my BEd honours in 2019, I was introduced and exposed to the use of IK to mediate science lessons by my supervisor. That fascinated and inspired me to the extent that the research focus of this study was exploring the making of a traditional soap to mediate learning of the topic of saponification in organic chemistry. My research on this topic was the first of its kind to be done at Rhodes University by a Namibian student. I was therefore excited to be a pioneer and trailblazer. In 2021, while teaching the topic of saponification, I gave my Grade 11 chemistry learners a homework task of finding out from their parents and grandparents how soap was made back in the day. I did this as a way of integrating their IK with the science I teach them in class. They were inspired by the experience.

#### **1.4 Statement of the Problem**

This study was motivated and inspired by the fact that the topic of saponification in organic chemistry is poorly performed by learners. This is evident in the past Chemistry examiners' reports (MEAC, 2016–2021). For example, the Chemistry examiner's report (2020) stated that the questions on the topic of saponification were "fairly answered by the learners, however, more could be done to help learners understand this topic as some mixed up their explanations".

I assumed that this might be linked to the limited understanding and interpretation of the learning objectives and basic competencies of this topic by the teachers as prescribed in the Chemistry syllabus of 2018. Another reason might be the lack of integration of learners' IK

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<sup>1</sup>Mahangu – Traditional crop harvested in the northern part of Namibia that is used to make flour.

during teaching and learning. In this regard, Kanime (2015) and Denuga (2019) alluded that at times, teachers who teach Chemistry seem to possess limited knowledge of new teaching approaches and methodologies. In addition, some scholars such as Nikodemus (2017) and Simasiku (2017) have attributed a lack of understanding of science concepts to the fact that some teachers seem not to integrate IK when teaching science concepts. This is compounded in part by the fact that although the Namibian senior secondary school curriculum is in support of this integration of IK, it, however, does not clearly stipulate how this knowledge should be integrated and implemented in the classrooms. As a result, teachers are faced with challenges on how to successfully integrate IK in their classrooms to the benefit of learners (Nikodemus, 2017). For example, in his study, Simasiku (2017) revealed that science teachers struggled to integrate learners' IK in their classes as they lacked the awareness and pedagogical insights on how it should be done.

Thus, it is against this background that in this interventionist case study I explored working *with* four Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of the topic of saponification in organic Chemistry. It was envisioned that this study might improve teachers' PCK (Mavhunga & Rollnick, 2013) and ultimately improve learners' performances.

### **1.5 Purpose and Significance of the Study**

The purpose of this study was to explore working *with* four Grade 11 chemistry teachers to mobilise the indigenous technology of making soap to mediate learning of the topic of saponification in organic chemistry, with a view to making this topic accessible and relevant to teachers who are regarded as learners in this study. Furthermore, this study was intended to help teachers gain practical knowledge on how soap is made using IK which they might integrate with WS knowledge. It was envisioned that this might promote the link between WS knowledge and IK to enable border crossing from home to school science (Aikenhead & Jegede, 1999) as alluded to earlier.

Essentially, this interventionist study is an extension of previous studies conducted by Namibian scholars such as Hashondili (2020), Shifafure (2014), and Shinana (2019) to mention a few whose focus was on how to integrate IK into science teaching. The salient aspect of this study, however, was to tap into the cultural heritage or funds of knowledge of the expert community members' traditional ways of making soap. I thus aimed to work *with* four Grade

11 chemistry teachers rather than *on* them as reiterated by Ngcoza and Southwood (2015) in co-developing exemplar lessons that integrated IK.

Moreover, the study might highlight and illustrate how to integrate IK and WS in our classrooms. This resonates with the findings of Asheela et al. (2021), Ndevahoma (2019), and Shinana et al. (2021) that the use of IK with hands-on practical activities using easily accessible materials from the local environment promotes active learner and teacher engagement in class. The findings of my study might be of benefit to teachers (including myself) by enhancing our personal PCK (Carlson & Daehler, 2019). Learners, curriculum developers, textbook authors, examination officials and the entire science teaching community might hopefully also benefit from this study.

Notably, concerning the unprecedented COVID-19 backdrop which took the entire world by surprise in 2020, one method of reducing the spread of the virus is the regular washing of hands with soap for about 30 seconds as per the WHO (2019) safety protocols. This study is also being conducted as mitigation to the above-stated problem as it looked into traditional ways of making soap for those who cannot afford the commercial ones in shops. This IK of making soap will also be shared with learners. Hopefully, some might use it to make their own homemade soaps for personal hygiene or for sale to make a profit and encourage their entrepreneurial skills. But the main purpose of our current health predicament is to make this soap to help reduce the spread of this deadly virus.

## **1.6 Research Goal**

The main goal of this study was to explore working *with* four Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning on the topic of saponification in organic Chemistry. To achieve this goal the following objectives and research questions were addressed:

### **1.6.1 Research objectives**

These were to examine:

1. The Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of IK in their teaching.
2. The learning opportunities created (or not) for Grade 11 chemistry teachers during the presentations on how to make soap traditionally by the expert community members.

3. How to support Grade 11 chemistry teachers in co-developing exemplar lessons on saponification that integrate concepts from the traditional practice of making soap.

### **1.6.2 Research questions**

1. What are Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of IK in their Chemistry teaching?
2. What learning opportunities are created (or not) for Grade 11 chemistry teachers to interact, participate and learn during the presentation by the expert community member(s)?
3. How can Grade 11 chemistry teachers be supported in co-developing exemplar lessons on saponification that integrate local IK in their classroom?

### **1.7 Theoretical and Analytical Frameworks**

In this study, Vygotsky's (1978) socio-cultural theory (SCT) was used as the theoretical framework. Vygotsky posits that "human activities that take place in a cultural context are mediated by language and other symbol systems, and can be understood when investigated in their historical development" (1978, p. 191). Within the SCT, I focused on the following concepts: mediation of learning, culture and language, social interaction and the zone of proximal development (ZPD).

I complemented Vygotsky's SCT with Shulman's (1987) PCK as an analytical framework. According to Shulman (1987), PCK is a teaching theory that focuses on the knowledge that teachers possess and draw upon to teach learners. Within PCK, I drew on the seminal work of Mavhunga and Rollnick (2013) and I looked at their five topic-specific pedagogical content knowledge (TSPCK) components, namely student prior knowledge, curricular saliency, what is difficult to teach/understand, representations including analogies and conceptual teaching strategies.

## 1.8 Data-Gathering Methods

In this study, I used the following data-gathering methods:

- semi-structured interviews;
- semi-structured questionnaires;
- workshops discussions;
- participatory observation;
- stimulated recall interviews; and
- journal reflections.

## 1.9 Keywords

The following are concise definitions of some keywords/concepts used in this thesis.

### **Organic Chemistry**

- This is the study of substances that contain the element Carbon (Ajayi et al., 2018).

### **Saponification**

- This is the process of reacting or combining fat and alkali to produce glycerol and soap (Ajayi et al., 2018).

### **Indigenous Knowledge**

- Refers to the understanding and skills developed by local communities and passed from generation to generation over long periods (Keane et al., 2016).

### **Indigenous Technology**

- Refers to the production of materials or goods by local people within their immediate communities using their own knowledge. For example, arts, crafts, black smithing, brewing and weaving (Emeagwali & Shizha, 2016).

### **Socio-cultural Theory**

- 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).

## **Ubuntu**

- This is an African dictum for human interdependence and its concomitant link with actions such as social responsibility, love, belonging, sharing, citizenship and participation (Waghid, 2020).

## **Pedagogical Content Knowledge**

- A teaching theory that focuses on the way teachers present and transform SMK to make it comprehensible to their learners (Shulman, 1987).

## **Topic-specific Pedagogical Content Knowledge**

- These are analytical frameworks that describe various forms and ways of presenting the subject matter to make it comprehensible to learners (Mavhunga & Rollnick, 2013).

## **1.10 Thesis Outline**

This study was conducted *with* four Grade 11 chemistry teachers from different schools within the Walvis Bay circuit of the Erongo region of Namibia. The thesis consists of eight chapters and below is the overview of these chapters.

### **Chapter One: Situating the Study**

This chapter outlined the background of the study by providing the international and local context. In addition, my personal experience was also highlighted. Thereafter, the statement of the problem, purpose and significance of the study, research goal, objectives, questions and theoretical and analytical frameworks were discussed. Lastly, the data-gathering methods were introduced, followed by the definition of keywords/concepts used in the thesis. The outline of the chapters of the thesis is stated and it ends with the chapter summary.

### **Chapter Two: Literature Review**

This chapter reviews literature relevant and applicable to the context of this study to highlight what has been researched already. In this chapter, literature on concepts like saponification, prior knowledge, indigenous knowledge/technology, hands-on practical activities and visualisation, sense-making, language and science and professional development/professional learning communities (PLCs) are unpacked. Additionally, literature on conceptual related to

learning frameworks like teachers' conceptions and dispositions are also discussed, and then the chapter ends with a summary.

### **Chapter Three: Theoretical Frameworks**

This chapter outlines the frameworks that underpinned and informed this study, namely Vygotsky's socio-cultural theory (SCT) as the theoretical framework, and Shulman's PCK as the analytical framework. Furthermore, the chapter also looked into TSPCK and consensus and refined models of PCK and ends with a chapter summary.

### **Chapter Four: Research Methodology**

This chapter describes the research methodology that anchored this study. I discuss the research paradigms informing this study, that is, the interpretive and the indigenous research paradigms as well as the research design employed in this study. Within the research design, I discuss the case study approach, research site, sampling of the participants and research positionality and reflexivity. Furthermore, the data-gathering methods, research processes, data management and data analysis are unpacked. Lastly, validity, trustworthiness as well as ethical considerations are explained, ending off with the summary of the chapter.

### **Chapter Five: Semi-structured Interviews and Semi-structured Questionnaires**

In this chapter, I present, analyse, interpret and discuss data from semi-structured interviews and semi-structured questionnaires to answer research question one. Emerging themes and findings are discussed concerning literature and theory.

### **Chapter Six: Workshop Discussions and Participatory Observations**

In this chapter, I present, analyse, interpret and discuss data generated during workshop discussions and participatory observations during the presentations made by the two expert community members on how soap is made traditionally. The findings are used to address research question two. Additionally, the findings are discussed with reference to the literature and theory.

## **Chapter Seven: Stimulated Recall Interviews, Journal Reflections, and Co-development of an Exemplar Lesson Plan**

This chapter presents, analyses, interprets and discusses data derived from stimulated recall interviews, journal reflections and the discussions on the co-development of an exemplar lesson plan that integrated IK on soap making. The research findings are used to answer the third research question and were interpreted using literature and theory.

## **Chapter Eight: Summary of Findings, Recommendations and Conclusion**

The chapter presents a summary of findings in relation to the three research questions. It also presents some recommendations, areas for future research, limitations of the study, my personal reflections and overall conclusion.

### **1.11 Chapter Summary**

In this chapter, I presented the background of the study by discussing the international and local contexts and my personal experience. I also outlined the statement of the problem, purpose and significance of this study. I additionally discussed the research goals, objectives and questions. The theoretical and analytical frameworks, data-gathering methods, keywords as well as the thesis outline were also discussed. This was done to set the scene for this research study. In the next chapter, I discuss the literature review.

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## CHAPTER TWO: LITERATURE REVIEW

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### 2.1 Introduction

A literature review according to O’Leary (2014), is a review of a body of knowledge consisting of what has been found as well as the methodological contributions. In line with this, Bertram and Christiansen (2015) define a literature review as “a section that puts a research study into the context of previous research by showing how it fits into a particular field” (p. 13). These scholars further state that it is also a discussion of the important research that has previously been done in the field which is being researched. Furthermore, it mainly looks into the theories of what is being researched and the major findings of previous studies in that field.

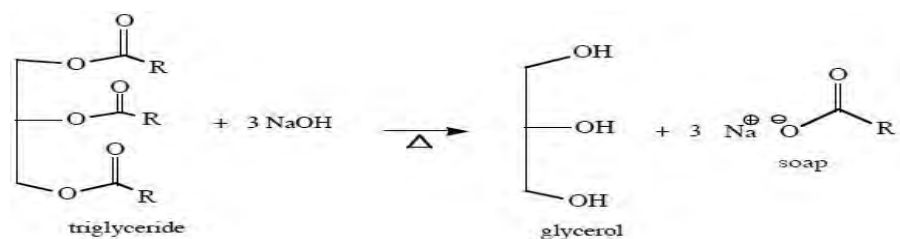
In this chapter, I thus discuss literature relevant to my study. Firstly, I discuss the concept of saponification in detail. Secondly, I discuss literature on prior knowledge. Thirdly, I discuss literature on IK, hands-on practical activities and visualisation, sense-making, professional development/PLCs and concepts related to learning with special reference to teachers’ conceptions and dispositions. Lastly, I end with a chapter summary.

### 2.2 Saponification

Saponification is defined by Ajayi et al. (2018) as “the process of reacting a fat (oil) and an alkali to produce a glycerol plus soap” (p. 126) and this process can be represented using the following chemical equation:



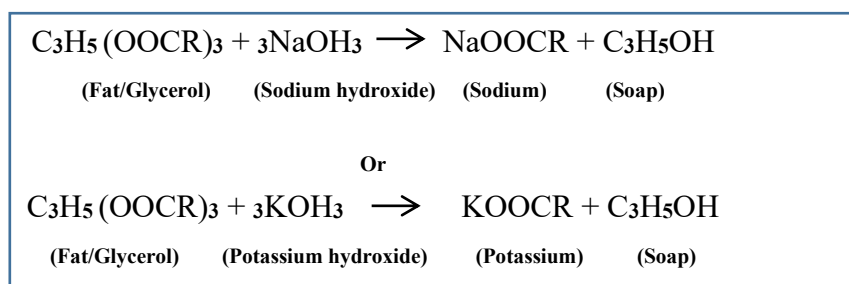
To Warra (2013), the term ‘saponification’ is derived from the Latin word ‘*saponins*’ which means soap or cleaning agent. He then defines saponification as a chemical reaction in soap making that involves the splitting of esters into alcohols and salts of carboxylic acids as shown below:



**Figure 2.1: Saponification process R is the long chain of carbon and hydrogen atoms (adapted from Warra, 2013, p. 142)**

Warra (2013) further explains that there are five major steps in the soap-making process, namely saponification, soap washing, fitting, moulding and drying. He adds that soap is any cleaning agent that is manufactured in bars, granules, flake or liquid form. It is made from a mixture of sodium or potassium salts of various fatty acids or natural oils and fats. In this regard, he avers that soap is used in everyday life activities like washing dishes, pots, clothes, and blankets and to keep us clean (Warra, 2013).

Regarding the fat or oil needed, Openshaw (2000) lists coconut seed oil, jatropha seed oil, castor seed oil and neem seed oil as the main oils that are used in making soap in most African countries. On the other hand, Onyegbado et al. (2002) posit that the Romans first produced soap about 5000 years ago from wood ash and animal fat. These scholars further remind us that large-scale commercial soap production only started in the early eighteenth century. During that time soap was produced by the kettle process which involved boiling fats or oils with caustic soda. They further explain that soap making is based on an alkaline hydrolysis reaction called saponification as shown by the chemical equations below.



**Figure 2.2: Chemical equations for the saponification process (adapted from Onyegbado et al., 2002, p. 73)**

Onyegbado et al. (2002) define saponification as a process that involves the salting out and fitting process to obtain soap. Similarly, Kowalski (2015) states that the term saponification is commonly used to describe the chemical process that result in the formation of soap. He adds that saponification involves the hydrolysis of an ester under basic conditions to form an alcohol and carboxylic salt. He further articulates that when aqueous sodium hydroxide/potassium hydroxide (caustic soda) is added to pure coconut oil at high temperatures above 80°C the reagents react to form soap and glycerol.

Following a similar line of thought, Arasaretnam and Venujah (2019) contend that the chemical composition of soap is a blend of sodium and potassium salts of long-chain fatty acids which are made by saponification reaction by the hydrolysis of animal fat and alkali. They further add that it is possible to use vegetable oils as well. For instance, Panda (2003) proffers that the saponification reaction is also called the cold process for making soap which is the alkaline hydrolysis of triacylglycerols. He further points out that these esters are the major constituent of vegetable oils and animal fats. These oils react with a strong mineral base like sodium hydroxide/potassium hydroxide in an aqueous medium to produce soap and glycerol. In the context of this study, such soap was made using indigenous or traditional technology as a form of prior knowledge.

### **2.3 Prior Knowledge**

Roschelle (1995) defines prior knowledge as the knowledge that learners possess at hand before they meet new information. It is at times also called intuitive knowledge obtained from previous grades or informal interactions at home or in the community. He further argues that to make the best of new knowledge, teachers need to understand just how prior knowledge affects learning. Kuhlane (2011) in her study conducted in South Africa revealed that meaningful learning takes place in a classroom where the teacher elicits learners' prior everyday knowledge. Her study further showed that when learners' prior everyday knowledge is utilised, it increases their class participation. Concurring is Enghono (2013), who in her study in Namibia with teachers shared the same sentiments that including learners' prior knowledge resulted in active engagement by the teachers who were learner participants in her study. Sedlacek and Sedova (2017) also contend that when teaching is based on learners' prior knowledge it results in improved participation and hence performance. Sharing the same sentiments are Abah et al. (2015) who accentuate that learners can only be active contributors

to the teaching and learning process if their prior knowledge is relevant to the subject matter. They aver that this is where integrating the learners' IK becomes pertinent.

This suggests that for effective science learning to take place learners' socio-cultural backgrounds should be taken into account (Mavuru & Ramnarian, 2020; Shizha, 2013). This helps to contextualise and make science relevant to learners (Gwekwerere, 2016) and smoothens science border crossing between home and school (Aikenhead & Jegede, 1999).

However, Taylor (1999) warns that prior knowledge should not be used in such a way that it replaces the topic or concept being taught. He further cautions that this might lead to misconceptions and misunderstandings that can result in undesired effects. Hence, in the context of this study, I first asked teachers how soap was made traditionally in their culture as it is also recognised that prior knowledge could be in the form of IK.

#### **2.4 Indigenous Knowledge or Indigenous Technology**

Kibirige and van Rooyen (2006) define IK as a legacy of knowledge and skills unique to a particular indigenous culture involving wisdom that has been developed and passed on over generations. They further state that IK is local knowledge derived from interactions between people and their environment. Holding a similar line of thought is Senanayake (2006), who describes IK as “the unique knowledge confined to a particular culture or society” (p. 1). It is also considered funds of knowledge of a local people. Nyika (2017) and Ogunniyi (2007a) postulate that IK refers to knowledge gained by people as they live and work in their communities. They further extend that IK can be in the form of beliefs, norms, songs, the local language, imitations and stories which are usually passed from generation to generation orally (Kibirige & van Rooyen, 2006). In this regard, Ogunniyi (2004) also refers to IK as a form of traditional wisdom which often employed a trial-and-error method involving rituals. Substantiating this though is Hoppers (2005), who explains IK as the knowledge that is embedded in the cultural web and history of a people including their civilizations.

In recent years, IK has gained attention and acknowledgement as another form of science that can be used to explain phenomena and social-cultural realities of diverse African societies (Emeagwali & Shizha, 2016). Moreover, IK is used synonymously with traditional and local knowledge to differentiate the knowledge developed by a given group social group or

community from the knowledge generated by the western academy and its institutions (Chilisa, 2012). Chilisa goes on to outline the characteristics of IK:

- An accumulative and present generation of experiences, observations and trial-and-error experiments.
- It is dynamic with new knowledge continuously added and external knowledge adapted to suit local situations.
- All members of the community that is elders, women, men and children have IK.
- The quantity and quality of IK that an individual possesses will vary according to age, gender, socioeconomic status, daily experience, roles and responsibilities at home and in the community.
- IK is stored in people's memories and activities and is expressed in stories, songs, folklore, proverbs, dance, myths, cultural values, beliefs, rituals, cultural laws, the local language, artefacts, forms of communication and organisations.
- IK is shared and communicated orally and by specific examples and through cultural practices such as dance and rituals.

IK is understood as a way of knowing developed by indigenous people over generations as a result of sustained occupations, thus African IK's are seen as foundations to reshape African curricula and education systems – although it does not claim universality, its relevance for specific contexts, livelihoods and cultures of a local people is crucial (Seehawer, 2018a). This according to Higgs (2016) advances the “cultural and socio-educational transformation of the African continent” (p. 90).

Aikenhead and Jegede (1999) suggest that IK can be used as a bridge between home and school science. Agreeing with this notion are Kibirige and van Rooyen (2006) who believe that learners enjoy the process of linking old and new knowledge learnt at home and school. In this regard, the (MEAC, 2016) emphasises that teachers should use learners' existing IK and culture to create new knowledge. Govender (2014) stresses that integrating learners' IK in classrooms results in them being motivated to learn. This resonates with Naidoo and Vithal (2014) who allude that integrating IK in classrooms increases learner participation (Sedlacek & Sedova, 2017). On top of that, the integration of IK in classrooms helps to decolonise and Africanise science education according to Seehawer (2018a). Moreover, IK can be used as a cultural tool to make science more accessible by moving from the known to the unknown, which will help

learners to understand deep abstract scientific concepts (Mawere, 2015). Msimanga and Shizha (2014) are of the view that IK is important for cultural identity and helps learners connect their cultures and brings back the roles of parents and community elders in education (Klein, 2011; Lavallee, 2009; Mateus & Ngcoza, 2019).

In the context of this study, I integrated IK and WS. This was done by the <sup>2</sup>expert community members during the process of making soap to mediate learning on the topic of saponification. From my personal experience in class, when learners see that their IK is being mentioned they get excited and interested and as a result, tend to engage more in the discussions. I also hoped that this would happen with the teachers who were regarded as learners in the context of this study when the expert community members were demonstrating how soap is made traditionally. My view of integrating IK in classes by teachers might help in preserving the African traditions and cultures that have been eroded by western cultures. Resultantly, at times, learners find that moving between the micro-culture of the family and school hinders their success in science according to Aikenhead and Jegede (1999).

Notwithstanding, Mukwambo et al. (2014) posit that IK is implicit in nature in the sense that it contains a lot of myths and unproven facts that are not scientific. They thus warn that this can lead to misunderstandings and misconceptions if not carefully integrated into the classroom. That is why for many African countries like Mozambique, IK remained unofficial and was considered superstitious with no legitimacy for inclusion in the school curriculum (Afonso-Nhelevilo, 2013). Klein (2011) also cautions that IK should not be seen as the answer to all problems and thereby cautions against romanticising it. This view resonates with that of Nikodemus (2017) who believes that some cultural beliefs and practices are not scientific.

To this, Kibirige and van Rooyen (2006) suggest that learners should be allowed to debate unproven cultural beliefs to minimise misconceptions and confusion. In contrast, however, Horsthemke and Schäfer (2007) highlight that some learners perceive IK as being outdated and irrelevant. They further postulate that even though IK is considered the best approach to help learners to link science to their everyday lives (Gwekwerere, 2016), some teachers are finding it difficult to apply. This assertion has resonance with Nikodemus's (2017) study which

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<sup>2</sup>Expert community members – in my research study's context are the custodians of the traditional knowledge and technology on soap making.

revealed that teachers struggled to apply IK in their science classes as they had limited pedagogical insights on how to do it. The teachers also stated that they did not know whose IK to use in class as IK differs from culture to culture and there were many learners from different cultures in the classes they were teaching.

According to Seehaver (2018a), some challenges that impede the use or integration of IK in schools are not limited to the following: teacher education does not train teachers on what and how to use IK in schools; lack of indigenous teaching materials; curriculum does not give any guidance of IK in school science curriculum; time constraints to teach IK is high; IK is not asked in exams; lack of available teaching materials; teachers do not have the right IK and learners have different IKs. In the same vein, Seehaver (2018a) goes on to propose solutions to the above challenges stating that teachers should give homework about IK to learners for learners to go find answers from home; invite expert community members like traditional healers, herbalists and elders to the classroom and take learners to excursions like nature, heritage sites and museums where they can go learn more about IK – this she called the bottom-up approach to the decolonisation of education. This approach is also referred to by Breidlid and Botha (2015) as a counter-hegemonic cultural force to that of colonialism, which is a prerequisite to decolonisation and Africanisation education (Mukwambo et al., 2014).

Some Namibian scholars at Rhodes University who are proponents of IK who I personally know are Asheela (2017), Kudumo (2020), Liveve (2017), Nikodemus (2017), and Shifafure (2014). For example, Nikodemus's (2017) study focused on how to mediate learning on the topic of rates of chemical reactions using the IK of making <sup>3</sup>*Oshikundu*. His study revealed that most learners showed a lot of prior knowledge about *oshikundu*. This was because many of them had seen it being prepared by their mothers, grandmothers or aunts at their homes. This in my view is a true testimony that the integration of IK and WS is possible and beneficial in Namibian schools.

In this study, the making of soap by expert community members was used as an intervention for the integration of IK in a WS classroom to mediate the learning of the topic of

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<sup>3</sup>Oshikundu – a non-alcoholic traditional beverage, which is made from fermenting Ongundo, Uushutu and Mahangu mixed with water. It is mainly consumed by the Oshiwambo and Okavango people of Namibia. It provides the body with carbohydrates, proteins, vitamins and minerals.

saponification in organic chemistry. As alluded to earlier, IK is traditional in nature and is generally passed on orally and experientially (Kibirige & van Rooyen, 2006). On the other hand, WS is Eurocentric and manifests itself powerfully in our ideas, culture and education. It originates from Europe and America, it is more abstract in context, and uses scientific methods of reasoning (Abah et al., 2015), as shown by the summary Table 2.1 below.

**Table 2.1: Shows the differences between IK and WS (adapted from Abah et al., 2015, p. 672)**

Aspect	IK	WS
1. View of knowledge	<p>Sacred, spiritual &amp; secular</p> <p>Holistic, integrated &amp; intuitive</p> <p>Stored orally</p> <p>Powerful, local, less valued</p> <p>Distantly</p>	<p>Secular excludes spirituality</p> <p>Scientific, analytical, reductionist</p> <p>Stored in books, library, computers</p> <p>Rational, valid, global</p> <p>Weak locally</p>
2. Objective	<p>Long term recall</p> <p>Cultural &amp; ecological</p> <p>Practical</p> <p>Involves critical thinking</p>	<p>Short term recall</p> <p>Economical</p> <p>Abstract</p> <p>Involves logic thinking</p>
3. Methods of teaching and learning	<p>Lengthy period of acquisition</p> <p>Learning through experience</p> <p>Teaching methods: examples, rituals, storytelling, modelling</p> <p>Tested in practical life situations</p>	<p>Rapid acquisition</p> <p>Learning by formal education</p> <p>Teaching methods: didactics</p> <p>Tested are artificial involving simulations</p>

Mukwambo et al. (2014) emphasise that there is a dialectical relationship between IK and WS. They state that the two worldviews should be used to complement each other rather than being viewed as mutually exclusive or oppositional. These scholars further propose that IK is

embedded in WS and can be used as prior knowledge to reduce challenges associated with WS. They further aver that learning is more meaningful and authentic if it is built on prior knowledge. Concurring, Seehawer and Breidlid (2021) posit that there is a dialogue between IK and WS. In this regard, Asheela et al. (2021) recommend the use of easily accessible resources when doing hands-on practical activities.

## **2.5 Hands-on Practical Activities and Visualisation**

Practical activities are science activities that are used by science teachers to teach learners individually or in groups. They involve learners observing, handling and manipulating objects (apparatus) and materials (chemicals) they are studying (Millar, 2010; Ongunleye, 2010). These scholars further postulate that practical activities ensure the linkage and connection of theory and practice of science concepts. In addition, Ates and Eryilmaz (2011) define practical activities as any instructional approach involving activity and direct experience with natural phenomena, or any educational experience that actively involves learners in working with objects to gain knowledge or understanding. While the Science Community Representing Education (SCORE) (2013) explains practical activities as learning experiences in which learners interact with materials to observe and comprehend the natural world. To Shivolo (2018), hands-on activities or investigational work involve the manipulation of scientific apparatus and chemicals by learners in a classroom or laboratory.

Concurring is Nhase (2019), who says that hands-on practical activities help learners in understanding scientific skills such as observation and lead to meaningful learning (Asheela et al., 2021). Woodley (2009) points out that practical activities assist learners in understanding scientific concepts by making sense of them. Sedlacek and Sedova (2017) explain that hands-on practical activities should be enjoyable in order to effectively encourage deep learning and inclusivity in class, which in turn results in active participation by learners. In this regard, Asheela et al. (2021) are of the view that practical activities should be hands-on, minds-on and words-on. These scholars further contend that practical work encourages learners to predict, explain, explore, observe and explain what they are learning. They called this approach PEEOE, which they say is important for teachers to consider when doing practical work with learners. Supporting this approach is Nikodemus (2017), who revealed that practical activities increase learners' interest and motivation in science concepts, while Asheela (2017) also in support of the PEEOE approach, revealed in her study conducted in Namibia working with

teachers that teachers enjoyed doing practical activities. This was seen in their keen interest in partaking in all practical activities. A separate study conducted by Shinana (2019) using *oshikundu* to mediate the learning of enzymes revealed that the practical activities that were done during the workshops helped in contextualising the WS concept, which I hoped would happen in my study.

Moreover, according to Ufonabasi and Nsimeneabasi (2017), practical work creates a platform for learners to fundamentally use their minds in learning standards and laws of science. They add that when learners do their own work at their own pace and level, it helps them learn to take responsibility for their own learning and this increases their self-confidence. To Mwangi and Sibada (2017), practical work helps in developing a positive attitude to learn science. Similarly, the purpose of practical work according to SCORE (2009) is to encourage observation and communicational skills; make phenomena more real; arouse and maintain interest; promote logical and critical thinking, and develop the ability to co-operate and solve problems. These views resonate well with that of Shikongo (2020) who argues that the teaching of science is not complete when practical work is not incorporated. This scholar goes on to say that science practical work serves as a platform for learners to develop positive attitudes towards science, foster interest in science-related fields and foster collaboration among other learners which elevates their self-image. Hence, the statement by Woodley (2009) that “practical work is part and parcel of what teaching and learning of science are all about” (p.49) and science teachers are encouraged to make use of practical activities when teaching.

Additionally, the MEAC (2016) calls for teachers to exercise professional discretion on which teaching approach to use. Practical work in science classes is identified as one of these approaches. It further stipulates that it may be necessary and preferable for teachers to improvise where need be. They can do this by finding learning and teaching support materials (LTSMs) from easily available and inexpensive objects in their immediate environment such as sticks, springs, bottle tops and cardboard provided that they are safe and hygienic (MEAC, 2016). Concurring with this view is Asheela (2017) who states that using easily accessible materials greatly contributes to learners’ classroom participation which in turn improves their practical skills. Echoing the same sentiments are Sedlacek and Sedova (2017) who argue that hands-on practical activities provide opportunities for learners to comprehend and understand scientific knowledge and skills being mediated by the teacher in class. Furthermore, the rationale of the Chemistry syllabus (MEAC, 2016) is to impart to learners experimental and

investigative practical skills (MoE, 2018). It further goes on to stipulate the practical activities, approaches or demonstrations required for each topic as shown by the extract below.

**Table 2.2: Shows practical activities for saponification (adapted from the Chemistry syllabus, 2018, p. 17)**

<p><i>The practical activities, approaches or demonstrations required for Topic 3 Materials are listed below. These are considered basic and all learners should be exposed to them as a minimum requirement.</i></p>
<ul style="list-style-type: none"><li>- <i>Design and conduct experiments to investigate the compressive and tensile strength of different building materials</i></li><li>- <i>Carry out surveys in the local environment to identify the uses of different building materials</i></li><li>- <i>Design and carry out an experiment to investigate the insulating properties of different roofing materials</i></li><li>• <i>Investigate emulsifying effects of soaps and detergents</i></li><li>• <i>Prepare soap through hydrolysis of fat or oil</i></li></ul>

However, from my observations and analysis of the National Curriculum (MEAC, 2016) and Chemistry syllabus (MoE, 2018), they do not clearly stipulate how practical activities should be conducted by the teachers and what apparatus and chemicals should be used. It is against this background that in this study, I invited expert community members to demonstrate practically to the four Grade 11 chemistry teachers and me how soap is made traditionally. The purpose of that hands-on practical activity was to help Chemistry teachers to make sense of the topic of saponification. Another reason was to link IK to the WS of making soap.

Despite all the benefits of using practical activities in class as alluded to by scholars such as Asheela (2017) and Nikodemus (2017), Hodson (1990) seems to critique the use of practical activities stating that practical work is at times misunderstood and does not result in guaranteed learning outcomes for all learners. Concurring is Asheela (2017), who lamented factors that hinder practical activities as per her study results and findings, such as some teachers that did not carry out practical activities because there were limited or no resources such as laboratories, apparatus and chemicals. Another factor is that some teachers lack the pedagogical knowledge and skills on how to conduct effective practical activities. They also do not use local improvised easily accessible materials from the surroundings. The use of IK (technology) is limited and at

times nonexistent. Moreover, according to literature, hindrances to practical work in schools are scarcity of resources and facilities, poor technical support for teachers, poor laboratory design, limited time, overcrowded classrooms and lack of funding (Kandjeo-Marenga, 2011; Kapingeli & Rutto, 2014; Malathi & Rohini, 2018; Ogunleye, 2010).

To address this dilemma, scholars such as Asheela et al. (2021), Mutanho (2016), Nikodemus (2017) and Shinana (2019) call for the use of IK (technology) and easily accessible materials in mediating these practical activities. This suggestion resonates well with that of Aikenhead and Jegede (1999) who state that practical activities should be integrated with IK (technology) for learners to cross smoothly between home and school science. In support, Mutanho (2016) further adds that practical activities should involve the hands-on and minds-on approach for learners to understand science concepts better. He additionally avers that practical activities encourage active participation among learners. Kudumo (2020) posits that teachers should represent the learning content in a way that learners can visualise what is being taught.

Cook (2006) defines visualisation as a pedagogical approach that combines visuals and verbal information, while Lioyd (2015) explains visualisation as a language that involves using images to convey a message. Rapp and Kurby (2008) state that visualisation is a teaching approach that helps to unveil hidden or abstract concepts making them understandable. Following a similar thought of reasoning, Nyamakuti (2020) explains visualisation as the process of using concrete materials to bring reality into the classroom to complement and improve learners' understanding. A plethora of studies conducted in Namibia by proponents of IK integration in school science such as Hashondili (2020), Kakambi (2020) and Kudumo (2020) describe visualisation as a teaching and learning method which combines visual and verbal information. For example, these scholars observed that attending presentations by the expert community members using IK to mediate science concepts should be viewed as visualisation.

In this regard, Ferreira et al. (2013) argue that visualisation is important in the sense that it helps illustrate ideas words cannot describe. In this study, the practical demonstration of soap making by the expert community members visualised the hidden science concepts in the form of saponification. This view is backed up by Rundgren and Yao (2014) who contend that visualisation helps in illustrating abstract science concepts and makes them easily

understandable. They further say visualisation in science education is a cognitive domain that makes invisible ideas visible and helps make abstract concepts explicit to learners.

However, Cook (2006) cautions that not all visual representations result in desired outcomes. He further posits that if learners do not have prior knowledge of the topic at hand (Mavhunga & Rollnick, 2013), visualisation cannot be effective. Hence, it could be surmised that visualisation is closely linked to prior knowledge (Cook, 2006).

In the context of this study, visualisation was in the form of all the cultural artefacts and tools the expert community members used in making the soap. This resonates well with Mavhunga and Rollnick's (2013) Topic-Specific Pedagogical Content Knowledge (TSPCK), as visualisation is part of the component that deals with representation. These scholars describe representation as ways in which teachers mediate the learning of concepts to make it easy for learners to comprehend. To Shulman (1986), visualisation entails the use of analogies, illustrations, examples, explanations and demonstrations to help others understand and make sense of the topic being taught.

## **2.6 Sense-making**

Ash (2004) defines sense-making as a mental process where learners, in my case teachers, are able to make meaning of the concept being taught. He further proffers that successful sense-making only happens if it is done in a social interaction set-up as alluded to by Vygotsky (1978). Sharma (2010) explains sense-making as a way in which individuals make sense of the world around them. In addition, Ushona (2013) says that sense-making involves learners or teachers being enlightened by new concepts emerging from the topic being taught. Concurring, Liveve (2017) posits that sense-making is the ability of learners or teachers to bond scientific language and concepts to their already existing knowledge under real-life conditions (Gwekwerere, 2016).

Ford (2012) is of the view that for learners or teachers to engage in sense-making, they need to understand and comprehend the scientific practice at hand, in my case saponification. For instance, in the context of this study, soap making was used as an epistemic tool for teachers to construct knowledge and make sense of it. Furthermore, the teachers had to come up with concept maps around the topic of saponification as evidence that they made sense of the topic under research. In concurrence are Campbell et al. (2016), who aver that sense-making helps

in reasoning and the learning of scientific concepts around the topic of discussion. Additionally, Nikodemus (2017) emphasises that sense-making is when meaning materialises which is a crucial part of language, talk and communication. He goes on to state that sense-making occurs during socialisation, and defines it as turning circumstances into a situation that is comprehended explicitly in words and that serves as a springboard into action.

Taking counsel from the following scholars (e.g. Msimanga & Lelliot, 2014; Mavuru & Ramnarian, 2017), I suggested to the expert community members to use their indigenous language and this boosted their self-confidence and at the same time, encouraged full participation by everyone. This ultimately resulted in the Chemistry teachers making sense of what the expert community members were demonstrating, which helped substantiate the context of this study – which was to explore the use of IK in the making of soap to see whether this mediation enabled teachers to make sense of saponification. Audet et al. (1996) encourage the use of reflective journals during the sense-making process. These scholars posit that journal reflecting helps in internalising the concepts being learnt. This was observed in the study as teachers could be seen making notes in their journals. The workshop on soap making was an informal form of professional development for the four Chemistry teachers.

## **2.7 Professional Development and Professional Learning Communities**

The Namibian national curriculum has recently transformed. Physical Science has now been split into two standalone subjects, namely Chemistry (my focus area) and Physics. This was done because at the tertiary level, students choose to specialise in one of these subjects. Hence, it was deemed necessary for learners to choose their field of specialisation already at high school, which might make it easier for them to progress in these subjects at the tertiary level. At school also, teachers are given the freedom to choose which subject they want to teach provided they are well qualified in it and have the necessary knowledge, values, skills and experience.

It is, therefore, imperative for teachers who are teaching Chemistry to be trained by the Ministry of Education through their in-service training programmes. Professional development is one way of doing so. Professional development programmes should be designed in such a way that they improve the Chemistry teachers' SMK as well as their PCK as alluded to by Shulman (1987). Buczynski and Hansen (2010) explain that professional development is a way of empowering teachers with knowledge and skills to provide quality education. Mizell (2010)

avers that professional development can be done through in-service training activities like workshops, conferences, college courses, co-teaching, mentoring, reflections on lessons taught, study groups, teacher networks and seminars. He adds that professional development is not always bound to well-planned occasions like workshops but can also happen informally between colleagues at schools during subject and staff meetings or hallway discussions. Ngcoza and Southwood (2015) define professional development as a transformative, ongoing capacity and knowledge-building process for teachers.

In agreement are Ngcoza and Southwood (2019) who state that professional development should be designed and structured in such a way that it is continuing and not once-off or one-size-fits-all. These scholars further echo that teaching is an ongoing activity or process and keeping the teachers up-to-date with the latest development in their fields is vital, as it results in professional growth and fulfilment. They also accentuate that professional development should capacitate teachers with the necessary skills and knowledge to improve and effectively deliver quality education.

Additionally, Fatih (2020) posits that the professional development of teachers is to constantly update their knowledge, skills and attitudes in their subject areas. Fatih (2020) further contends that teachers' professional development involves learning opportunities that enable teachers to adapt to changes in the education system. For example, a research study that was carried out in Turkey by Fatih (2020) showed that teachers' professional development indirectly increased learners' achievement by increasing teachers' effectiveness. For instance, Denuga (2019), in his study conducted in Namibia with Chemistry teachers also revealed that professional development helped teachers learn from one another which resulted in improved teaching and ultimately learner performance. These views all resonate well with that of Eun (2008), who says that professional development activities like workshops allow teachers to engage with each other and share best teaching practices that ultimately benefit learners.

According to Desimone and Garret (2015), professional development is when teachers experience a vast range of activities and interactions that can increase their knowledge and skills, improve their teaching practice and contribute to their personal, social and emotional growth. They also contend that for professional development to be effective it should contain the following five features: (a) content focus – activities should be about subject matter content and how students learn that content; (b) active learning – there should be opportunities for

teachers to observe, receive feedback, analyse work, make a presentation as opposed to passively listening to lecturers; (c) coherence – content, goal and activities that are consistent with the school curriculum; (d) sustained duration – professional development should be an ongoing process; and (e) collective participation – groups of teachers from the same grade and subject should come together to build an interactive learning community. Concurring is Cadero-Smith (2020), who proposes that teacher professional development should be sustained over some time for it to be effective.

However, it should be noted that although professional development activities have good intentions, some teachers do not easily accept or learn all that is shared on these platforms according to Gess-Newsome and Carlson (2013). In this regard, Ngcoza and Southwood (2019) advocate that professional development programmes should be tailored designed and developed in such a way that they meet teachers' needs and expectations for them to embrace such activities. This can be done in the form of professional learning communities (PLCs) (Brodie, 2013).

Brodie (2013) defines PLCs as a way in which teachers critically interrogate their practices in an ongoing, reflective and collaborative way to promote, improve and enhance their teaching. Concurring is Chauraya and Brodie (2018) who postulate that PLCs are groups of teachers who come together to engage in regular, systematic and sustained cycles of inquiry-based learning. These scholars further proffer that PLCs provide space where teachers come and reflect on their teaching approaches and see how to improve them – this is what Ngcoza and Southwood (2019) refer to as webs of development. Professional learning communities (PLCs) are designed not only to determine what students will learn but also to develop a space for teachers to determine how to respond when students do not learn (Hoaglund et al., 2014). Wilson (2016) is of the view that PLCs provide an environment that encourages professional development, collaboration and innovation among teachers. This view is also supported by Mutanho (2021), who posits that teachers' continuing professional development is central to any educational reforms that are believed to improve teachers' teaching.

In the context of this study, professional development was in the form of intervention. The intervention took the form of practical workshop demonstrations on soap making by the expert community members with the four Chemistry teachers using indigenous technology. These workshops aimed to improve teachers' SMK and PCK (Shulman, 1987). Vygotsky (1978)

argues that learning best happens in a social set-up with the mediation of cultural artefacts. During these practical demonstrations, the expert community members engaged the Chemistry teachers in hands-on practical activities using indigenous technology (see Section 2.5).

## **2.8 Concepts Related to Learning**

Jabareen (2009) defines these as interlinked concepts that inform a phenomenon being studied; furthermore, concepts related to learning are ideas or interrelated ideas that guide a research study (Bertram & Christiansen, 2015). In the context of my study, I used conceptions and dispositions as concepts related to learning by the four Chemistry teachers. I now discuss these below.

### **2.8.1 Conceptions**

Conceptions refer to views that teachers have towards a subject (Atallah et al., 2010). These scholars posit that teachers' conceptions are influenced by their experiences in class which later affect the quality of their teaching. Scholars such as Randy et al. (2016) verbalise that conceptions are viewed as what learners hold for a subject and what they believe is required in learning and doing it. For example, a study that was conducted in Namibia by Asheela (2017), showed that teachers believed that doing hands-on practical activities could not be done at schools without apparatus. However, the results of the study further revealed that after the intervention on how to perform hands-on practical activities using easily accessible materials, these teachers' conceptions and beliefs changed (Asheela et al., 2021).

Thus, in the context of this study, I intended to explore the four Chemistry teachers' conceptions of the integration of the IK in soap making. I did this to establish how they mediated the learning of saponification using the IK of making soap. Thereafter, I established how that influenced (or not) their teaching. However, it should be acknowledged that teachers' conceptions are closely linked to their dispositions.

### **2.8.2 Dispositions**

Atallah et al. (2010) opine that dispositions are a habitual tendency to exhibit a frequent, conscious and voluntary behaviour directed towards learning a subject. Lending support to this description is Graven (2012), who points to the fact that disposition, is an act of a learner seeing themselves as a doer and knower of a subject. In concurrence is Nelsen (2014) who argues that disposition in teaching is a cluster of habits, which describe our predisposition to draw upon

modes of response to situations and problems that arise within a specific context. He further adds that dispositions are about physical actions but also include thoughts that guide our actions.

In the context of this study, dispositions are used interchangeably with attitudes that the Chemistry teachers exhibited during the research process. Furthermore, I was eager to see if there were any shifts or changes in the four Chemistry teachers' dispositions regarding the use of indigenous technology.

## **2.9 Chapter Summary**

In this chapter, I discussed the literature relevant to this study. Firstly, I looked at the topic of saponification in detail. Secondly, I discussed various concepts which informed this study, namely prior knowledge, IK, hands-on practical activities and visualisation, sense-making, professional development and PLCs. Furthermore, I also discussed literature on teachers' conceptions and dispositions as this study's concepts related to the learning frameworks. In the next chapter, I discuss the theoretical and analytical frameworks that underpinned this study.

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## CHAPTER THREE: THEORETICAL AND ANALYTICAL FRAMEWORKS

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### 3.1 Introduction

A theoretical framework is a structure on which research is based. It is the vehicle driving all aspects of the research including the research problem, methodology, data collection, data analysis and data presentation (Merriam, 2009). In this chapter, I thus present the theoretical and analytical frameworks that underpinned this study.

My study is informed by the following theoretical frameworks, Vygotsky's (1978) SCT and Shulman's (1987) PCK. Within PCK; I used Topic-Specific Pedagogical Content Knowledge (TSPCK) by Mavhunga and Rollnick (2013) as an analytical framework. I also used the TSPCK with the consensus PCK model by Carlson and Daehler (2019). I now discuss all these frameworks below.

### 3.2 Theoretical Framework: Vygotsky's Socio-Cultural Theory

This study is informed by Vygotsky's (1978) SCT. Vygotsky describes SCT as a learning theory that emphasises the key role of society and culture in development and learning. The salient key to this theory is the concept of social learning. He maintains that mental processes begin as actual social relationships among people on the inner psychological level and later the new information is processed further on the intrapsychological level and this he called internalisation.

Vygotsky (1978) further simplified the term internalisation as the process of building mental models of tasks learnt through mediated action with more knowledgeable others (MKOs). He further says that internalisation is transferring learning from the social (interactional) plane to the individual (internal) plane. Lantolf and Beckett (2009) define internalisation as the process through which learners' appropriate social tools of mediation, cultural artefacts and language self-regulate their cognitive activities. Holding a similar view are Lantolf and Thorne (2006), who explain internalisation as the process of learning from social to individual. The idea is that

teachers in this study might best learn when working with others during the collaboration in making the soap.

It was through this collaboration with more skilled persons or MKOs, in my case the expert community members, that the Chemistry teachers were afforded an opportunity to internalise the concept learnt as alluded to by Vygotsky (1978). This view of learning is similar to social constructivism in which learners, in my case Chemistry teachers, built knowledge socially rather than just getting and storing the knowledge that was being taught by the expert community members. I chose to use Vygotsky's (1978) SCT because it emphasises how learners, in my case Chemistry teachers, learn in a social set-up. Within Vygotsky's SCT, I used the following concepts: mediation of learning; culture and language; social interactions, and the ZPD. I now discuss each of these below.

### **3.2.1 Mediation of learning**

Mediation is the link between teachers and learners that directly affects learners' understanding of knowledge and skills according to Vygotsky (1978). He states that mediation is used as a cultural tool in cognitive change. Additionally, mediation involves a person being purposively emerged in the learning activity and process. Vygotsky (1978) submits that mediation moves the learners from the known to the unknown knowledge. He further posits that mediation is the representation of cultural tools and how a child uses these cultural tools to resolve a problem or achieve a target.

Kozulin (2003) classified mediation into three categories (a) human mediator (MKOs); (b) psychological/symbolic mediator (skills & language used by MKO); and (c) external mediator (tools used by MKO and participants). During the mediation, the process of scaffolding is involved which is the support given to learners to help mediate the learning of a concept. Usually, it is given in smaller units and when the learner is progressing at the task at hand, this support is gradually removed (Brunner et al., 2004). Concurring is Schumm (2006), who describes scaffolding as help provided to learners which are gradually diminished or stopped to make them more independent. However, the idea of mediation is perceived differently by Turuk (2008), who describes mediation as the role in the development of the child which is played by the MKO.

In the context of this study, the human mediators were the expert community members because they demonstrated to me and the four Chemistry teachers how soap is made using indigenous technology. The psychological mediators were the technical skills, knowledge and language used by the community members. In my case, the home languages were Oshiwambo and Khoekhoegowab. The use of these two languages allowed all participants to communicate and participate more freely with each other, and this resonates with Eun (2008) and Gibbons (2003) who accentuate that language plays an essential role in the mental life of an individual.

### **3.2.2 Culture and language**

Vygotsky (1978) identifies language as one of the most important cultural tools for social mediation. He asserts that the internalisation of language changes the way we think. He further submits that this new way of thinking, in which language becomes a cultural tool for thinking, leads to the formation of higher mental functions like critical thinking. Adding to this line of thought are Bloom and Keil (2001), who articulate that language is not just a means of communication but instead, it can also be a medium used for thought and reasoning. In agreement is Gibbons (2003), who denotes that language is an important cultural tool in the learning process.

To Aikenhead and Jegede (1999), a language is a cultural tool that is vital in smoothening border crossing among learners. These scholars add that if learners are allowed to practice their cultures including their indigenous language, it makes it easier for them to understand what is taught in class. Sharing the same views are Mavuru and Ramnarain (2020), who expound that language helps learners to construct knowledge and make sense of scientific concepts taught in class, making it relatable and relevant to their socio-cultural backgrounds. However, they warn teachers to be careful with using home indigenous languages to avoid the exclusion of some learners, especially in multicultural classes. According to Vygotsky (1978), language as a cultural tool plays a crucial role in sense-making as topics or concepts are taught in a language as a medium of instruction. For instance, in the context of this study, local home languages (Oshiwambo and Khoekhoegowab) were used to mediate the process of making soap. Language usage is very crucial when it comes to social interactions in a classroom set-up as it is used as a medium of instruction and assessment.

### **3.2.3 Social interactions**

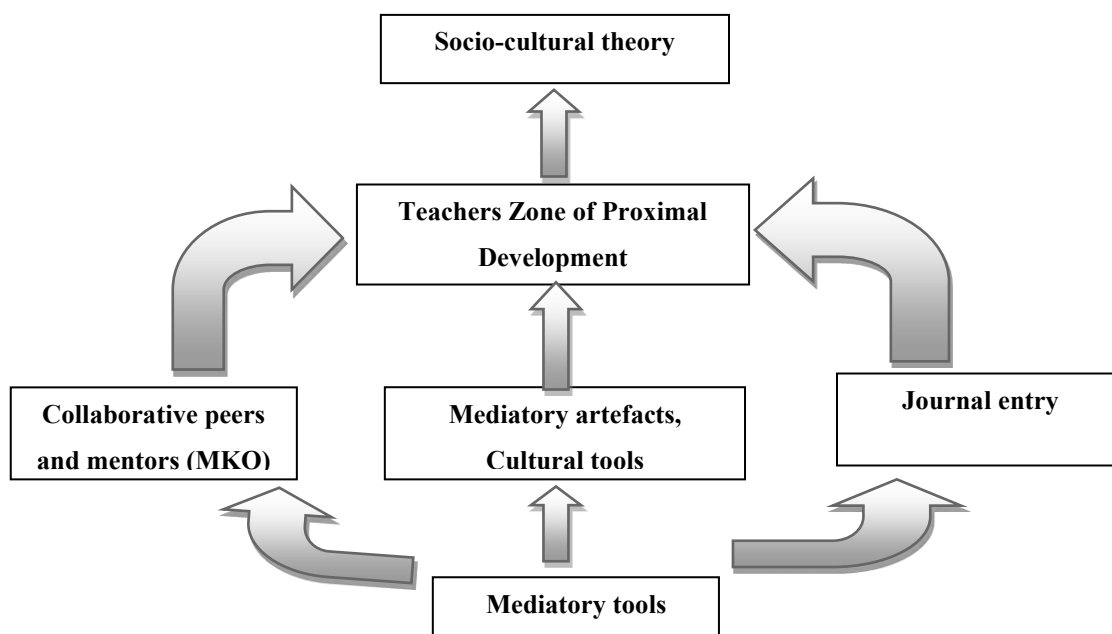
Vygotsky (1978) postulates that learning takes place in a social arena when people interact with each other and learn from those that know more. He refers to such people as the MKOs. In the context of education, these people are adults (teachers and parents) and children (peers) who scaffold learners to increase their development and performance (Stott, 2016). In the case of this study, social interaction took place at the site of the practical presentations on how to make soap as participants were engaged with each other socially. The MKOs were the expert community members who are the custodians of the indigenous technology on how to make soap. That is, they are knower's and have funds of knowledge in that specific field.

This approach of inviting community elders to mediate science concepts from an indigenous perspective is referred to as bottom-up decolonisation by Seehawer (2018a) and Mutanho (2021). The learners in this study were the Chemistry teachers and me and we observed and took part in discussions. I have noticed from my experience as a Chemistry teacher that learners learn more when they are given hands-on group work activities as reiterated by Asheela et al. (2021) in their study; for example, during science fair expo projects presentations at my school. Learners always acknowledged that they enjoyed working in groups and learnt a lot from others including their peers, parents and community members like librarians when they were compiling their projects. This act of learners working with others has a tremendous impact on their ZPD.

### **3.2.4 Zone of Proximal Development**

The ZPD is defined by Vygotsky (1978, p. 86) as “the distance between the actual development level as determined through independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers”. Vygotsky (1978) describes the concept as what a child can do on their own and what a child can do with the help of a knowledgeable person. Furthermore, he extends his description by stating that what a child can do in co-operation today, he can do alone tomorrow. Additionally, he postulates that learning needs to move from the known to the unknown, to take the child from the stage of not fully capable to capable. From the stage where learners require help to a stage of sufficiency. This concept of Vygotsky testifies that the development of the child is possible under the guidance of a teacher, parent or peer. Moreover, the idea of ZPD is interpreted by Mitchel and Myles (2004) as the domain of skills or

knowledge wherein the child is not capable of independent functioning. However, the child can get the targeted results when they are given relative scaffolding (see Figure 3.1 below).



**Figure 3.1: Showing influential factors in the teachers’ZPD (adapted from Ebadi et al., 2010, p. 242)**

In the context of this study, the teachers including myself learnt from the expert community members how to make soap using indigenous technology. Thus, they imparted to us the knowledge and skills on how to integrate this new knowledge into our Chemistry lessons. This view sits well with those of Ebadi et al. (2010) who echo that individuals learn best in group settings like the collaboration of the MKOs and Chemistry teachers in making soap. In the same vein drawing from Eun (2008), the community members helped Chemistry teachers (less knowledgeable) into the most proximal level of development by aiding them with the knowledge of how soap is made traditionally. It was envisioned that by the end of the presentation by the community members, the Chemistry teachers and I would have moved from the stage of not knowing –being unable to make soap and integrate indigenous technology in mediating the topic of saponification – to a stage of knowing, and being able to implement the acquired knowledge and skills along the continuum of the ZPD. Concerning the above diagram, the mediatory tools were the language the expert community members used, while the cultural tools and artefacts were the traditional tools and ingredients that they used to make the soap.

However, Ameri (2020) critiques Vygotsky's SCT and his concept of ZPD. This scholar states that the ZPD component is unclear in the sense that it does not account for a precise picture of a child's learning needs, present capabilities and motivational influences. He also avers that the ZPD does not explain the process of development or how it occurs. Furthermore, Ameri (2020) argues that the SCT disregards the role of the individual but foregrounds the collective more. I now discuss the analytical framework used in this study.

### **3.3 Analytical Framework: Shulman's Pedagogical Content Knowledge**

This study is also informed by Shulman's (1986) PCK. Shulman defines PCK as "the blending of content and pedagogy into an understanding of how topics, problems or issues are organized, represented and adapted to the diverse interest of learners and represented for instructions" (1986, p. 8). He posits that teachers should possess the knowledge to recognise and address the misconceptions learners may have about a topic. They should employ and adapt the best strategies and methods or teaching style that makes topics meaningful and interesting to their learners.

Shulman (1987) further explains PCK as the knowledge that includes "an understanding of what makes the learning of a specific topic easy or difficult" (p. 9). This suggests that the teacher should know the teaching strategies and the support materials needed to teach that specific topic. Additionally, Shulman's (1986) PCK is a teaching theory focusing on how teachers transform the subject matter into teachable units of knowledge accessible to the diverse interest of learners. This later resulted in Shulman (1987) identifying seven categories:

- (i) Subject Matter Knowledge (SMK);
- (ii) Pedagogical Content Knowledge (PCK);
- (iii) Curriculum Knowledge Pedagogy (CKP);
- (iv) General Pedagogy;
- (v) Knowledge of learners & their characteristics;
- (vi) Knowledge of educational context; and
- (vii) Knowledge of educational purpose and values.

I chose to use Shulman's (1987) PCK because it is all about how teachers transform SMK so that it is comprehensible and understandable to learners. In my case, the learners were the four Chemistry teachers and me while the expert community members took the role of being

teachers as they were knowledgeable about the traditional practice of making soap. For this study, I focused on the SMK which entails the knowledge of concepts, theories and ideas of the subject discipline. In the same vein, I also focused on the PCK which includes and involves the methods and styles of teaching and learning.

However, PCK is not without its critiques. For instance, Kind (2009) states that PCK is not yet backed up by theory to support its existence. Shing et al. (2015) charge that “similar to teaching, PCK is complex and difficult to define explicitly” (p. 46). Concurring is Loughran et al. (2016) who are of the notion that PCK is quite well understood but it is still under-theorised. On the other hand, Settlage (2013) articulates that the problem with PCK is that knowledge is treated as information without sufficient regard for how it manifests itself as action. Another critique of Shulman’s conceptualisation of PCK is that it lacks empirical grounding according to Backman and Barker (2020).

Within PCK, I used Mavhunga and Rollnick’s (2013) Topic-Specific Pedagogical Content Knowledge (TSPCK) as my analytical framework which is an extension of Shulman (1986) and Geddis and Woods’s (1997) seminal work on PCK (see Figure 3.2 below).

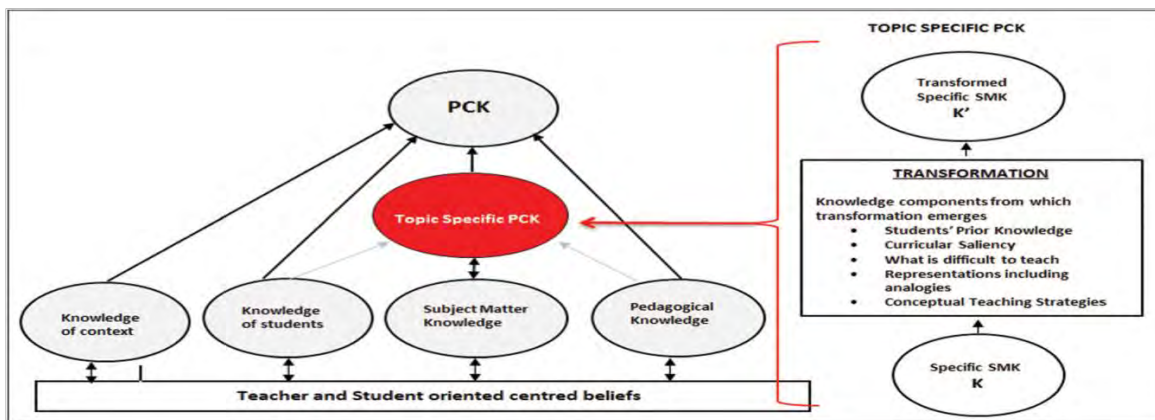


Figure 3.2: Showing the five components of TSPCK (adopted from Mavhunga & Rollnick, 2013, p. 115)

I now discuss the five TSPCK components as shown on the right-hand side of the model in Figure 3.2 above.

*(i) Prior knowledge*

According to Mavhunga and Rollnick (2013), this component calls for teachers to elicit learners' everyday knowledge. This includes what learners were taught in the previous grades. In the context of my study, however, this also encapsulates everyday life knowledge from home and community, for example, on the indigenous technology of making soap. It also calls for the teachers to have the skills to handle the preconceptions and misconceptions learners might have. Furthermore, teachers should not dismiss errors of learners but instead, use them to enhance learning.

*(ii) Curriculum saliency*

To Mavhunga and Rollnick (2013), this component demands that teachers identify the major concepts around the topic which learners need to understand. It also entails the sequencing of the specific topic and emphasises the identification of the most important concept in that topic.

*(iii) What is difficult to teach or understand (WDT/U)*

This component emphasises how teachers should deal with those concepts that are challenging to teach or difficult for learners to understand and comprehend. It also refers to gatekeeping concepts that are difficult to understand, often because they cause conflict with previously established understandings (Mavhunga & Rollnick, 2013).

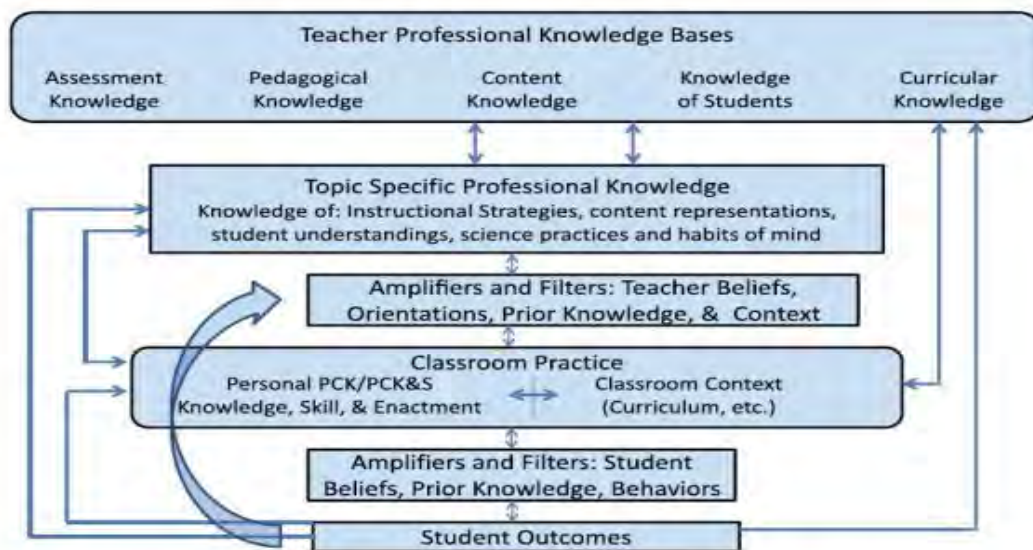
*(iv) Representations*

Mavhunga and Rollnick (2013) describe this component as the various forms and ways of presenting the subject matter to make it comprehensible to learners. It entails mechanisms that the teacher will use to explain the topic for learners to understand easily. It involves the supporting, scaffolding or explanations of difficult concepts. They state that it also includes the use of mediation tools like models, simulations and analogies to foster learners' understanding of school science concepts. It further refers to a combination of representations at macro, symbolic and sub-microscopic levels that may be employed to support explanations.

(v) *Conceptual teaching strategies*

Mavhunga and Rollnick (2013) posit that conceptual teaching strategies are teaching methods and styles that can be explored by the teacher. They are aimed at helping learners acquire curriculum knowledge and usually, the choice of the teaching strategy considers any misconceptions and the educational purpose and needs of the learners. It may also refer to teaching strategies derived from the consideration made of the other components.

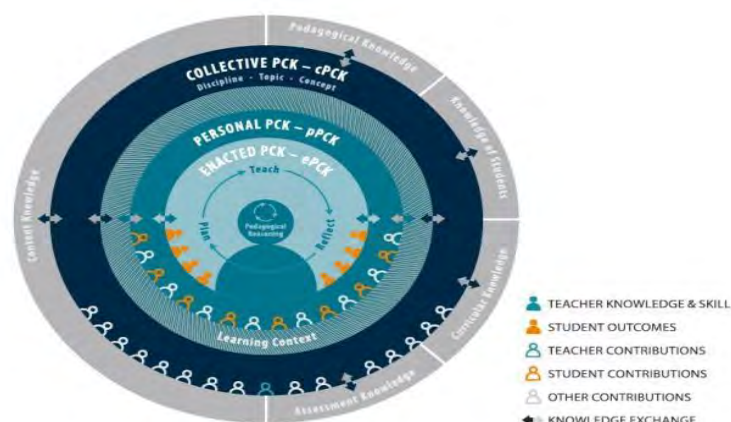
I chose to use these components because I believed that they might lead me to a better understanding of how teachers elicit their learners' prior knowledge, how they organise and present the ideas, how they make abstract concepts meaningful to the learners and the teaching materials and strategies they use. Due to much criticism of Shulman's PCK, however, some international research scholars met in the USA in the state of Colorado in 2012. At that summit, a consensus PCK model was developed and agreed upon as an extension of Shulman's (1987) PCK theory. This model was referred to as the teacher professional development model.



**Figure 3.3: Consensus model of PCK from PCK summit 2012 (Gess-Newsome, 2015, p. 31)**

From the consensus PCK model, Gess-Newsome (2015) defines PCK as the knowledge and skills teachers use when planning and teaching a specific topic in a classroom context, in my case the specific topic is saponification. Unfortunately, this model has also been critiqued for having inadequate details about PCK. As a result, it was further improved and developed to

incorporate other multidimensional natures of PCK according to Carlson and Daehler (2019) as shown in Figure 3.4 below.



**Figure 3.4: Refined consensus model of PCK (Carlson & Daehler, 2019, p. 83)**

The refined consensus model consists of three dimensions: collective PCK, personal PCK and enacted PCK (Carlson & Daehler, 2019). I will now discuss these concepts below.

- Collective PCK is specialised knowledge that is held by multiple teachers in the field. This knowledge is usually not private but public. In the context of this study, it is the knowledge that the four Chemistry teachers and I possessed as a collective. This knowledge is usually acquired from institutions of higher learning like universities and colleges.
- Personal Pedagogical Content Knowledge is the knowledge that teachers acquire during their teaching careers. In my case, this is the knowledge the Chemistry teachers and I had acquired through years of teaching Chemistry at the high school level.
- Enacted Pedagogical Content Knowledge is the knowledge that the teachers use when they teach in class. In my case, this knowledge was revealed during the co-development of the exemplar lesson plan that integrated the IK of soap making.

In sum, in this study, I opted to use Vygotsky's (1978) SCT and augmented it with Shulman's (1987) PCK because these theories complement one another. For instance, the SCT is a learning theory central to which is culture, language and social interactions. In the context of this study, the three aspects were fostered through the practical demonstrations of traditional soap making by the expert community members. On the other hand, PCK's emphasis is on

pedagogy or instructional strategies to make knowledge comprehensible to learners (teachers) so that there could be a shift in their ZPDs. Social interactions were thus enhanced through the use of representations in the form of the indigenous technology of soap making to understand the concept of saponification in organic chemistry.

### **3.4 Chapter Summary**

In this chapter, I discussed the theoretical frameworks that informed my study, namely Vygotsky's (1978) SCT and Shulman's (1986, 1987) PCK. I also discussed Mavhunga and Rollnicks' (2013) TSPCK as my analytical framework. Furthermore, I also discussed the consensus PCK model of Gess-Newsome (2015) and the refined consensus PCK model of Carlson and Daehler (2019). In the next chapter, I discuss the research methodology that underpinned this study.

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## CHAPTER FOUR: RESEARCH METHODOLOGY

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### 4.1 Introduction

Teddle and Tashakkori (2009) define methodology as an approach that shows how research questions are asked and answered. Concurring, Creswell (2014) adds that a research methodology is the identification of procedures or techniques used to analyse a conducted research study. I thus needed an appropriate research methodology for an interventionist study whose aim was to mobilise the indigenous technology of making soap to mediate the learning of saponification in organic chemistry.

In this chapter, I thus discuss the research methodology that underpinned this study. Firstly, I discuss the interpretive and indigenous research paradigms that informed this study. Within the indigenous research paradigm, I focused on the Ubuntu perspective. Secondly, I discuss the research design I employed in this study. Within the research design, I discuss a case study research design; the research site and sampling of the participants and their profiles; my positionality and reflexivity; the data-gathering methods; research processes; data management; data analysis; validity and trustworthiness, and the ethical considerations of my study, then end off with a chapter summary.

### 4.2 Research Paradigms

According to Chilisa (2012), the term paradigm was used by Thomas Kuhn in 1962 to present a particular way of thinking and seeing the world that is shared by scholars, researchers and scientists. It encapsulates commitments, world views, beliefs, values, methods and approaches shared across a discipline. She further goes on to define a paradigm as a way of describing a world view that is informed by philosophical assumptions about the nature of social reality (ontology), ways of knowing (epistemology), ethics and value systems (axiology) and research process and systematic inquiry (methodology) (Afonso-Nhelevilo, 2013).

Bertram and Christiansen (2015) state that paradigms are researchers' worldviews. Concurring is Maree (2016), who avers that research paradigms are lenses through which a researcher perceives the world. In addition, Creswell (2016) posits that a research paradigm is a lens used by the researcher to discern worldviews. In this regard, this study was informed by the interpretive and indigenous research paradigms. I now discuss each of these below.

#### **4.2.1 Interpretive paradigm**

According to Bertram and Christiansen (2015), an interpretive paradigm tries to understand the social world. They further say that it also seeks to understand the meaning which informs human behaviour. The focus of this paradigm is on human agency, behaviour and attitudes according to Davis and Bezuidenhout (2014). These scholars proffer that the main interest of the interpretive paradigm is people and how they do things in their contexts and their ideas about the world. In agreement are Bertram and Christiansen (2015) who explain that interpretive researchers do not aim to predict how people do things but rather understand how people make sense of their world. Moreover, Cohen et al. (2018) aver that the main aim of the interpretive paradigm is to understand the nature of human experience. They add that this paradigm views the social world as an emergent social process. Thomas (2013) argues that the interpretive approach is of the view that everyone's worldview is different. In line with this view is Tshabangu (2015) who proffers that interpretive studies seek to uncover people's multicultural conversations. Thomas (2013) further postulates that the interpretive approach is of the view that everyone's worldview is different, and it seeks to describe and understand human nature and lived realities (Seehawer, 2021).

In the context of this study, by using the interpretive paradigm I hoped to understand the four Grade 11 chemistry teachers' attitudes about how they integrate IK into their Chemistry teaching. However, one of the criticisms of the interpretive paradigm is that it tends to focus on descriptions at the expense of explanations (Rehman & Alharthi, 2016). To counteract this limitation and similar to Kakambi's (2020) study and other scholars, I complemented the interpretive paradigm with the indigenous research methodology.

#### **4.2.2 Indigenous research paradigm**

The indigenous research paradigm explores ways of making research a partnership between the researcher and the researched. It perceives literature as language, cultural artefacts, legends, stories, songs, practices, rituals, poems, dances, tattoos, lived experiences, funerals,

celebrations, weddings, wars, folktales and parables according to Chilisa (2012). Chilisa further submits that the indigenous research methodologies have four dimensions, namely (i) it targets a local phenomenon instead of using extant theory from the west to identify and define a research issue, (ii) it is context-sensitive and creates locally relevant constructs, methods and theories derived from local experiences and IK, (iii) it can be integrative, that is combining western and indigenous theories, and (iv) in its most advanced form, its assumption about what counts as reality, knowledge and values in research are formed by an indigenous research paradigm. Within the indigenous research paradigm, I focused on the Ubuntu perspective.

Ubuntu is a “philosophy of a collective effort characterized by the spirit of togetherness which sees human needs, interest, and dignity as of fundamental importance and concern” (Higgs, 2008, p. 453). In short, Ubuntu is an African adage or axiom that means “I am we; I am because we are; we are because I am” (Chilisa, 2012, p.102). Ubuntu is referred to by Le Grange (2012) as humanness or human dignity. He states that Ubuntu originates from the Xhosa expression “Umuntu ngumuntu ngabanye Bantu” (p. 331). Simply put, Ubuntu means I am because we are or the spirit of oneness found in African communities (Chilisa, 2012; Chilisa & Ntseane, 2010; Mkabela, 2015; Stefaroi, 2016). Keane et al. (2016) coin it differently to say “I am a person through other people” (p.6). There has been a broad consensus among scholars that Ubuntu is an African philosophy expressing humanness in values of compassion, solidarity, harmony, hospitality, sympathy, sharing, respect, love, self-awareness, self-determination, holism and spirituality (Chigangaidze, 2021; Tucker & Masango, 2017).

Moreover, Ogunniyi (2020, p.157) states that “Ubuntu has the potential to tame scientific practice in a way that promotes human virtues such as humanness, communalism, interdependence, equality, social justice and moral responsibility not only within the scientific community of practice but the society at large”. Mukwambo et al. (2014) refer to Ubuntu as a way in which African people help each other in the spirit of togetherness. This resonates so well with an African proverb that my supervisor always tells us: “if you want to go fast walk alone, but if you want to go far walk with others”. According to Mavuru and Ramnarain (2017), Ubuntu is an African philosophical notion that values sharing and emphasises interconnectivity by encouraging people to share their resources, knowledge and skills.

The use of the Ubuntu perspective in this study was in response to calls from scholars such as Seehawer (2018a) who call for decolonisation and contextualisation of WS taught in our schools towards more African-based science pedagogies. Mavuru and Ramnarain (2017) request a pedagogy that takes into account the African learners' socio-cultural backgrounds. Also, Ubuntu has been discussed as African philosophy, worldview, moral ethics and a way of knowing (Chilisa, 2012). To Chilisa, from a research perspective, Ubuntu comprises philosophical assumptions about the nature of reality (ontology), ways of knowing (epistemology) and ethics and values (axiology). She further argues that in an Ubuntu perspective, knowledge is not generated and validated by individuals or through conventional scientific processes but through communal discourse involving local people. Lending support to this is Ngcoza and Southwood (2015) who reiterate that within the Ubuntu perspective, research is conducted *with* the participants as co-researchers as opposed to researching on them. This view is also embraced and commended by Seehawer (2018a).

I used Ubuntu as a perspective because it focuses on indigenous cultures found in Africa. Ubuntu emphasises sharing and working together, something which has an affinity with the aim of my study in the sense that I invited expert community members to share how soap is made traditionally using local IK. That afforded the four Chemistry teachers and me an opportunity to interact with the expert community members to understand the science embedded in the traditional practice of making soap.

### **4.3 Research Design**

A research design is a plan showing how the researcher will collect and analyse data needed to answer research questions (Bertram & Christiansen, 2015). Similarly, Cohen et al. (2018) describe a research design as a strategy the researcher uses to answer research questions based on evidence. In this study, I adopted a case study research design.

#### **4.3.1 Case study**

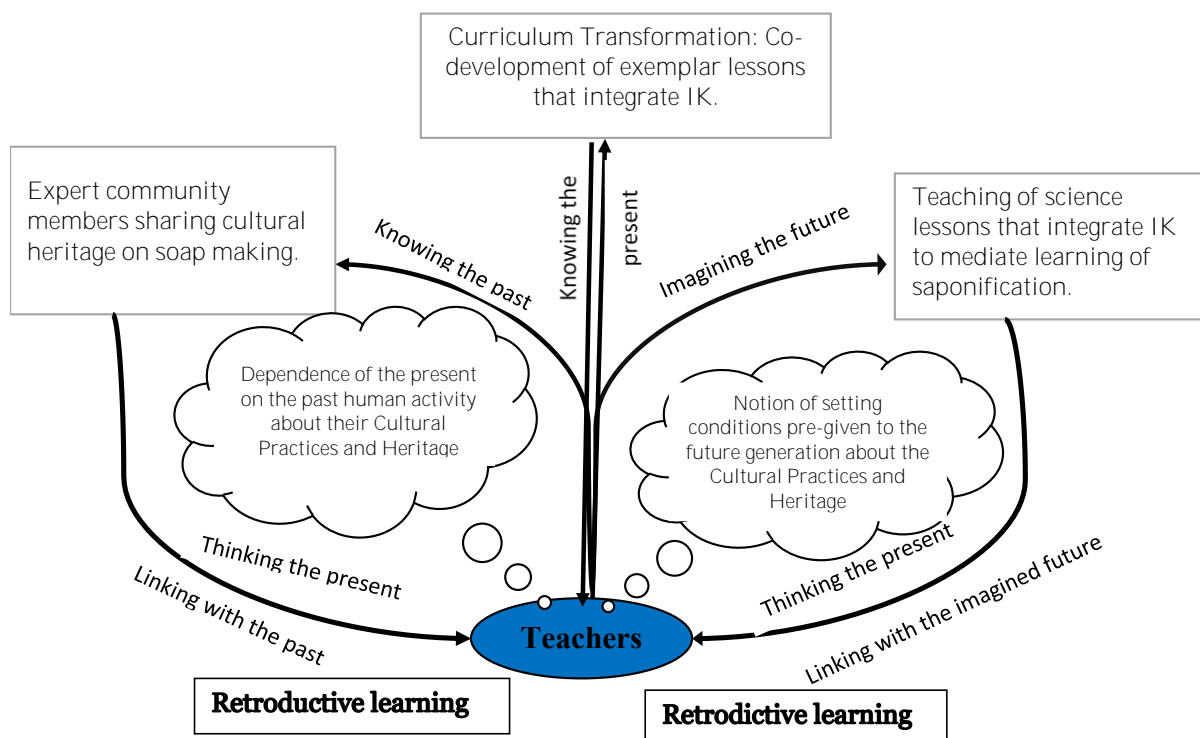
Within the interpretive and indigenous research paradigms, I employed a qualitative case study research design. Bertram and Christiansen (2015) define a case study as “a systematic and in-depth study of one particular case in its context” (p. 42). Similarly, Creswell (2014) describes a case study as a comprehensive investigation of a confined and bounded system. Agreeing, Cohen et al. (2018) contend that a case study is a specific instance that is frequently designed to illustrate a general principle. They further assert that it allows researchers to examine issues

in detail rather than superficially. On the other hand, Maree (2016) postulates that a case study is a method used by researchers to make meaning out of the situation being studied. This view resonates with that of Thomas (2013), who expounds that a case study involves an in-depth study of a case to get a detailed understanding of a phenomenon.

In the context of this study, a case study was deemed appropriate as I hoped to search for an in-depth understanding of how the four Chemistry teachers make sense of the science in the traditional soap-making process. It also gave me insight into their pedagogical knowledge and skills. The case constituted the four Grade 11 chemistry teachers from schools within the circuit, who worked together as co-learners in a learning community (Ngcoza & Southwood, 2019). This was done in order to create a platform for expansive learning (Engeström & Sannino, 2011). The unit of analysis was based on the social interactions, participation and learning experiences during the workshop presentations that were conducted by the two expert community members.

Similar to the studies by Hashondili (2020) and Mayana (2020), a participatory approach was adopted in this qualitative case study. In the context of this study, a corroboration with expert community elders took place. Additionally, the study was also informed by Chikamori et al.'s (2019) Transformative Model of Education for Sustainable Development known as (TMESD) framework. Chikamori et al. (2019) define sustainable development as development that meets the needs of the present without compromising the ability of the future generations to meet their own needs. The TMESD framework or model fits well with local IK designs such as the formulation of lessons and the involvement of the expert community members who are the custodians of the local IK or cultural heritage. The TMESD framework helped explain the process of how IK could be integrated and enacted in science (Chemistry) lessons.

The TMESD framework consists of three learning sub-processes, namely (i) *knowing the present*, (ii) *past-present relationships*, and (iii) *future-present* according to Chikamori et al. (2019) (see Figure 4.1 below).



**Figure 4.1:** Shows the learning process regarding the integration of IK in science lessons (adopted from Chikamori et al., 2019, p. 9)

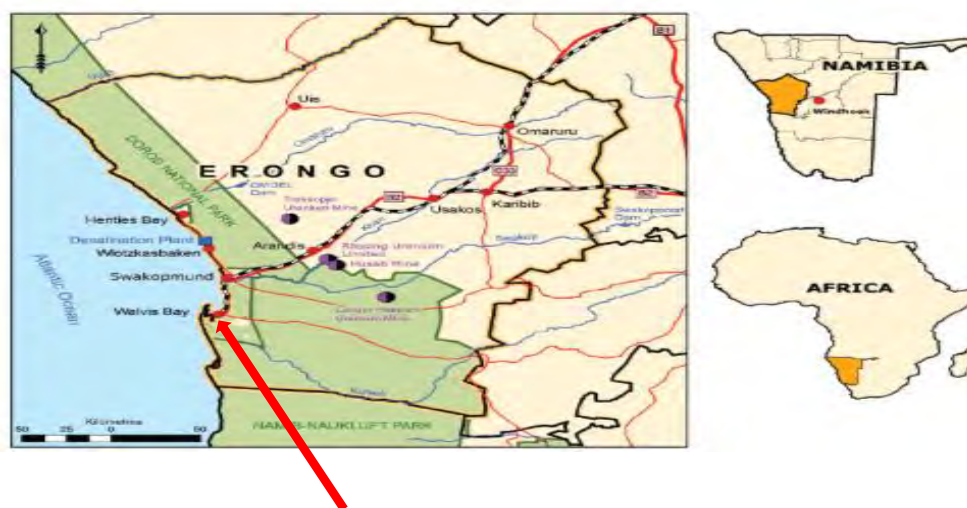
These scholars further explain the process of studying the past-present relationship as *retroduction* and future-present relationships as *retrodiction* (see Figure 4.1 above).

Taking counsel from Mavhunga and Rollnick (2013), the specific topic in this study’s context was saponification (soapmaking). The first sub-process (knowing the present) was achieved through the use of semi-structured questionnaires and semi-structured interviews. The data gathered were used to find out teachers’ attitudes and pedagogical insights on saponification, and how they integrate IK or not when mediating learning of saponification in their classrooms. In the second sub-process (past-present relationship), the teachers were engaged in an intervention workshop demonstration in which two expert community members shared their IK on how to make soap. During this practice, the Chemistry teachers were given the opportunity to link and make sense of the scientific concepts embedded in the traditional soap-making process with that of saponification. Lastly, the third sub-process (future-present) was achieved through reflections and co-development of exemplar lessons that integrate IK on soap making to mediate saponification.

The TMESD framework by Chikamori et al. (2019) was deemed applicable for this study because it is anchored in the design and enactment of science lessons that integrate IK. It also gave the expert community members as the custodians of this cultural heritage a platform to come and share it with the teachers.

#### 4.4 Research Site and Sampling of Research Participants

The research study was conducted in the coastal town of Walvis Bay in the Erongo region of Namibia and the name of the school is SSDD (Pseudonym) (see Figure 4.2 below). It is a government school with a staff composition of 37 teachers and a total learner population of 1040 from different socio-cultural backgrounds (Mavuru & Ramnarain, 2017) at the time of the study. Chemistry is an optional subject that is taught in English and is a medium of instruction in all government schools (MoE, 2015). The school does have a science laboratory but it is not functional as it lacks infrastructure like gas and water pipes. It also has some outdated apparatus and chemicals to conduct experiments and investigations. It was against this backdrop that the expert community members were invited to do practical demonstrations of making soap to mediate saponification in organic chemistry. The community members used IK (technology) with easily accessible resources and materials (Asheela et al., 2021).



**Figure 4.2:** The research site (Erongo maps Namibia) [https://www.researchgate.net/figure/1-Fieldwork-area-in-Erongo-Region-Namibia-Map-Roessing-Uranium-2017\\_fig10\\_338375434](https://www.researchgate.net/figure/1-Fieldwork-area-in-Erongo-Region-Namibia-Map-Roessing-Uranium-2017_fig10_338375434)

Cohen et al. (2018) refer to sampling as the process of defining and selecting the population on which the research will focus. They further affirm that sampling is a process of picking the people from a population to be part of the research study. Maree (2011) says sampling is all about deciding and choosing who should partake in the study. On the other hand, Bertram and

Christiansen (2015) state that sampling has to do with “a researcher making a decision which people, settings, events or behaviors to include in the study” (p. 59).

In this study, purposive sampling was used. Palys (2008) describes purposive sampling as a non-probability sample. It is selected based on the objective and need of the study at hand. Bertram and Christiansen (2015) point out that purposive sampling means that the researcher makes specific choices about who to include in the research study. They further state that participants are chosen for a specific purpose that fits the needs of the study – they call this criterion sampling. Similarly, Cohen et al. (2018) define it as a selection of strata that fits the purpose of the study.

In this study, I worked with four Chemistry teachers from different schools within the circuit. I approached and negotiated with them orally prior to the commencement of the research study. Thereafter, I gave them consent forms after the research proposal was approved by the university’s ethics committee. I also paid courtesy visits to the two expert community members’ sites, and this was done for familiarisation and trust-building, something which is critical when working with community members. I also approached a colleague at my school to be my critical friend. He was requested to assist with videotaping all the activities during the research study.

I chose to work with the two expert community members (a female and a male) because they were the custodians of the indigenous technology of making soap. This helped me and the four Chemistry teachers in acquiring the knowledge and skills needed to mediate the learning of saponification. I also chose these four Grade 11 chemistry teachers from different schools because I wanted to establish a community of practice that we could use to improve our practices (Lave & Wenger, 1991). We are currently using this interactive community of practice to share the best teaching and learning practices.

## 4.5 Participants' Profiles

**Table 4.1: Teachers' profiles**

Name	Surname	Age	Qualification	Teaching experience	Tribe
1.Thomas	Willibard	26	BEd-H	3	Oshiwambo
2.Gotlib	Undjombala	35	BETD/BEd-H	8	Oshiwambo
3.Otto	Amateta	36	DE	2	Kavango/ovambo
4.Weri	Katjirua	37	MASTEP	5	Herero

**Table 4.2: Expert community members' profiles**

Name	Surname	Date of birth	Qualification	Occupation	Tribe
1.Emma	Annantias	72/01/10	Standard 8	Cleaner	Oshiwambo
2.Reinhardt	Nawaseb	65/06/26	Standard 8	Retired caretaker	Khoekhoegowab

## 4.6 My Positionality and Reflexivity

Moser (2008, p. 89) refers to positionality as factors that “impact the way we do our research and how people we work with perceive us”. He adds that these factors include gender, race, ethnicity, religion, age, position and power dynamics. Bourke (2014) posits that positionality is determined by where the researcher stands in relation to the participants. Cohen et al. (2018) assert that the relationship between the researcher and participants is not the same in terms of power. For example, they state that mostly, those with more power research those with less power. Additionally, Holmes (2020) describes positionality as an individual’s worldview and

the position they adopt about a research task and its social and political contexts. He posits that positionality consists of the researcher's ontological and epistemological assumptions.

On the other hand, reflexivity is the action of carefully thinking and critically pondering the implications of the different decisions of the research project. It is about how the researcher will put actions in place to guarantee, not just the well-being of their participants, but also the reliability and validity of the data collection process (Holmes, 2020). For Chilisa (2012), reflexivity refers to the assessment of the influence of the researchers' background and ways of perceiving reality, experiences, ideological bases and interests during the research. She goes on to say that the researcher is the main data collector, and the researcher also analyses, interprets and reports the findings. It is important, therefore, that the researchers' thoughts, feelings, frustrations, fear, concerns, problems and ideas are recorded throughout the study.

Since I was teaching the subject and at the same time conducting the study with four Grade 11 chemistry teachers from neighbouring schools, I was aware of the power dynamics. In this regard, Thomas (2013) proffers that interpretive researchers (like me) have an undeniable position in the research process. This position affects the way they observe and make interpretations. However, being a male teacher born and raised in an urban area placed me in a less knowledgeable position when it came to making the soap traditionally. Since this study was based on the presentation by expert community members, I was therefore placed in a position of a co-learner and not an academic expert.

I was also cognisant of the fact that being a master's student doing science education could put me in a compromising position. The Chemistry teachers might have perceived me as the MKO as reiterated by Vygotsky (1978). To counteract this, I created and built a good rapport and trust with all participants that were involved in this study. I also told them that I was conducting this research project *with* them and not on them as reiterated by Ngcoza and Southwood (2015).

I also ensured that my participants were not obliged or forced to participate in my study which was conceptualised as a community of practice or PLC. I also explained to them that participation in the project was 100% voluntary and they were free to withdraw their participation. However, it should be noted that I politely did this as it might have sounded disrespectful to them (Mutanho, 2021).

To further strengthen the relationship with my participants I visited the expert community members' homes. These visits aimed to explain to them what the research study was all about. In the same vein, I also went to the schools where the Chemistry teachers were teaching for me to familiarise myself with their classroom set-ups. I also explained to my critical friend that his role was to help in capturing all activities on a video recorder. Lastly, in an effort to make them all feel comfortable around me; I explained to the participants that during this entire research study we were all learning from each other in the spirit of Ubuntu.

#### **4.7 Data-Gathering Methods**

Data gathering methods are a variety of approaches used by a researcher to gather data according to Cohen et al. (2018). Data gathering involves the use of different techniques and tools to collect data (Leedy & Ormrod, 2010). These scholars further aver that data collection tools help in answering research questions. Looking at the perimeter and context of my study I used the following data gathering methods to help me answer my three research questions: semi-structured interviews, semi-structured questionnaires, workshop discussions, participatory observations, stimulated recall interviews and journal reflections.

I chose to use a variety of data gathering methods because I wanted to gather as much data as possible in an effort to enhance triangulation (Cohen et al., 2018). My reasoning resonated with that of Mills (2011), who suggests that using different data gathering methods helps with the triangulation of data which enhances the validity of the research. He further points out that this strategy reduces the risk of systematic bias or limitations of a specific method as it allows the researcher to gain a broader understanding of what they are busy researching on. I will now discuss the data gathering methods.

##### **4.7.1 Semi-structured interviews**

Bertram and Christiansen (2015) define interviews as the conversation between a researcher and the respondents. According to them, the researcher asks the respondent questions to obtain answers. Maree (2014, p. 86) defines an interview as a “two-way discussion whereby the interviewer asks the participants questions with the aim of collecting data and to learn about the ideas, beliefs, views, opinions, and behaviors of the participants”. In addition, Cohen et al. (2018) argue that the use of semi-structured interviews provides the researcher with rich and reliable data about the phenomenon being studied.

In this study, I used semi-structured interviews (see Appendix F), which are explained by Chilisa (2012) as a focused interview that has questions contained in an interview guide. According to Cohen et al. (2018), semi-structured interviews have the flexibility of asking both open-ended and closed-ended questions. This gives the researcher more freedom to ask the interviewee more probing questions for more clarity according to O’Leary (2017) – this was done after designing an interview schedule. I chose to use semi-structured interviews because I had hoped that they would help me gain pedagogical insights into my participant’s teaching approach to saponification. With permission from all the participants, I videotaped all the interviews. I did this to ensure that no information was lost during the transcription process. Furthermore, I chose this type of interview because I felt that it could help me get detailed information about the Chemistry teachers’ dispositions. Additionally, many people prefer talking to writing.

The main disadvantage of interviews is that they tend to reach a limited number of people according to Bertram and Christiansen (2015). In my case, for instance, I only interviewed four Chemistry teachers face to face at a time that was convenient for them and all Covid-19 protocols were adhered to. However, since my study was a case study it was not intended to be generalised. It took about 10–20 minutes for each participant to be interviewed at their respective residence in the afternoon.

#### **4.7.2 Semi-structured questionnaires**

Bertram and Christiansen (2015) submit that a questionnaire comprises a list of questions that a respondent answers (see Appendix G). They indicate that questionnaires can contain either closed-ended or open-ended questions. These scholars expounded that closed-ended questions are questions where respondents must choose answers from given possible answers, while open-ended questions allow the respondents’ freedom to answer a question in their own words. Additionally, semi-structured questionnaires ask more open-ended questions than closed questionnaires and open-ended questions are questions that respondents may answer as they like or wish. Meanwhile, Cohen et al. (2011) charge that questionnaires are advantageous in the sense that they are often used to survey participants’ attitudes, opinions and knowledge of a specific subject. They contend that questionnaires can be given to many people who are geographically spaced out. They, however, caution that the researcher needs to be present to

explain some questions to illiterate participants and they might at times lead to a low return rate if not collected back immediately.

In the context of this study, I first piloted my semi-structured questionnaires with two of my MEd colleagues. I did this to confirm whether the questions were clear and understandable. The pilot semi-structured questionnaire revealed that one question was not very clear as per the response of one of my MEd colleagues. He stated that one of my questions was too general and broad. I welcomed the constructive feedback and narrowed it down to make it more specific. At the same juncture, Bertram and Christiansen (2015) also share the same sentiment, that before questionnaires are distributed to the participants they should first be piloted with a smaller sample, as this helps to ensure that questions asked are clear and unambiguous.

I administered the questionnaires directly in person to the four participants to complete, while adhering to the Covid-19 protocols of social distancing, mask-wearing and sanitising. It took about 20 minutes for each teacher to complete, although one participant took a bit longer to complete – about 30 minutes – as I had to unpack some questions for this participant. For example, she did not fully understand the question of how soap is made in her culture. This strategy aided me in terms of getting valid and trustworthy data. In the end, I got back all four questionnaires I gave out.

#### **4.7.3 Workshop presentation and discussions**

Orngreen and Levison (2017, p. 71) define a workshop as “an arrangement whereby a group of people learns, acquire new knowledge, perform creative problem solving or innovations in relation to a domain-specific issue”. Eun (2008) points out that workshops help in improving teachers’ pedagogical insights. In support of this assertion are Sedlacek and Sedova (2017) who postulate that social interactions such as workshops help in improving teachers’ learning process and this is what Vygotsky (1978) refers to as collaborative learning. Workshops were conducted in three stages:

##### *During stage one*

The first workshop focused on the induction and orientation to the research study where I took the opportunity to explain to the participants how we were going to conduct the entire research study. I did this to build trust with them. Additionally, I ensured that all Covid-19 safety

protocols were adhered to by the participants. Thereafter, the four Chemistry teachers, my critical friend and I, planned out which times were convenient for our meetings.

#### *During stage two*

The second workshop took place at the home of the female expert community member where both presentations were done. I further encouraged the four Grade 11 chemistry teachers to ask questions and to write down everything in their reflective journals. I also asked my critical friend to videotape all the social interactions and engagement between the participants.

#### *During stage three*

Similarly to Shinana's (2019) study, the last workshop focused on creating concept maps using the science concepts that emerged from the presentation of traditional soap making. Thereafter, we co-developed exemplar lessons that integrated IK (see Appendix P). I had hoped that would improve these teachers' understanding of saponification. All these activities were informed by Vygotsky's (1978) SCT and Mavhunga and Rollnick's (2013) TSPCK components. All activities and interactions were videos recorded by my critical friend. Data generated at this stage were used to answer research question three (see Appendix H).

#### **4.7.4 Participatory observations**

Observation means that the researcher goes to the site of the study which could be a school, classroom or community meeting, and observe what is happening there (Bertram & Christiansen, 2015). Maree (2011) explains observation as a systematic process of recording the behaviour patterns of participants without necessary questioning or communicating with them. On the other hand, Cohen et al. (2018) are of the view that observation is a systematic way of looking at and noticing events that gather primary data. As for Creswell (2016), participatory observation entails a researcher making notes on the behaviours and activities of participants at the research site.

In the context of my study, I used participatory observation and thus had an affinity with the indigenous research paradigm. Gay et al. (2012) describe participatory observation as a setting where the observer becomes a part of and a participant in the situation being observed. For example, in my case, I took part in the activities such as the discussion on how soap is made traditionally. In so doing, I got first-hand live data. Furthermore, I observed how the four Grade

11 chemistry teachers interacted, participated and learnt or not during the soap-making process by the expert community members. I also acted as a learner during all the observations. That is, I asked probing questions for clarity and made some notes in my reflective journal. After the observations, I arranged with the four Chemistry teachers to watch the videos recorded by my critical friend. From there I engaged my teachers in discussions in a form of stimulated recall interviews. Data generated answered research question three (see Appendix I).

#### **4.7.5 Stimulated recall interviews**

Gass and Mackey (2017) define stimulated recall interviews as techniques that allow participants to recall thoughts they had when carrying out a task. They further state that stimulated recall interviews are at times used to evaluate the effectiveness of teaching. Stimulated recall interviews are all about collaborative inquiries between researchers and participants (Nguyen et al., 2013). Nguyen et al. (2013) emphasise that a stimulated recall interview is an inquiry that takes place between the researcher and participants which is audio or video recorded. Cementing this thought are Gass and Mackey (2017) who indicate that during stimulated recall interviews, participants are given the opportunity to clarify or rectify their thoughts or actions.

In the context of my study, I used this method to check the accuracy of my observations. Maxwell (2012) states that the use of stimulated recall interviews is a validation technique that can be used by the researcher. However, Busse and Ferri (2003) caution that stimulated recall interviews are very exhausting as they require a lot of mental effort to remember everything that has happened. To help smoothen this, I asked my critical friend to videotape all activities. I chose this method because it helped me in examining the four Chemistry teachers' thoughts, decisions and actions (see Appendix J). Data generated were used to answer research question 3.

After the two presentations by the expert community members (which were recorded by my critical friend with both verbal and written consent from all participants), I played and watched the recorded videos with the four Chemistry teachers to refresh their minds as advocated by Cohen et al. (2018). This was done to probe the Chemistry teachers' understanding of what transpired during the presentations by the expert community members. For example, looking at the chemistry concepts that emerged from the presentations, social interactions and shifts or not in the Chemistry teachers' conceptions and dispositions towards the integration of IK in

their lessons on teaching saponification. The stimulated recall interview gave me the opportunity to ask the four Chemistry teachers for clarity and further deliberation during the presentations on soap making. I did this to validate the data I gathered, for reflection and data triangulation to enhance the trustworthiness of my research. However, the main challenge I encountered with this method was the issue of time, as teachers were busy with other activities like academic work and household duties, so I had to keep the interviews short and sweet about 30 minutes. All Covid-19 health protocols were adhered to – social distancing, wearing of face masks, open windows and hand sanitising. To my surprise, one of the participants even showed us their vaccination certificate card and encouraged we all to go get vaccinated.

#### **4.7.6 Journal reflections**

Reflection is a process whereby one looks back on their experiences (Lamb, 2013). Journal reflections help in consolidating knowledge and skills learnt (Killen, 2015). Concurring, Goker (2016) posits that reflections are used in an educational context as tools to enhance understanding. He further postulates that reflections play an important role in teachers' continuing professional development since it has the potential to allow them to address weaknesses in their teaching. Eun (2008) states that the writing of reflections by teachers leads to self-analysis and the internalisation of the knowledge they have acquired. Janesick (1999) contends that journal writing allows one to reflect and look deep into their words, beliefs and behaviours. This view resonates with that of McMillan and Schumacher (2014) who aver that journals are one's personal learning experiences.

In the context of my study, I provided my participants with diary books/journals in which they recorded all their experiences during the entire research process (see Appendix K). I further motivated them to record their thoughts and actions before, during and after the research study. In this regard, Creswell (2012) states that journal writing helps in keeping track of the professional growth of research participants. I also hoped that the journal reflections might help me in seeing the change in the participants' ZPD as envisioned by Vygotsky (1978). Data from these journals helped me in answering my third research question.

**Table 4.3: Shows a summary of research questions & data instruments**

Research questions	Data collection method
1. What are Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of IK in their Chemistry teaching?	Semi-structured interviews Semi-structured questionnaires
2. What learning opportunities are created (or not) for Grade 11 chemistry teachers to interact, participate and learn during the presentation by the expert community members?	Workshop discussions Participatory observation
3. How can Grade 11 chemistry teachers be supported in co-developing exemplar lessons on saponification that integrate IK in their classroom?	Stimulated recall interviews Journal reflections

**Table 4.4: Shows a summary of the data gathering methods used in this study**

Method	Purpose: to establish	Targeted research question
1. Semi-structured interviews	Teachers' attitudes and pedagogical insights on the use of IK in their lessons.	1
2. Semi-structured questionnaire	Teachers' attitudes and pedagogical insights on the use of IK in their lessons.	1
3. Workshop discussions	How teachers interact, participated and learnt or not during the presentation by the expert community members.	2
4. Participatory observation	The learning opportunities created (or not) for the teachers during the presentation on how to make soap traditionally by the expert community members. Scientific concepts that emerged from the expert community members' presentations on soap making.	2
5. Stimulated recall interviews	If the presentation by the expert community members influenced or not teachers' ability to teach the concept of saponification using IK.	3

6. Journal reflections	How to support the teachers in co-developing exemplar lessons on saponification that integrate concepts from the traditional practice of soap making. How teachers express themselves about the integration of IK in their Chemistry lessons and the use of IK to develop concept maps.	3
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## 4.8 Research Process

Below is how I carried out my research:

### *Phase 1*

I conducted an orientation workshop where I introduced myself to all my participants. I did this for us to get to know each other more. It is here where I explained the aim of the project, its roles and how data were to be captured, recorded, analysed and presented. I also gave them the whole research scope and allowed them to ask questions.

### *Phase 2*

I conducted semi-structured interviews and questionnaires with the Chemistry teachers to get their pedagogical insights regarding the integration of IK into their lessons. I purposively and conveniently sampled these Chemistry teachers from my neighbouring schools. With their written consent, I videotaped the interviews and transcribed them to avoid data being lost or distorted. The data I got from the semi-structured questionnaires and interviews answered my research question one.

### *Phase 3*

I went to the expert community members' site of soap production with the participants so that we could familiarise ourselves with the environment. I choose expert community members who were more knowledgeable on soap making using IK. The main aim of the familiarisation visit was to contextualise the traditional method of making soap to western science (saponification).

#### *Phase 4*

This was the actual visit to the production site with the four participants. During this visit, the expert community members practically demonstrated to us how soap is made using IK. During this meeting, I told the Chemistry teachers to write down everything they were observing in their journals (science diaries) and participatory observation schedules. I further probed them to ask the expert community members a lot of questions. I told my critical friend to videotape all the interactions that took place with the permission of both expert community members and Chemistry teachers. This was done so that no data (information) were lost. Data from this phase were used to answer my research question two.

#### *Phase 5*

After the presentation by the expert community members, I organised a reflection session with the participants. We looked at how to tailor and adopt the knowledge and skills obtained to plan exemplar lessons that integrate IK when mediating saponification. The data were used to answer research question three.

#### *Phase 6*

Afterwards, I organised stimulated recall interviews which were also recorded and transcribed. All transcripts were given back to the participants for validation before they were stored for verification.

#### *Phase 7*

In the last session, I had another reflective session where I asked teachers to create concept maps that arose from the presentation on soap making. I further asked them to write an overall reflection on the whole research process of what they had learnt or not in their journals.

### **4.9 Data Management**

This involves the gathering, recording, analysing and storing of data (Peersman, 2014). In the context of my study, the data I collected were stored in a well-managed and organised arc file. I kept both soft and hard copies of these files for security reasons. I stored all my data collection instruments and drafts as evidence of my study. These files are kept on my desktop PC, laptop and hard drive and I have copied them onto a CD as well and stored them in different locations.

Furthermore, I have printed all documents for storage in my hand file titled 'my thesis hand arc file'. I did this to create a paper trail.

#### **4.10 Data Analysis**

Maree (2008) defines data analysis as a systematic approach to qualitative data analysis aimed at identifying and summarising the data gathered. In addition, Merriam (2009) explains that data analysis is “the process of making sense of data” (p.175). Having similar views are Merriam and Tisdell (2016) who posit that data analysis is the process of making meaning out of the data collected. Leedy and Ormrod (2014), state that data analysis involves a researcher reducing a large quantity of qualitative data into a small set of manageable information with the help of inductive methods of sorting and categorising the data.

In the context of this study, I employed an inductive-deductive thematic approach to data analysis. Data from the gathering methods were transcribed verbatim manually with the help of a critical friend. He translated the workshop discussions by the two expert community members into a story format as they spoke in their home languages of Oshiwambo and Khoekhoegowab respectively. Episodes within the narrated stories were colour coded and these codes were analysed to extract patterns and trends which were then grouped together into categories. Similar categories were linked to form sub-themes which were further combined to formulate themes (see Appendices F1 & G1). These themes are discussed later in relation to the appropriate literature and theory.

#### **4.11 Validity and Trustworthiness**

Creswell (2016) explains that validity measures how accurate and credible the findings of the research study are. Cohen et al. (2018, p. 245) add that “validity is an important key to effective research”. Maxwell (2012) argues that there are two hindrances to validity, and they are research bias and reactivity. Research bias is when researchers impose their own views and theories and then present them as findings, for example, collecting data that support their own goals according to Aurini et al. (2016). On the other hand, research reactivity has to do with the change in behaviour of the participants because they are being watched, observed and studied (Aurini et al., 2016). This is also known as the Hawthorne effect according to Bertram and Christiansen (2015). To prevent researcher bias and reactivity in this study, I used a technique called triangulation. Cohen et al. (2011) describe triangulation as the use of two or

more data collection methods. Yin (2016) says that triangulation is a technique that ensures that qualitative research data are valid and can be trusted. In the context of this study, I used semi-structured interviews and questionnaires, workshop discussions, participatory observations, stimulated recall interviews and journal reflections as methods for data collection.

Data from all these methods were analysed to see if they were in sync with each other or not (Bertram & Christiansen, 2015). To further enhance the validity and trustworthiness of my data, I positioned myself as a neutral person. That is, I tried not to have any preconceptions and prejudgments when transcribing the data. I asked my critical friend to be my assistant in collecting, analysing and interpreting the data and also give a detailed thick description of the data I generated in this study. I arranged a meeting with all participants where we reflected and ensured that no data were lost or distorted during the transcription process. All this was done to reduce researcher bias and reactivity. Additionally, I piloted and tested the interview questions with my fellow master's scholars before giving them to the participants. At the end of the study, I needed to go pay a visit to the expert community members to verify with them the data they gave me, and to go show them the findings and thank them for the vital part they played in the entire process.

#### **4.12 Ethical Considerations**

According to Chilisa (2012), ethics refers to regulations of conduct of a given profession or a group, in my case, academic scholars. She adds that ethics involves values, a code of conduct during research and the protection of the researched from physical, mental or psychological harm. It also includes discrimination by the community. The code of conduct to protect the research includes ensuring anonymity of the research and confidentiality of the responses.

In concurrence, Bertram and Christiansen (2015, pp. 65-66) define the concept as follows “ethics has to do with behavior that is considered right or wrong”. They further state that ethics involves three basic principles:

- (i) Autonomy

This implies that as a researcher I needed to get consent from my research participants. In my case, I explained the aims and objectives of my research study to my participants. I also made

it clear to them that their participation in my study was voluntary and that they could withdraw at any time. I also gave them a consent form to sign.

(ii) Non-maleficence

My research study did no harm to the participants. To ensure this I explained to the participants that their names and personal details would be treated with the highest confidentiality and secrecy they deserved. Pseudonyms and codes were used to conceal their identities after consulting them. I further told them that their views and opinions would be treated with anonymity. However, I explained to them that the information could be revealed if they wanted me to do so.

(iii) Beneficence

This meant that my study should be of benefit to all members involved and its findings should help others in the chemistry field. For instance, I hoped that my study would benefit Chemistry teachers by showing them how to integrate IK into their lessons, which I hoped might result in learners understanding and performing better in the topic of saponification and Chemistry as a subject. I also hoped that this study might give the expert community members the respect and recognition they deserve when they shared their traditional knowledge and skills on how soap is made. I also think that this research might improve our (mine and critical friend) research skills and make us competent researchers. Lastly, I hoped my research findings might add value to the entire chemistry field, especially in the area of integrating IK and WS for the mediation of topics in chemistry lessons.

*Other ethical principles worth noting are:*

(a) Respect and dignity

In this study, I ensured that all my participants' identities were concealed, and their information, views and opinions were treated with anonymity and confidentiality. This was done by assigning them pseudonyms and codes unless they did not want it to be done. I did all this to protect their privacy. I allowed the participants to sign consent forms in which I indicated that their participation was 100% voluntary and that they could withdraw at any time if they so wished without being prejudiced. I also constantly communicated and visited them in order to explain the aims and benefits of the study and to build trust. I also ensured that all my research activities with them did not interfere with their academic and personal schedules. Additionally,

I told them that all activities were to be videotaped and that if it was to be shared with others permission would be required from them.

(b) Transparency and honesty

I explained to all participants what the aims, objectives and processes of the research study were about. In the same vein, I also told them their roles and the benefits of the study. Furthermore, I explained the reason for the consent forms. Permission to carry out this research study was sought from the executive directors' office, regional director of Erongo, Walvis Bay circuit inspector and the principals of the various schools in writing.

(c) Accountability and responsibility

I conducted this research study within the protocols established by the Rhodes University educational ethics committee on research studies. I was accountable for all data generated and findings which I kept in a secure storage facility both in electronic and printed formats. My responsibilities, among others, were to ensure that social learning took place and that all participants benefited from the study. I was in constant communication and consultation with my supervisor for guidance and mentorship during the entire research process.

(d) Integrity and academic professionalism

I declare that this thesis is my original work. All scholars, researchers, academics, institutions, organisations and authors cited, quoted and paraphrased have been acknowledged through the use of the APA 7<sup>th</sup> referencing style as per Rhodes University's academic writing requirements. All data (information) in this thesis are genuine and have not been manipulated or fabricated in any way.

### **4.13 Chapter Summary**

In this chapter, I discussed the research methodology underpinning this study. That is, I discussed the paradigms informing the study as well as the research design employed in this study. Furthermore, the research site, sampling of research participants with their profiles and the aspects of positionality and reflexivity were also discussed. Additionally, data gathering methods, research processes, data management and analysis were explained. Lastly, validity, trustworthiness, ethical considerations and the chapter summary were considered.

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## CHAPTER FIVE: SEMI-STRUCTURED INTERVIEWS AND QUESTIONNAIRES

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### 5.1 Introduction

The goal of this study was to mobilise the indigenous technology of making soap to mediate the learning of the topic of saponification in organic chemistry. In the previous chapter, I discussed the research methodology I used in the study. I explained how data were gathered to answer my three research questions. In this chapter, I thus present, analyse, interpret and discuss the data generated from the semi-structured interviews and semi-structured questionnaires. The aim of these two data gathering methods was to address and find answers for my research question 1:

*What are Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of IK in their Chemistry teaching?*

### 5.2 Data from Semi-structured Interviews

The semi-structured interviews were audio recorded with the participants' written consent and each interview lasted for about 20 minutes. Thereafter, I transcribed the interviews word for word manually so that no information was distorted (see Appendix F1). The code for the semi-structured interview is SSI, while the teachers were coded T1 to T4 representing teacher 1 to teacher 4. Additionally, the gender of each teacher participant was included, for instance, M for males and F for females. Ultimately, the teachers were coded as teacher 1 male semi-structured interview response (T1MSSIR); teacher 2 male semi-structured interview response (T2MSSIR); teacher 3 male semi-structured interview response (T3MSSIR) and teacher 4 female semi-structured interview response (T4FSSIR). This was done to enable easy analysis and interpretation of the data from the semi-structured interview. These codes are used throughout the thesis. While the participants' quotes are verbatim, they may have been grammatically edited for clarity.

**Table 5.1: Shows teacher participant profiles**

<b>Information</b>	<b>Category</b>	<b>Teachers codes</b>
1. Gender	3 males	T1-T3
	1 female	T4
2. Teaching experience	3 years	T1
	8 years	T2
	2 years	T3
	5 years	T4
3. Age	26	T1
	35	T2
	36	T3
	37	T4
4. Qualification	BEDHons	T1
	BETD	T2
	DE	T3
	MASTEP	T4

This research study was conducted in a coastal town of Namibia at SSDD (pseudonym). Four Chemistry teachers participated, that is, three males and a female. In terms of their teaching experience, it ranged from two to eight years in teaching Chemistry and their ages ranged from 26 to 37 making them fairly young, energetic and full of enthusiasm. In terms of their qualifications, I must say they were all well qualified to teach Chemistry at the high school level, as they possessed the following: T1 had a BEDHons; T2 had a BETD; T3 had a DEand T4 had a MASTEP.

### 5.3 The Formulation of Themes from Sub-themes

Data gathered and generated from the SSIs were classified according to the question they answered and sub-themes were formulated accordingly. Thereafter, similar sub-themes were amalgamated into themes (see Appendix F1). The four Chemistry teachers' attitudes and pedagogical insights on the use of IK in their Chemistry lessons were not the same; as a result, three themes were formulated and then developed. The themes are teachers' attitudes and pedagogical insight on teaching saponification; Chemistry teachers' understanding of IK; and the integration of IK into Chemistry lessons to mediate saponification.

**Table 5.2: Shows themes and sub-themes that emerged from semi-structured interviews**

<b>Research question 1:</b> <i>What are Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of IK in their Chemistry teaching?</i>			
<b>Themes</b>	<b>Sub-themes</b>	<b>Literature</b>	<b>Theory</b>
1. Teachers' attitudes and pedagogical insight on teaching saponification.	<ul style="list-style-type: none"> <li>- Teachers' views of practical activities.</li> <li>-Teachers' attitudes on leaner-centred education.</li> <li>-Importance of culture in teaching</li> </ul>	Nyambe (2008); Millar (2010); Ongunleye (2010); Nyambe and Wilmot, (2012); Mavhunga and Rollnick (2013); Ajayi et al. (2018); Shinana et al. (2021).	<ul style="list-style-type: none"> <li>-PCK (Shulman, 1987);</li> <li>-SCT (Vygotsky,1978)</li> </ul>

2. Chemistry teachers' understanding of IK.	- Understanding the concept of IK.  -IK as prior knowledge	Roschelle (1995); Hoppers (2005); Kibirige and van Rooyen (2006); Senanayekes (2006); Ogunniyi (2007a); Chilisa (2012); Nyika (2017).	- SCT (Vygotsky, 1978)
3. The integration of IK in Chemistry lessons to mediate saponification.	- Teaching styles, methods and approaches.  - IK as prior knowledge	Roschelle (1995); Hoppers (2005); Kibirige and van Rooyen (2006); Senanayekes (2006); Ogunniyi (2007a); Millar (2010); Chilisa (2012); Nyika (2017).	- PCK (Shulman, 1987)  - SCT (Vygotsky, 1978)

In the following section, I present and discuss the themes that emerged from the semi-structured interview data concerning the literature and the theory used.

### 5.3.1 Teachers' attitudes and pedagogical insights on teaching saponification

From the SSI that I conducted with the four Chemistry teachers, it emerged that teachers have a positive attitude towards the topic of saponification. For instance, T3M commented that:

*Great experience in the sense that mostly I teach it through practicals, where I make students prepare their own soap using different flavours of their choice and what I provide them is sodium hydroxide/potassium hydroxide which is the alkali which is not accessible to them. (T3MSSIR)*

From this excerpt, it could be argued that this teacher seems to embrace and understand the importance of hands-on practical activities (Asheela et al., 2021) as a teaching method to mediate saponification. This view resonates with that of Millar (2010), Ongunleye (2010) and Shinana et al. (2021) who postulate that practical activities ensure the linkage and connection of theory and practice of science concepts. It can also be seen that this teacher's PCK and SMK (Shulman, 1987) are of a good standard in the sense that he knows exactly what type of alkali

his learners need to make their soaps. Moreover, his explanation is also in accordance with that of Ajayi et al. (2018) who state that the alkali needed for soap making is sodium hydroxide/potassium hydroxide. T3M also seems to have a good conceptual teaching strategy (Mavhunga & Rollnick, 2013). He seems to know his learners' needs and chose the practical teaching strategy and allowed them to learn through a learner-centred approach – with them doing or making the soap themselves instead of the teachers doing it as recommended (Nyambe, 2008; Nyambe & Wilmot, 2012). However, when I interviewed T1M, his response was that:

*My experience is that saponification is quite challenging when we approach that topic, like I said previously because of the gap between grades 9 & 10 in terms of the content and for saponification, it's a bit challenging for these learners because so many things that are missing.*(T1MSSIR)

This particular response shows that this teacher's line of reasoning is in affirmation with Shulman's (1987) when he explains PCK as the knowledge that includes an understanding of what makes the learning of a specific topic easy or difficult. This clearly shows that the teacher is aware of the most challenging part of the concept. T4F was of the view that she likes teaching saponification and she said: *"I like to learn new ideas from different cultures"* (T4FSSIR). This excerpt seems to illustrate a point about learning and culture, which is emphasised in Vygotsky's (1978) SCT as a prerequisite for development in a social learning set-up.

### **5.3.2 Chemistry teachers' understanding of indigenous knowledge**

From the interviews, all four teachers showed some understanding of IK. For instance, T1M defined IK *"as the knowledge that is related or referred to as cultural traditions in our local communities"* (T1MSSIR). This teacher's definition resonates with the definition by scholars such as Ogunniyi (2007a) and Nyika (2017). To elaborate more, these scholars postulate that IK refers to knowledge gained by people as they live and work in their communities. In this regard, T2M commented that *"my understanding of IK, is the local information and practices that our ancestors used, things older generations used to do and passed it on from one generation to another"* (T2MSSIR). This explanation is similar to that of Kibirige and van Rooyen (2006) who define IK as a legacy of knowledge and skills unique to a particular indigenous culture involving wisdom that has been developed and passed on over generations.

When T3M was asked the same question, he responded differently and said that “*indigenous knowledge is the knowledge we acquire when we interact with the environment or surrounding or from locally available learning sources*” (T3MSSIR). We can see his response centred on the environment. This finding is congruent with Senanayekes (2006) and Hoppers (2005) who proffer that IK is derived from the immediate environment. These scholars also argue that this knowledge is unique to a particular culture and is embedded in the cultural web and history of the local people.

On the other hand, T4F elaborated that “*IK is the use of indigenous ideas to come up with something like making soap*” (T4FSSIR). From her response, it could be concluded that she was looking forward to the soap-making process. Notably, most of their definitions and explanations were similar to that of Chilisa’s (2012) characteristics of IK. Also, these teachers used similar key terms in their definitions such as local communities, cultural traditions, generations and local environment. This corroborates Ogunniyi’s (2007a) idea of traditional wisdom.

### **5.3.3 The integration of indigenous knowledge in Chemistry lessons to mediate saponification**

Three out of four Chemistry teachers said that they do try to integrate IK into their lessons. For instance, T1M reflected that:

*We used to borrow ideas from our local cultures such as the use of plant leaves and some wood ash because normally when you combine them with water, they can produce some soap that can make things clean; that is how I try to make use of IK in the class.*(T1MSSIR)

From this excerpt, it could be deduced that this particular teacher has some insight into how soap is made by mixing plant leaves, wood ash and water. This method of soap making coheres with the literature of scholars such as Arasaretnam and Venujah (2019), Kowalski (2015), Onyegbado et al. (2002) and Warra (2013). These scholars explained that soap is made by combining fat (oil) from plant leaves with sodium hydroxide/potassium hydroxide (ash). Another important aspect the teacher mentioned is the use of local culture in teaching science. Sharing the same sentiments are Aikenhead and Jegede (1999), who suggest that IK can be used as a bridge between home and school science and this they called border crossing.

This notion is also commended by Govender (2014) and (MEAC, 2016). For instance, Govender (2014) stresses that integrating IK in classrooms results in higher learner motivation, participation and achievements. In this regard, T2M commented that:

*Okay, ya I try as much as possible because saponification is all about soap production, so I tend to start off by asking the learners to mention the local things they use for cleaning purposes instead of using soap – to bring some to class so others can see them.*(T2MSSIR)

From my analysis of this response, it could be surmised that the teacher is asking learners to bring easily accessible materials from their immediate environment as a way of making his lessons interesting and enjoyable for the learners (Asheela et al., 2021). In support of such a teaching method, the (MEAC, 2016) calls for science teachers to improvise where necessary in finding LTSMs from their immediate environments such as sticks and bottles, provided they are hygienic and fit to be used as representations and analogies (Mavhunga & Rollnick, 2013). Concurring are Asheela et al. (2021) who add that practical activities should be in the form of hands-on, minds-on and words-on to fully empower learners with all the needed practical skills in science. In contrast to T2M, T3M said that “*I am sorry I do not integrate IK in my lessons, I was not taught about it at university. But I am willing to learn*” (T3MSSIR). From the above excerpt, it is clear that institutions of higher learning should start teaching IK to teacher trainees so that when they start teaching in schools, they in turn, teach IK to their learners. This teacher needs to be commended for his willingness to learn about IK. Furthermore, in contrast to T3M, T4F indicated that she does integrate IK in her lessons:

*I usually tell my learners to go home and ask their parents and grandparents what they used to use to clean their bodies and clothes and the next day when they come to class they come and present. For example, one child from the Herero (Himba) culture said her parents used to use Otjive (red lotion) for cleaning their bodies.* (T4FSSIR)

From this excerpt, we could say T4F’s teaching method involves the elicitation of learners’ prior home knowledge (Kuhlana, 2011; Mavhunga & Rollnick, 2013; Roschelle, 1995). This notion has an affinity with Kibirige and van Rooyen (2006) that learners enjoy the process of linking old and new knowledge learnt at home and school (Aikenhead & Jegede, 1999). This is also regarding the (MEAC, 2016) which emphasises that teachers should use

learners' existing IK and culture to create new knowledge. This move of bringing or asking for IK of parents or elders is referred to by Seehawer (2018a) as a bottom-up approach to the decolonisation of education – an ideal that is also advocated by scholars such as Mateus and Ngcoza (2019).

## **5.4 Data from Semi-Structured Questionnaires**

In this section, I present, analyse, interpret and discuss data generated from semi-structured questionnaires. I administered the semi-structured questionnaires personally to each Chemistry teacher after school. I was also present when they completed them just in case they wanted to ask me a question concerning the questions on the form. The answering of the questionnaires for each teacher lasted about 15-20 minutes. Thereafter, I collated the responses from the semi-structured questionnaires. Following that, I coded the semi-structured questionnaires as SSQ, while the teachers were coded T1 to T4 representing teacher 1 to teacher 4. The gender of each teacher participant was M for males and F for females. As a result, teachers were coded as teacher 1 male semi-structured questionnaire response (T1MSSQR); teacher 2 male semi-structured questionnaire response (T2MSSQR); teacher 3 male semi-structured questionnaire response (T3MSSQR); and teacher 4 female semi-structured questionnaire response (T4FSSQR).

### **5.4.1 The formation of themes from sub-themes**

Data gathered and generated from the SSQ were grouped according to the question they answered and sub-themes were formulated and then linked into themes (see Appendix G1). Four themes were developed, namely the benefits of integrating IK in science when teaching saponification; challenges to the integration of IK in Chemistry lessons on saponification; teachers eliciting learners' prior knowledge about saponification; and teachers' cultural (traditional) knowledge of soap making.

**Table 5.3: Shows the themes and sub-themes that emerged from the semi-structured questionnaires**

<b>Research question 1: What are Grade 11 chemistry teachers' attitudes &amp; pedagogical insights on the use of IK in their Chemistry teaching?</b>			
<b>Themes</b>	<b>Sub-themes</b>	<b>Literature reviewed</b>	<b>Theory used</b>
1. The benefits of integrating IK in science when teaching saponification.	<ul style="list-style-type: none"> <li>- Increased learner motivation and participation.</li> <li>- Comprehension of scientific concepts.</li> <li>- Merger of theory and practice.</li> </ul>	Sedlack and Sedova (2017); Naidoo and Vithal (2014); Govender (2014); Kibirige and van Rooyen (2006); Aikenhead and Jegede (1999); Mawere (2015); Mukwambo et al. (2014); Seehawer and Breidliid (2021).	-SCT (Vygotsky, 1978).
2. Challenges on the integration of IK in Chemistry lessons on saponification.	<ul style="list-style-type: none"> <li>- Lack of pedagogical insights by teachers.</li> <li>-Lack of teaching materials/chemicals.</li> <li>- Lack of laboratory facilities.</li> </ul>	Seehawer (2018).  Asheela et al. (2021).  Kandjeo-Marenga (2011).	-PCK (Shulman, 1987).
3. Teachers eliciting learners' prior knowledge about saponification.	<ul style="list-style-type: none"> <li>- Topics/concepts taught in previous grades.</li> <li>- The use of learners' IK on soap making as prior knowledge.</li> </ul>	Mavhunga and Rollnick (2013); Roschelle (1995).  Abah et al. (2015); Mavuru and Ramnarainn (2020); Taylor (1999).	-PCK (Shulman, 1987)  -SCT (Vygotsky, 1978).
4. Teachers' cultural/traditional knowledge of soap making.	<ul style="list-style-type: none"> <li>- Limited knowledge of soap making by teachers from different cultures</li> </ul>	Chauraya and Brodie (2018); Mutanho (2021); Ngcoza and Southwood (2019)	-SCT (Vygotsky, 1978)

I now present and discuss the themes that emerged from the semi-structured questionnaires.

#### **5.4.2 The benefits of integrating indigenous knowledge in science when teaching saponification**

The teachers who participated in this study indicated the following benefits of integrating IK into science (Chemistry, saponification in particular).

- *Teachers/learners will know how to make their own soap at home/school.*
- *Teachers'/learners' participation will be high as they can relate to the indigenous ingredients of soap making.*
- *Teachers/learners will learn from different cultures.*

These findings resonate with scholars such as Aikenhead and Jegede (1999), Govender (2014), Kibirige and van Rooyen (2006), Naidoo and Vithal (2014) and Sedlacek and Sedova (2017) who believe that IK can be used as a bridge between home and school science. Moreover, integrating IK in classrooms helps motivate learners to participate in class, which results in them understanding deep abstract science concepts (Mawere, 2015).

Additionally, T1M said: *“It is a good method to bring home science to class as it will help in merging theory to practice”* (T1MSSQR). Concurring is Mukwambo et al. (2014) who posit that there is a dialectical relationship between IK from home and WS. Similarly, Seehawer and Breidlid (2021) aver that there is a dialogue between these knowledges and thereby advise teachers to tap into it and make use of it. To these scholars, these two worldviews are not mutually exclusive and should be used to complement one another for the holistic development of learners.

#### **5.4.3 Challenges to the integration of IK in Chemistry lessons on saponification**

Even though various local and international scholars and the NCBE (MEAC, 2016) call for the integration of IK in science lessons, it, however, does not clearly stipulate how it should be implemented. For instance, T2M lamented that *“I want to incorporate IK in my lessons, but I don't know how, as for me myself I was not taught about it at varsity. It is also not found in our syllabus and books, you see there are no examples for us to use”* (T2MSSQR).

From this excerpt, it appears that T2M is in support of integrating IK in his classes but lacks the pedagogical insights. This is further exacerbated by the fact that he does not have supporting documents and resources to help him with the implementation. Corroborating this teacher's lamentation is Seehawer (2018a), who states that one challenge that impedes the use or

integration of IK in schools is the fact that teacher education institutions do not train teachers on what and how to use IK in schools. For instance, Nikodemus's (2017) study conducted in Namibia revealed that teachers indicated that they struggled to apply IK in their classes due to a lack of or limited pedagogical insight on how to do it. Seehawer (2018a) also argues that another challenge to the integration of IK in schools is the lack of indigenous teaching materials. Her point is in sync with that of T1M who said that "*Yes, the availability of materials is a challenge, especially at schools in remote areas*" (T1MSSQR).

From the teachers' responses, another factor that stood out as a challenge was the lack of laboratories. For example, T3M complained that "*The classroom set up is not conducive for practicals of this nature and we need a lab*" (T3MSSQR). This sentiment is also echoed by Kandjeo-Marenga (2011) who argued that a factor that hinders the successful implementation of hands-on practical activities is the issue of a lack of functional laboratories in schools. To counteract and refute this argument, Seehawer (2018a) proposes the following: teachers should take learners out of the classroom on field trips and excursions and teachers should invite expert community members like healers, herbalists and elders to class to mediate science topics with their IK, as a way of bridging school and home science. Concurring, Asheela et al. (2021) advise science teachers to improvise and use easily assessable materials from their immediate local environment to make science teaching and learning enjoyable.

#### **5.4.4 Teachers eliciting learners' prior knowledge about saponification**

Regarding elicitation of learners' prior knowledge, T1M said that "*before I start teaching about saponification I normally ask them what they have learnt in Grade 9 about chemical reactions, acids and bases because these topics are the building blocks to understanding saponification*" (T1MSSQR).

From this excerpt, it can be concluded that this teacher has good curriculum saliency (Mavhunga & Rollnick, 2013) in the sense that he knows the major concepts of the topic at hand and what learners should know from the previous grades. Roschelle (1995) defines prior knowledge as the knowledge that learners possess at hand before they meet new information. Similarly, Mavhunga and Rollnick (2013) call for teachers to elicit learners' everyday knowledge that encapsulates everyday life knowledge from home, previous grades and the community.

Additionally, T4F wrote that “*I normally ask them how they make soap in their cultures using indigenous knowledge; this is how I check their prior knowledge*” (T4FSSQR). This teacher’s method is in agreement with Abah et al. (2015) who aver that integrating learners’ IK in classes is vital in the sense that it increases their participation and hence their performance. It also takes learners’ socio-cultural backgrounds into account (Mavuru & Ramnarian, 2020) in an effort to smoothen science border crossing between home and school science (Aikenhead & Jegede, 1999). However, Taylor (1999) cautions teachers not to use prior knowledge out of context as it might lead to misconceptions and misunderstandings.

#### **5.4.5 Teachers’ cultural/traditional knowledge of soap making**

All four Chemistry teachers were asked to explain how soap is made traditionally in their respective cultures – their responses are as follows:

*I am a Herero (Himba), yes we use Otjive to clean our bodies. (T1MSSQR)*

*Kavango, yes mix wood ash, water and some leaves but I am not very sure from there as to what they do. (T2MSSQR)*

*Oshiwambo, I really don’t know maybe I can learn. (T3MSSQR)*

*Oshiwambo, I am not really sure of what they use traditionally, but I believe they do. (T4FSSQR)*

It can be concluded from their responses that most of them had limited knowledge of how soap is made traditionally in their cultures. Hence, I invited the two expert community members who demonstrated how soap was made traditionally as a form of professional development. Ngcoza and Southwood (2019) define professional development as a transformative, ongoing capacity- and knowledge-building process for teachers. This view is also supported by Mutanho (2021), who posits that teachers’ continuous professional development is central to any educational reforms like the establishment of PLCs (Chauraya & Brodie, 2018) to enhance and improve their teaching.

## **5.5 Chapter Summary**

In this chapter, I presented, analysed, interpreted and discussed the data generated from the SSIs and SSQs. This was aimed at answering my first research question. The findings revealed that teachers have a positive attitude toward the use of IK in their Chemistry lessons. They showed a good understanding of what IK is. Furthermore, they gave the benefits of integrating IK into science lessons and demonstrated a good understanding of how to elicit learners' prior knowledge about saponification. However, they cited challenges that impede the integration of IK in schools. Lastly, most teachers in the study did not know how soap was made traditionally in their culture. In the next chapter, I present, analyse and discuss data gathered and generated from the workshop presentations and discussions of the two expert community members and through participatory observations.

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## CHAPTER SIX: WORKSHOP DISCUSSIONS AND PARTICIPATORY OBSERVATIONS

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### 6.1 Introduction

The goal of this study was to mobilise the indigenous technology of making soap to mediate the learning of saponification in organic chemistry. In the previous chapter, I presented, analysed, interpreted and discussed data generated from semi-structured interviews and semi-structured questionnaires. These data gathering methods were aimed at answering my first research question of this study. In this chapter, I thus present, analyse, interpret and discuss the data gathered from the workshop discussions during the presentations by the two expert community members and participatory observations. The aim of these two data gathering methods was to find answers to my second research question:

*What learning opportunities are created (or not) for Grade 11 chemistry teachers to interact, participate and learn during the presentations by the expert community members?*

The invitation of the local expert community members to share their IK and skills in soap making with the Chemistry teachers was the most salient part of this study. This resonates with the call made by the (MEAC, 2016) which states that teachers should invite community members with expertise in cultural practices to come to schools and support the teaching and learning process. This move of inviting community elders into science classrooms to help mediate science concepts with IK is also advocated by Seehawer (2018a), who refers to it as a bottom-up approach to the decolonisation of education. The data from the workshop presentations were subsequently used by the Chemistry teachers to co-develop an exemplar lesson plan on saponification that integrated IK (see Appendix P). The chapter begins with the profiles of the two expert community members who were invited to demonstrate how soap is made traditionally using IK. The workshops were aimed at allowing the expert community members to share their cultural ways of making soap indigenously with the four Chemistry teachers.

## 6.2 Expert Community Members' Presentations

In this session, my critical friend assumed two roles, video recording the sessions and translating the two indigenous languages, namely, Oshiwambo and Khoekhoegowab to English. The process of how soap is made traditionally was used as a mediating tool of the scientific concept of saponification. The two expert community members were the MKOs as reiterated by Vygotsky (1978). The expert community members were encouraged to use their indigenous languages, namely Oshiwambo and Khoekhoegowab to enable them to express themselves freely. This is what Gibbons (2003) avers, that language usage is an essential mediation tool that can be used as a vehicle through which IK can be transferred and preserved (Chilisa, 2012). Furthermore, Oshiwambo and Khoekhoegowab were mediating cultural tools that were used by the expert community members to promote social interactions and active participation among the Chemistry teachers (Sedlacek & Sedova, 2017).

In addition, the critical friend was an added advantage as he translated from these two indigenous languages into English for everyone to understand. This has an affinity with Msimanga and Lelliot (2014) who describe this process as translanguaging. These scholars define this as the use of two different languages to help contextualise communication in a multicultural social setup. All Covid-19 health safety regulations and protocols were adhered to such as hand sanitising, social distancing and the wearing of a face mask.

### 6.2.1 Biographical information of the two expert community members

Table 6.1 below shows the biographical information of the two expert community members, who presented and demonstrated how soap is made traditionally. The expert community members were assigned codes. For example, the female expert community member is FECM and the male expert community member is MECM. These codes are used throughout the thesis.

**Table 6.1: Shows biographical information of expert community members**

<b>Biographical information</b>	<b>Category</b>	<b>Community members code</b>
1. Age	50	FECM
	57	MECM

2. Gender	Female	FECM
	Male	MECM
3. Cultural background (tribe/dialect)	Oshiwambo (Oshidonga)	FECM
	Damara (Khoekhoegowab)	MECM
4. Highest standard passed	8	FECM
	8	MECM
5. Occupation (work)	Cleaner at a local school	FECM
	Retired caretaker at a local school	MECM

From the table above, it can be seen that the two expert community members' ages ranged from 50–57. Each expert community member had a specific role in the soap-making process. For instance, the female expert community member was responsible for extracting the oil from the Marula seeds. On the other hand, the male expert community member had the responsibility of making ash from wood. However, they jointly collaborated in making the soap. In terms of their cultural background, FECM is Oshiwambo and speaks the Oshidonga dialect, while MECM is a Damara and speaks the Khoekhoegowab dialect. Thus, their presentations were done in these respective dialects. My critical friend did the translations from these dialects into English as he was conversant in both languages. The workshop presentations took place at FECM's home, where she had prepared all the indigenous materials, utensils and tools that were needed for soap making. As their highest standard passed was standard 8 (Grade 10), I asked why they ended their schooling at this standard. FCEM said she fell pregnant and that forced her to leave school and that she had wanted to become a labour inspector. As for the MECM, he left school at that standard to go join the army during the war of the liberation struggle – he always wanted to become a farmer. Concerning their occupations, FECM is employed as a cleaner at a local school, while MECM is a retired caretaker at a neighbouring school.

In the next section, I present the summary of the presentations made by the two expert community members which were videotaped by my critical friend with written consent from the participants (see Appendix D). Similar to Nhase (2019), I then transcribed the videos into a story format or narration.

### 6.3 Female Expert Community Member's Presentation

- *The extraction of oil from the Marula seeds*

At first, the expert community member made sure that all the traditional utensils that were required were prepared before we arrived at her home. Before her presentation as per cultural norms she welcomed us as follows: “*Tangi kaagundjuka yoskola yetu sho mwatokola opo muye tuningeni othewa pegumbo lyange, mumone kutya othewa ohai longwa ngini yomahuku goongongo. Onda pendula unene shi mwa tokola muye muningile pegumbo lyandje aagundjuka ondemu pendula unene*” (To the youth of our schools, I thank you for coming to my place to come and see how soap is made from Marula seeds. I am very grateful that you guys chose to come so we do this experiment at my place I am very happy). Afterwards, the Chemistry teachers introduced themselves one by one. Then, FECM served us *oshikundu* as a welcoming drink while she was displaying the Marula seeds and utensils in front of us.



**Figure 6.1: Shows a female Chemistry teacher drinking *oshikundu***

As an introduction, FECM showed us the Marula seeds and said that:

*Shino nda tumba ngei ohatu shithana elilo, manga shi shili melilo osho amahuka go omahuka go omahuku oha gazi moongongo. Paife omahuku ngano otandi ga tula*

*koshini, shini osho omuhi ohatu gu longitha okutsa omahuku. Opo nee ga hengumuke nawa gashiwe ga ete omagadhi ondina okuga tsa manga* (What I have here is a traditional basket plate and what is inside is called Marula seeds which are from Marula trees, we get our oil from the Marula nuts. Later I am going to put Marula seeds into the mortar and pound them with a pestle to extract the oil).



**Figure 6.2: Shows FECM explaining Marula seeds as participants take notes**

*“Inima mbino omushi kutya ikwashike?”* (Let’s start the workshop now; do you guys know what the names of the utensils in front of you are?). T1 responded, *“Yes, this is a cup and that is a calabash”*. T4 said this is a mortar and pestle. The FECM with a smile on her face said, *“Iya, inima omwishi nawa, ndino etiti, ndino elilo, eshi oshini, no mpamba. Ompamba otayi longithwa nokutulamoomeya”* (Yes, I see you know them, this is a bowl, basket, mortar and pestle and a calabash used for carrying water). *“Paiefe oandi mulikile kutjia oshini ashi longithwa gnini mo kutwa. Nge to tsu uninga kashona to endifa omuhi kumbinga adishe”*. (Let me now show you how to use the mortar and pestle to pound the seeds. When you pound it, you should be gentle; you move the pestle side to side so that the oil produced can be a lot). *“Kwafe lange oku tulako omeya moshini ge tetsu”* (Can you help add water for me while I am pounding?).



**Figure 6.3: Shows expert community members and participants identifying the utensils**

T2 helped by adding water into the mortar using a calabash. T3 asked, “*Why are we adding water?*” The FECM responded “*Niinga ngaha wuu kitha, opo ne tamudjii omagadhi, telela ndikutulileko omeya tsikila no kutsa twendelele*” (We add water to speed up the process of oil extraction).



**Figure 6.4: Shows FECM demonstrating how to pound Marula seeds**

From there, the FECM invited one of the female participants to come to help her pound the seeds and she cautioned. “*Oto hepeke omagadhi, tala paife ninga nge, shino ahatu shithana Okuyenga<sup>4</sup>, shampaa omahaku tweya yenge etatu kutha mo omaghadhi shi hashi hupu po ohatushi ithana ezi*” (Look you are wasting oil you need to be gentle, this process of extracting

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<sup>4</sup>*Okuyenga*- Oshiwambo traditional way/method of extracting oil from Marula seeds.

oil is called Okuyenga<sup>5</sup>, after extracting the oil needed to make the soap, the brown residue is called *ezi*).



**Figure 6.5: Shows FECM guiding participantson how to pound the Marula seeds**

The FECM then explained that now at this stage we add water bit by bit so that the oil can start forming. After that, it will rise to the top because it is light. T4 explained that oil rises because it has a lower density compared to water. Continuing, the FECM explained that the water should be lukewarm. She further explained that if it is too cold the oil will take longer to come and if it is too hot the mixture of the seeds, oil and residue will completely mix and spoil the texture of the oil. She thus warned that the water temperature should be in between (lukewarm) for perfect results.

*Paife onda hala ne okutula ko omeya koshini ndele andi tsuko natango, andi tala kutya omeya ngatetula ko oge thike peni opo ne omagadhi gavule geye. Ashike tango ondina okutala kutya omeya ngano oga talala nenge oga pupyala omanga inaa ndi gatula koshini. Elala kano lyomeya ngano opo ga hengumune omahuku opo omagadhi geye. Ohatu longitha ashike omeya ngele tatu yenge. Kapuna we shilwe hatu longitha oga pumbwa gakale pokati ano kageshi omatalala goka geshi omapyu unene (I am now putting lukewarm water into the mortar using a calabash so that the oil can start melting from the seeds). Ngaashi ngei ote tula mo omeya omatalala shaashi oga pupyala shinene, andi gatala ngele ogeli nawa. Omeya inaga pumbwa ga kale ga pupyala unene ga talala unene. Oga pumbwa ga kale pokati. Ngano omeya tetula mompamba opo ndi*

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<sup>5</sup>Okuyenga- Oshiwambo traditional way/method of extracting oil from Marula seeds.

*tule koshini opo ga hengumune omagadhi* (Now I will add water to the mortar as we pound for the oil to form, the water should not be too hot or cold it should be lukewarm).



**Figure 6.6: Shows FECM pouring water into the mortar with a calabash**

Lastly, the FECM asked the participant to extract the oil and T4 volunteered. “*Ino tapulula kowe, ngeno okwali ote longitha eshini andolala onda mana nale*” (We would have been done already if we were using the underground mortar, but none the less it is fine).



**Figure 6.7: Shows a participant pouring Marula oil from the mortar into a bowl**

The FECM extended her presentation and explained to us that “*Ohatu longitha omagadhi kuringa othewa, oku gwaya no kulitha ano okuga tula kiikulya. Ohatu ga landitha tu monemo imaliwa*” (The oil we had extracted apart from being used in soap making like we just did, it is also used as skin lotion, in the cooking of food and is sold to make money for basic daily necessities). She further commented by saying “*Omagadhi gogene ohaga tulwa mokambiga*

*kevi, ngeno ngaashi nge paife shaashi okambiga kakepo otatu longitheni ashike etiti*” (Traditionally the oil is stored in a special pot, but because we do not have that here we will store the oil in a clay pot).



**Figure 6.8: Shows the researcher pouring the Marula oil into the traditional lunch consisting of Mahangu porridge, ombidi & marathon chicken served by FECM**

#### **6.4 The Male Expert Community Members’ Presentations**

- *The formation of charcoal (wood ash)*

The MECM welcomed us by saying:

*Kaise tagera aid eiganub, garama gam mistera /a ei gna. #gam khloen taxura //ganta. Nen gexu tiei /na ma-na. Se inira kuru unai. #gam khloen tei esi-a gao tradisieb tixuna ratani. //gam khloen gera ne tse //gou ta seii ra tsaub, #gom an tsio lei. Goora texu guru ehaili xu* (I thank you for the opportunity given to me to be here, where young people will be taught how to make soap traditionally. I will show you guys how to make charcoal and then we will mix the charcoal, water, the Marula oil you extracted earlier and salt to make our soap).



**Figure 6.9: Shows MECM welcoming participants**

From there, the MECM explained to us about the wood needed to make the charcoal/wood ash: “#gei gunub gera sisen u-he //geisa kausa” (A specific type of wood that has a soft core is used to make fire, which later forms charcoal and ultimately wood ash).



**Figure 6.10: Shows MECM explaining about wood to participant**

Then the MECM asked the participants, “*Toe e #gae ha /hoe sa khau sa?*” (What is needed to make a fire?). T3 responded that to make fire, which is also known as combustion or oxidation, you need fuel like wood and air, but oxygen in particular because it supports combustion, and a heat source like a lighter. The MECM added that “#Nesis ti //geib na tage matches na/geisa ra khau. *O/goro //geib /na tage //gau era doros /ga gei sagere khau*” (These days we use matches to make a fire, in the olden days we used dorosa<sup>6</sup> to make a fire). Then the MECM went on to explain that:

*#gei ka//hui //khei tsi tagera goma //harab of//khei gumba //khei gulag biga gera tsoro tsi dage //gawa xu, doroba gere // gao. /geis ge gho tama gerei o,ota gera/ gom tsi ge*

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<sup>6</sup>Dorosa – old version lighter, similar to the ancient stone and wooden stick used for igniting a fire.

*//geisa gera khau. Kain ais ne xuma ta #gam khoena ra //gau haisa* (To make fire, wood is stacked together and dry cow dung or the soft core of a specific type of wood is sprinkled on top of the stacked wood. The fire is lit with the dorosa or matches and then oxygen is supplied via blowing air to stimulate and activate the fire).

The MECM made the fire, while participants watched on and took notes in their journals.



**Figure 6.11: Shows MECM demonstrates how fire is made and the participants observed and wrote some notes in their journals**

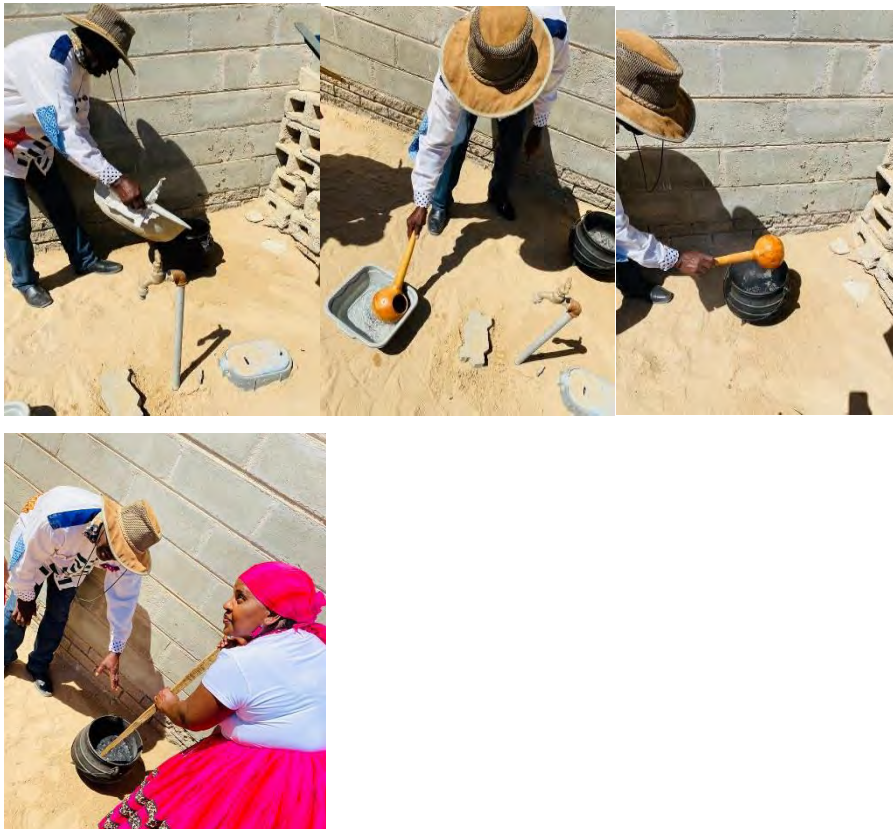
After a while (about 20 minutes), the MECM told participants that it was time to collect the charcoal/wood ash and said: “*//geis ta #hubi tao o,oigera tsauba rag au. Tsaub gera u-gaihe /kei khau toa ha/geisa xu. Tsau I gera /gao- /gaoe tis //gam-I-ga-ra huni /gaoe*” (Once the fire has burned, the wood ash is collected).



**Figure 6.12: Shows MECM collecting charcoal/wood ash**

- *The formation of wood ash water (alkali containing sodium hydroxide/potassiumhydroxide)*

Now we put “#tsao I tsi goman tsi gera //gami /gha /ga/ gaoe. Sus na tsaob tsi# gom //gami gera #gusus na //ghoe. #gu sus ge /ghama sus nara go /gara” (The charcoal/wood ash in the black pot and mix it with water and continuously stir until they are properly mixed). T1 asked, “Why is the mixture placed in the black pot?” The MECM responded saying it keeps heat for a longer period and that way reduces the amount of wood needed. In addition, I explained that the black pot is made from cast iron which happens to be a good conductor and radiator of heat. Additionally, it has a high specific heat capacity and so continues to heat the soap mix after the fire has died out. From there, the MECM said: “#gam-an tsi /gha ha //gami geru ha#gui-re” (Now we need to filter this mixture). T1 explained that the mixture was filtered to separate the charcoal from the wood ash water which was now the alkali, and called the charcoal the residue and the wood ash water the filtrate.



**Figure 6.13: Shows MECM pouring the charcoal/ wood ash into the black pot & then adding water into it using a calabash**

- *The formation of soap*

Then the MECM mixed the wood ash water, Marula oil and salt into the black pot which was on the fire and cooked the mixture while the participant continuously stirred until it boiled. From there it was removed and poured into a bowl for it to cool down and solidify: “#Ne sissa tage //gami tsaub //ha hasi, tsi //gui-I /hoi tsima //guiba ra huni /gao, /geis – ei-I mahina” (Now the wood ash that was taken is mixed with water and mixed in the pot on the burning fire).



**Figure 6.14: Shows MECM mixing Marula oil, wood ash water and salt into the black pot while the participant assisted in stirring the mixture to make the soap**

Lastly, the cooked liquid soap was poured into a container for it to cool down (dry up), mould and solidify. “#Netaga osei /gao kuna tagera u/gao gara//geib ei, //gho #gui ne/gaus ei see ra gurue” (Once the mixture of wood ash, Marula oil and saltwater are mixed properly on the fire the mixture is poured out into a container. Its placed there until it cools down and solidifies).



**Figure 6.15: Shows the liquid soap poured into a moulding container for it to solidify**

Figure 6.16 below shows me washing the black pot with the soap that was made during the workshop presentations by the expert community members.



**Figure 6.16: Shows the soap made being used to wash the black pot by me**

## **6.5 Data from Workshop Discussion and Participatory Observation**

In this section, I present the extracted episodes which I linked together to form sub-themes, and then the common sub-themes were combined into themes. Afterwards, the themes were further linked in relation to participants supporting statements that depicted their views and opinions, literature and theory. Through the workshop discussions and teachers' observations, I came up with five themes as shown below.

**Table 6.2: Shows themes and sub-themes that emerged from workshop discussions and participatory observations**

I now discuss the themes that emerged below.

Themes	Sub-themes	Literature reviewed	Theory used
1. Teachers' conceptual understanding of saponification.	-Saponification. -Teachers' views about saponification.	Ajayi et al. (2018); Mavhunga and Rollnick (2013).	PCK (Shulman, 1987)
2. Learning opportunities created.	-Linkages to science. -Inclusion of IK.	Mawere (2015); Schumm (2006); Roschelle (1995); Sedlacek and Sedova (2017); Mavhunga and Rollnick (2013); Nyambe (2008); Nyambe and Wilmott (2012).	SCT (Vygotsky, 1978)
3. Learning affordances.	-Learning during the presentations.	Mavhunga and Rollnick (2013); Sedlacek and Sedova (2017); Mavuru and Ramnarain (2019); Aikenhead and Jegede (1995); Roschelle (1995); Msimanga and Lelliot (2014).	SCT (Vygotsky, 1978)
4. Teachers' interactions and participation.	-Teachers talk, listen, ask and respond to questions. -Teachers participate in demonstrations.	Roschelle (1995); Mavhunga and Rollnick (2013); Kulhane (2011); Stott (2016); Cohen et al. (2018).	SCT (Vygotsky, 1978)
5. Shift in learning.	-Teachers' responses and participation.	Atallah et al. (2010); Eun (2008); Ngcoza and Southwood (2019).	PCK (Shulman, 1987) SCT (Vygotsky, 1978)

### 6.5.1 Teachers' conceptual understanding of saponification

From the observations I made during the practical presentations on soap making by the expert community members, it seems that the Chemistry teachers were afforded an opportunity to enhance their understanding of the concept of saponification. For instance, T1 said: *“For me,*

*I have learnt how oil is extracted from the Marula seeds to make soap*". T2 added that *"I have learnt that wood ash contains NaOH (sodium hydroxide) and KOH (potassium hydroxide) which is the alkali that is the ingredient needed in soap making"*. From these excerpts, it can be concluded that these teachers' conceptual understanding of saponification was enhanced. These findings corroborate with Ajayi et al. (2018) who mentioned that the two main ingredients of soap making are oil, in this context Marula oil, sodium hydroxide and potassium hydroxide from the wood ash water. Additionally, Mavhunga and Rollnick (2013) posit that conceptual understanding of topics enables teachers to select the best teaching strategies or methods aimed at helping learners acquire curriculum knowledge. Also, from these teachers' responses, I could be deduced that their SMK was enhanced (Shulman, 1987).

### **6.5.2 Learning opportunities**

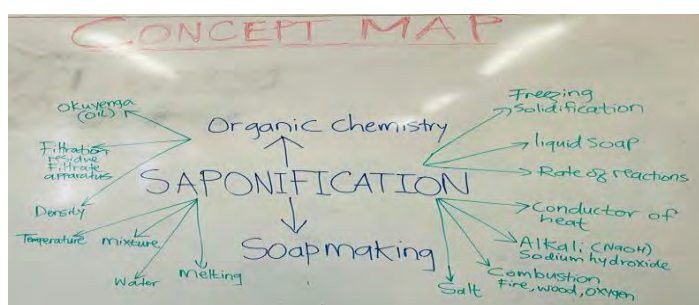
The practical demonstrations gave the platform for the expert community members to involve the Chemistry teachers in the soap-making process. For example, FECM asked a female teacher to help her in the pounding of the Marula seeds with the mortar and pestle. From such an act, one can see that although the FECM is not a teacher by profession, she seemed to know the principle of the learner-centred approach (Nyambe, 2008; Nyame & Wilmot, 2012). It could be seen how she allowed teachers to be actively involved in the learning activity as opposed to them just sitting and listening the whole time. This affirms Vygotsky's (1978) concept of mediation which he explains as using cultural artefacts to move from the known to the unknown and this in Mawere's (2015) view, makes science more accessible. Furthermore, I also observed that the FECM carefully guided and showed the female teacher how to correctly hold and move the pestle in the mortar. Such an action could be linked to what is known as scaffolding, which is help given to students which is then gradually diminished and stopped to make them more independent (Schumm, 2006).

Moreover, during the presentation of the MECM, he asked the Chemistry teachers several questions. For instance, he asked them what was needed to make a fire, T3 responded and said: *"You need a fuel it can be wood or charcoal, air especially oxygen because it supports combustion and the last thing you need is a heat source like matches or lighters"*. From such an interaction, it could be deduced that the MECM was eliciting what is referred to as prior knowledge (Kuhlane, 2011; Mavhunga & Rollnick, 2013; Roschelle, 1995). This, in my view,

is pivotal in the sense that it increases participation among the participants (Sedlacek & Sedova, 2017).

### 6.5.3 Learning affordances

The local expert community members practically demonstrated how soap was made traditionally. Their presentations provided an opportunity for the four Chemistry teachers to link these presentations to their own teaching practices. For instance, the Chemistry teachers were able to come up with scientific concepts that emerged from local expert community members' presentations.



**Figure 6.17: Shows a concept map**

From the concept map, it could be observed that the four Chemistry teachers made sense of the practice of soap making. They could link it to the various science concepts/topics listed and shown above in Figure 6.17. It can also be seen that these teachers are aware of the cross-curricular issues within the Chemistry syllabus (MoE, 2016). This also speaks to curriculum saliency (Mavhunga & Rollnick, 2013) which shows sequencing and arrangements of topics in a particular order.

Additionally, during the presentation, the local expert community members interacted openly with the participants as reiterated by Sedlacek and Sedova (2017). Notably, these expert community members involved the Chemistry teachers during their presentations. For instance, the FECM asked one of the female Chemistry teachers to assist her with the pounding of the Marula seeds. She also asked the Chemistry teachers to identify the traditional utensils, for example, she said “*Inimabino omushi kutya ikwa shike?*” (Do you know what these utensils are?). This act resonates with Vygotsky’s (1978) SCT, which states that learning takes place through social interactions with MKOs. Similarly, MECM also involved the Chemistry teachers. For instance, before he started his presentation, he elicited the Chemistry teachers’

prior knowledge (Mavhunga & Rollnick, 2013; Roschelle, 1995). He did this by asking them how the fire was made to which T3 responded – this showed that learning was taking place.

Learning was also observed when teachers took notes in their journals when the expert community members were presenting. For instance, T2's reflections on the workshop were:

*I have learnt during this workshop discussion that IK integration in our Chemistry lessons is very important in mediating the topic of saponification. I have also learnt how oil is extracted from the Marula seeds and that wood ash contains sodium hydroxide (NaOH) and potassium hydroxide (KOH) needed to make the soap.*

From the above excerpt, it is clear that there was a shift in learning. This was the very same teacher who earlier stated in his semi-structured questionnaire that he does not integrate IK into his lessons as he was not taught about IK integration at university. But it seems that after the workshop presentations, his ZPD (Vygotsky, 1978) was increased. As a result, he was now eager to implement IK in his lessons especially on saponification as he gained an in-depth understanding.

The traditional utensils or mediatory artefacts (Vygotsky, 1978) used during the workshop presentations were those that the Chemistry teachers were familiar with. This was seen when teachers identified some of them when they were asked by the FECM to name them. Also, the teachers were able to relate the expert community members' explanations to their everyday prior knowledge (Kuhlane, 2011). For example, I explained that the black fire pot is mainly used in soap making because it is a good conductor of heat. This is because it is made from cast iron which has the ability to retain heat. In this way, these teachers were able to link this indigenous home science to the classroom science, enabling border crossing as emphasised by Aikenhead and Jegede (1999).

The languages used during these practical workshops were Oshiwambo (FECM) and Khoekhoegowab (MECM) respectively. That gave the participants the freedom to freely express themselves and it enabled full active participation. This is congruent with Vygotsky's SCT which is rooted in constructivism. The premise of the theory is that knowledge and understanding are created from social interactions as a result of the mediation of learning, culture and the use of language. Scholars such as Mavuru and Ramnarain (2019) and Msimanga

and Lelliot (2014) echoed that the use of home languages helps in the conceptual understanding of scientific concepts.

#### **6.5.4 Teachers' interactions and participation**

FECM started her presentation by asking the participants "*Inima mbino omushi kutya ikwashike*" (Do you know what these utensils are?). Scholars such as Roschelle (1995) and Kuhlana (2011) refer to this act as the elicitation of prior knowledge which Mavhunga and Rollnick (2013) describe as everyday life knowledge from home and community. The participants responded correctly. For instance, T1 said yes this is a cup, while T4 said this is called a mortar and pestle. This was an indication that the Chemistry teachers were learning during these social interactions among themselves – this is called peer learning by Stott (2016). They were also learning from the expert community members who are known as the MKOs as espoused by Vygotsky (1978).

Another interaction that was observed was when T3 asked why the FECM asked T2 to add water into the mortar. To this, the FECM answered by saying: "*Oatu tulamo omeya moshini ipo maghadhi andelele okuya*" (We add water in order to speed up the process of Okuyenga – oil extraction). From this excerpt, it could be noted that the FECM was knowledgeable and skilled in the craft of oil extraction. During her response, I reminded the participants to note the responses in their journals which they would use later during the co-development of exemplar lessons. This utterance I made is in line with Cohen et al. (2018) who suggest that quality observations are more than just looking or listening but requires to be recorded or written down for future references.

#### **6.5.5 Shifts in learning**

All four Chemistry teachers were asked what they had learnt during the presentation, and they responded as follows:

T1: *How to make oil, also learnt the name of the oil residue called ezi in my local language.*

T2: *I have learnt how to make soap traditionally from oil, wood ash and salt, I never knew this before.*

T3: *To make soap from local ingredients and cultural utensils.*

T4: *That soap can be made using local home knowledge.*

From these excerpts, it emerged that these four Chemistry teachers indicated that the workshop presentations by the two expert community members had changed their conceptions and dispositions (Atallah et al., 2010). They vowed on integrating IK when mediating saponification. These findings are consistent with Eun (2008) and Ngcoza and Southwood (2019) who argue that when teachers are engaged in continuous professional development programmes it helps in changing their teaching practices which might eventually benefit their learners. These scholars further averred that these activities are pivotal in professional development as they create the platforms for teachers to socialise, interact and learn from each other (Vygotsky, 1978). This results in their PCK and SMK increasing just as emphasised by Shulman (1987). In the end, the Chemistry teachers viewed IK as knowledge based on the local environment and community, community elders' knowledge, home knowledge that is not written in books and ancestral knowledge passed on through generations.

## **6.6 Chapter Summary**

In this chapter, I presented analysed, interpreted and discussed data from workshop discussions and participatory observations. This was aimed at answering my second research question. The findings revealed that all the teachers found the indigenous technology of soap making useful in mediating the understanding of saponification in organic chemistry. The teachers also interacted freely with the two expert community members, their mediatory artefacts (utensils/ingredients) and amongst themselves. They also took part in all activities and were eager to learn more. In the next chapter, I present, analyse, interpret and discuss data gathered from the stimulated recall interviews, teachers' journal reflections and the workshop on the co-development of an exemplar lesson plan that integrated IK.

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## CHAPTER SEVEN: STIMULATED RECALL INTERVIEWS, JOURNAL REFLECTIONS & CO-DEVELOPMENT OF EXEMPLAR LESSON PLAN

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### 7.1 Introduction

The goal of this study was to mobilise the indigenous technology of making soap to mediate the learning of saponification in organic chemistry. In the previous chapter, I presented, analysed, interpreted and discussed data generated from the workshops by the two expert community members and participatory observations. They were aimed at answering the second research question of this study.

In this chapter, I thus, present, analyse, interpret and discuss data derived from the stimulated recall interviews and teachers' journal reflections. These data sets were then used to co-develop an exemplar lesson plan that integrated IK on soap making (saponification) and to answer the study's third research question:

*How can Grade 11 chemistry teachers be supported in co-developing exemplar lessons on saponification that integrate IK in their classrooms?*

### 7.2 Data Derived from Stimulated Recall Interviews and Teachers' Journal Reflections

In this section, I discuss the data generated from the stimulated recall interviews and teachers' journal reflections. This stimulated recall interviews took place immediately after the two expert community members' presentations on soap making using IK. This was done while the teachers' memories of what had transpired were still fresh so they could recall all activities.

**Table 7.1: Data collection methods and teachers' codes**

Data collection methods	Teachers' codes used in discussions
Stimulated Recall Interviews (SRI)	T1MSRI; T2MSRI; T3MSRI; T4FSRI
Teachers Journal Reflections (TJR)	T1MJR; T2MJR; T3MJR; T4FJR

The Chemistry teachers were assigned codes as shown in Table 7.1 above. For instance, T1MSRI stands for teacher 1 male stimulated recall interviews and so on. As for T1MJR it represents teacher 1 male journal reflection and so on. These codes are used throughout the thesis. The data from the stimulated recall interviews and journal reflections were analysed inductively-deductively to formulate themes, which were then colour coded. Afterwards, these themes were interpreted and discussed in relation to literature and theory as shown below.

**Table 7.2: Themes that emerged from stimulated recall interviews and journal reflections discussed in relation to corresponding literature/theory**

Themes	Literature / theory
1. Teachers' understanding/comprehension of indigenous knowledge.	Chilisa (2012); Kibirige and van Rooyen (2006); Mutanho (2021); Nyika (2017); Seehawer (2018a); Seehawer and Breidlid (2021).
2. The importance and benefits of integrating indigenous knowledge in science lessons.	Kibirige and van Rooyen (2006); Msimanga and Shizha (2014); Mukwambo et al. (2014).

I now discuss these themes in detail below.

### **7.2.1 Teachers' understanding/comprehension of indigenous knowledge**

After the two expert community members' presentations on soap making, it appeared the Chemistry teachers had a fundamental change in their understanding and comprehension of what IK was to them. For instance, T4 reflected that *"this is knowledge known in the community and that can be transferred to other generations to come"* (T4FSRI). On the other hand, T2 indicated that IK is *"knowledge you get from local people, but it's not found in books"* (T2MSRI).

From these two Chemistry teachers' excerpts, I conjectured that they seem to understand what IK is. This is indicated by them calling attention to the fact that this knowledge is transferred from one generation to another. They further indicated that it is mostly not recorded or documented. These findings resonate with the explanations by scholars such as Kibirige and van Rooyen (2006) and Nyika (2017).

To elaborate more, Nyika (2017) postulates that IK can be in the form of beliefs, norms, songs, local languages, imitations and stories which are passed on from generation to generation orally. Furthermore, these scholars' views are in resonance with T2's journal reflection that "*indigenous knowledge is the knowledge that is acquired through storytelling by our grandparents, which usually happens around the fire in villages*" (T2MJR). It can be surmised, therefore, that this teacher acknowledges that the storytelling of IK is one of the most important methods through which it is transferred and preserved from one generation to another (Chilisa, 2012).

Another aspect that was revealed in these teachers' stimulated recall interviews and journal reflections is the issue of IK not being documented. In this regard, T2 reflected that "*indigenous knowledge is knowledge passed on orally from one generation to another but is not documented*" (T2MJR). Similarly, T4 recalled in her interview that "*indigenous knowledge is the knowledge you get from local old people but is not written in books*" (T4FSRI). This affirms the calls made by Mutanho (2021) and Seehawer (2021) to document all IK that can be used to mediate the learning of science concepts in classrooms. This ideology of integrating IK and WS is also supported by Seehawer and Breidlid (2021) who posit that there is a dialogue that exists between these knowledges that need to be explored. This notion is also encouraged by Mukwambo et al. (2014).

### **7.2.2 The importance and benefits of integrating indigenous knowledge in science lessons**

The Chemistry teachers in this study were asked what the importance and benefits of IK integration in their science lessons were and two of them responded as follows: "*It helps learners to link what they experience at home to what they hear in class*" (T2MSRI). "*Yes, it is important because traditional knowledge helps especially the youth to retain their cultural and traditional norms and practices*" (T4FSRI).

From the above extracts, T2's quote resonates with Aikenhead and Jegede (1999) who assert that integrating IK into school science helps in what they term border crossing which reduces intellectual dissonance (Le Grange, 2007). Additionally, it appears T4 is pointing out the importance of cultural norms and values. These findings cohere with Msimanga and Shizha (2014) who aver that IK is important for cultural identity and helps learners connect to their cultures and traditions.

Similar sentiments were also shared by T3 when he said: *“Yes, indigenous knowledge is very important in schools, because learners are losing their traditional moral values”* (T3MSRI). Notably, T3 cautioned that sometimes IK can confuse learners. This view can be linked to that of Mukwambo et al. (2014) who argue that IK is implicit in nature, in the sense that it contains a lot of myths and unproven facts that are not scientific at times. To this, Kibirige and van Rooyen (2006) suggest that learners should be given the chance to debate unproven cultural beliefs to minimise this confusion. Furthermore, from T1’s reflection: *“Learners should be taught about traditional knowledge in order to make things on their own using traditional knowledge and local materials”* (T1MJR). This reflection has an affinity to the goal of the study, which was making soap traditionally using cultural artefacts (Vygotsky, 1978).

### 7.3 The Co-development of an Exemplar Lesson Plan

In this section and similar to Hashondili (2020) and Kakambi (2020), I present, analyse, interpret and discuss data gathered from the workshop on the co-development of an exemplar lesson that integrated IK. The data derived were also aimed at answering the study’s third research question. Importantly, the engagement between the four Chemistry teachers and the two expert community members was meant for teachers to understand IK, and then plan how to integrate it into their lessons. The co-development of an exemplar lesson was a form of intervention and professional development activity (Fatih, 2020; Ngcoza & Southwood, 2019). It was also intended to establish a PLC among these four Chemistry teachers as reiterated by Chauraya and Brodie (2018) and Mutanho (2021). The planning session started with a discussion on what the four Chemistry teachers wanted to include when designing and developing this lesson plan that included IK of soap making. Below in Table 7.3 are the themes that emerged during the discussions.

**Table 7.3: Themes from the exemplar lesson plan discussions**

Themes that emerged	Literature reviewed	Theory used
1. Curriculum Saliency	Mavhunga and Rollnick (2013)	PCK (Shulman, 1986)
2. Lesson plan format (structure/layout)	Chemistry syllabus – NCBE (MEAC, 2016).	SCT (Vygotsky, 1978)

I now discuss each of these themes in relation to the Chemistry teachers supporting statements, the literature reviewed, and the theory used.

### 7.3.1 Curriculum saliency

During the workshop on co-designing and developing the exemplar lesson plan that integrated IK (technology), T1 said:

*The knowledge and skills that were presented by the two expert community members on how to make soap traditionally were relevant and applicable to the topic of saponification, which is how soap is made from the western science perspective.*

From this teacher's excerpt, it seems clear that he knows the concepts of the topic which learners need to understand. This according to Shulman (1986) is known as PCK, which he explains as the "blending of content and pedagogy into an understanding of how topics, problems or issues are organized, represented and adapted to the diverse interest of learners and represented for instructions" (p. 8). This is also in concurrence with Mavhunga and Rollnick (2013) who proffer that curriculum saliency is about teachers' awareness of major concepts around a topic which learners need to comprehend. Without this understanding, such a topic would be difficult. This then led the teachers to co-develop an exemplar lesson. The discussions continued with the formulation of the format of the lesson plan.

### 7.3.2 Lesson plan format

Below is a summary of the resolutions that were taken by the four Chemistry teachers regarding the components of the sample lesson plan that was designed at the workshop in accordance with the NCBE (MEAC, 2016).

#### The aspects that were decided to be included in the lesson plan

- **Subject**
  - **Grade**
  - **Theme**
  - **Topic**
  - **Duration**
  - **Teaching resources/media to be used** (easily accessible materials from the local environment)
- (from the curriculum/syllabus)

- **Learning objectives & basic competencies** (from the curriculum/syllabus)
- **Indigenous knowledge to be integrated** (chosen in relation to the theme, topic, teaching resources, learning objectives and basic competencies)
- **Monitoring of homework done** (teacher inspects previous work given with regard to IK discussed)
- **An appropriate short introduction** (teachers elicit learners' prior knowledge about IK to be discussed)
- **Presentation of subject content & learning tasks** (teacher uses a variety of conceptual teaching strategies & learners learn in a learner-centred manner)
- **Conclusion** (recap the summary of the lesson, and show learners the link between IK and WS)
- **Assessment** (orally question learners on IK learnt and its applications in everyday life)
- **Homework** (ask learners to go home and find out from their grandparents and immediate community about IK being discussed)
- **Task** (give learners a project to make use of IK to build and create models like soaps, chairs, tables, beds, axes, bow & arrows, drums, Marula oil, *oshikundu*, etc.)
- **Reading & Writing skills** (encourages learners to translate scientific English terms into their native languages and vice versa to help preserve their cultures)
- **Lesson reflections** (encourage learners to write in their journals or summary books of what they have learnt or not during the lesson on IK)

Afterwards, the Chemistry teachers decided to practically co-develop an exemplar lesson containing the IK they learnt from the two expert community members about soap making (see Appendix P). During the workshop on co-developing the lesson plan, teachers socially interacted and learnt from each other. This was seen in the way they actively contributed to the creation of the lesson plan. This has an affinity to Vygotsky (1978) who avers that learning and development happen best during social interactions. I further noticed a change in their ZPD in terms of their PCK and SMK (Shulman, 1987). For instance, during the workshop, teachers were giving a lot of input on how the lesson was to be designed. For example, T3 said: “*We should include a way in which we encourage our learners to reflect about what they have learnt or not during the lesson that includes IK*”. This reasoning is in line with Bertram and Christiansen (2015) who state that reflections are important in the learning process as they help one to look back and see what to change or not.

Additionally, at the workshop on the lesson planning the teachers decided on a uniform lesson structure (layout/ format). For instance, T4 stated that “*Guys we should have a common lesson plan, as it will encourage all of us to include the IK we have learnt from the two expert community members on soap making*”. The teachers then all agreed and came up with the format below (see Figure 7.1) which conforms to the Chemistry syllabus (MEAC, 2016). It integrated IK into soap making as encouraged by the NCBE (MEAC, 2016). For the actual lesson plan see Appendix P.

**Table 7.4: Shows the template for the co-developed lesson plan that integrated IK into soap making**

<b>SUBJECT: GRADE: DATE: DURATION:</b>
<b>THEME: TOPIC:</b>
<b>TEACHING AIDS AND RESOURCES</b>
<b>LEARNING OBJECTIVE OF THE LESSON: Learner will:</b>
<b>BASIC COMPETENCIES: Learners should be able to:</b>
<b>INDIGENOUS KNOWLEDGE TO BE INTEGRATED:</b>

**PRESENTATION OF THE LESSON:**

1. Monitoring of homework done:
2. An appropriate short introduction:
3. Presentation of subject content and learning tasks:
  - 3.1 teacher activities
    - \*
    - \*
    - \*
  - 3.2 learner activities
    - \*
    - \*
    - \*

4. Conclusion:

<b>ASSESSMENT/HOMEWORK/ TASK GIVEN TO LEARNERS</b>
Assessment =
Homework=
Task=
<b>OPPORTUNITIESTO DEVELOP LEARNER’S ENGLISH READING AND WRITING SKILLS IN THE SUBJECT</b>
Reading:
Writing:
Lesson reflections

**7.4 Chapter Summary**

In this chapter, I presented, analysed, interpreted and discussed the data generated from the stimulated recall interviews, teachers’ journal reflections and the workshop discussions on the co-development of an exemplar lesson that integrated IK into soap making. This was aimed at addressing and answering the study’s third research question. The findings revealed that

teachers comprehended and understood what IK was. They also appreciated the importance and benefits of integrating IK into their lessons. Furthermore, the Chemistry teachers managed to co-design and co-develop an exemplar lesson plan that integrated IK into soap making (saponification) (see Appendix P).

In the next chapter, I present and discuss the summary of the findings, the recommendations and the conclusion.

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## CHAPTER EIGHT: SUMMARY OF FINDINGS, RECOMMENDATIONS & CONCLUSION

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### 8.1 Introduction

In the preceding chapter, I presented, analysed, interpreted and discussed data generated from stimulated recall interviews, journal reflections and a workshop on the co-development of an exemplar lesson plan that integrated the IK of making soap. In this chapter, I thus present a summary of my findings and recommendations thereof. Furthermore, I also present areas for future research, limitations of the study and my personal reflections. The chapter ends with the overall conclusion of the study.

### 8.2 The Overview of the Study

The main goal of this study was to mobilise the indigenous technology of making soap to mediate the learning of saponification in organic chemistry. To achieve this goal, the following research questions were addressed:

1. What are Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of IK in their Chemistry lessons?
2. What learning opportunities are created (or not) for Grade 11 chemistry teachers to interact, participate and learn during the presentations by the expert community members?
3. How can Grade 11 chemistry teachers be supported in co-developing exemplar lessons on saponification that integrate IK?

To answer these research questions, I employed a variety of data collection methods. For research question one, for instance, semi-structured interviews and semi-structured questionnaires were used. For research question two, I used workshop discussions and participatory observations. For research question three stimulated recall interviews and journal reflections were employed.

### 8.3 Summary of Findings

I now present the summary of my findings in relation to each research question. I start off with research question one as follows:

#### ***Research question 1***

*What are Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of IK in their Chemistry lessons?*

The findings revealed that teachers had and showed a positive attitude towards the use of IK in their Chemistry lessons. For instance, T4F said “*I like to learn new ideas from different cultures*” and this coheres with Vygotsky (1978) who posits that culture is a prerequisite for the learning and development of an individual. It was also revealed that the Chemistry teachers showed a good understanding of what IK is. This was seen in some of their definitions, like the one by T2M who defined IK as “*local information and practices that our ancestors used things older generations used to do and passed it on from one generation to another*”. His definition seems to be similar to that of scholars like Kibirige and van Rooyen (2006) who defined IK as a legacy of knowledge and skills unique to a particular indigenous culture involving wisdom that has been developed and passed on over generations.

The study's findings also revealed the benefits associated with integrating IK in science lessons. For example, the teachers mentioned the following benefits: teachers will know how to make their own soap at home and school; teachers' engagement and participation will increase as they learn from each other's cultures and traditions. These findings resonate with the views of scholars such as Aikenhead and Jegede (1999) and Sedlacek and Sedova (2017), to mention a few, who aver that IK can be used as a bridge between what is learnt at school and what is seen at home and this results in active engagement and participation.

On the other hand, the study's findings revealed some challenges that impede the integration of IK in schools as cited by T2M:

*I want to incorporate indigenous knowledge in my lessons but I don't knowhow, as for me myself, I was not taught about it at varsity. It is also not found in our syllabus and books, you see there are no examples for us to use. (T2MSSQR)*

This teacher's sentiments seem to corroborate Seehawer's (2018a) assertion that educational institutions of higher learning that do not train their student teachers on what and how to integrate IK are impeding its full integration. Lastly, the study also revealed that the four Chemistry teachers had limited knowledge of how soap is made in their respective cultures. For instance, T3M stated in the questionnaire that "*I really don't know, maybe I can learn*". Hence, there was a need to invite two local expert community members who Vygotsky (1978) refers to as the MKOs to come to demonstrate how soap is made traditionally.

### **Research question 2**

*What learning opportunities are created (or not) for Grade 11 chemistry teachers to interact, participate and learn during the presentations by the expert community members?*

The findings of the study revealed that there was active interaction and participation (Sedlacek & Sedova, 2017) during the practical presentations by the two expert community members. It was revealed in the study that the expert community members asked teachers a lot of questions. For instance, FECM at the start of her presentation asked "*Do you know what these utensils are?*" MECM asked them how fire is made. This is what scholars such as Mavhunga and Rollnick (2013) and Roschelle (1995) refer to as elicitation of prior knowledge, which is crucial in the learning process. Additionally, FECM invited the female Chemistry teacher to help her in pounding the Marula nuts with the mortar and pestle. Such an act has an affinity with Vygotsky's (1978) SCT, which states that learning and development best take place during social interactions with MKOs or knowledgeable peers as further espoused by Stott (2016).

The study also revealed that the teachers were learning during the presentations. For instance, they were seen making notes in their journals. The notes were subsequently used to co-develop an exemplar lesson plan on saponification that integrated IK into making soap. They also came up with concept maps on topics that emerged from the making of soap traditionally. These are known as representations according to Mavhunga and Rollnick (2013). Moreover, the Chemistry teachers showed a shift in learning. For example, during the semi-structured interviews and questionnaire, T2M indicated that he does not integrate IK because he was not taught about it at university and hence, he felt that he lacked the pedagogical insight. He reflected that he has learnt now how to integrate IK into his lessons. He was also part of the co-development of the exemplar lesson plan on saponification that integrated IK. As a result

of all this, his SMK and PCK (Shulman, 1987), TSPCK (Mavhunga & Rollnick, 2013) and ZPD (Vygotsky, 1978) were enhanced and improved.

The findings further revealed that the use of vernacular or home languages, Oshiwambo and Khoekhoegowab, allowed the expert community members to express themselves freely which increased participation (Mavuru & Ramnarain, 2020; Msimanga & Lelliot, 2014) as they could communicate openly. This is congruent to Vygotsky (1978), who posits that language plays a pivotal role in the mediation of learning. The critical friend also played a crucial role in translating from these vernaculars to English which is the official medium of instruction and the language of learning and teaching as stipulated in the national curriculum and Chemistry syllabus (MoE, 2016). This notion of translating from one language(s) to another to mediate communication is similar to what Aikenhead and Jegede (1999) call cultural border crossing.

### ***Research question 3***

*How can Grade 11 chemistry teachers be supported in co-developing exemplar lessons on saponification that integrate IK?*

The study revealed that the four Chemistry teachers managed to co-design and then co-develop an exemplar lesson plan. Their exemplar lesson plan integrated the IK of making soap to mediate the concept of saponification in organic chemistry (see Appendix P). The workshop on co-developing the exemplar lesson plan was a professional development activity as reiterated by Fatih (2020) and Ngcoza and Southwood (2019). It was also a way of establishing a community of practice (Mutanho, 2021) and a PLC (Chauraya & Brodie, 2018) in an effort to capacitate the four Chemistry teachers' SMK (Shulman, 1987) and their TSPCK (Mavhunga & Rollnick, 2013).

Furthermore, the findings revealed that the Chemistry teachers comprehended and understood what IK was. For instance, T4 reflected: *“This is knowledge known in the community and that can be transferred to other generations to come”* (T4FSRI). This explanation resonates with that of Nyika (2017) who posits that IK can be in the form of beliefs, norms, songs, local languages, imitations and stories which are passed on from one generation to another orally. Moreover, T2M defined IK as *“knowledge passed on orally from one generation to another but is not documented”* (TM2JR). His definition has an affinity to calls made by Mutanho (2021) and Seehawer (2021) to document IK in science lessons.

## 8.4 Recommendations

Based on the findings of my study I recommend the following:

- Institutions of higher learning should introduce the teaching of IK in their curriculum so as to equip student teachers with the necessary PCK (Shulman, 1987) on the concept of IK, as the exclusion of IK poses difficulties in making sense of abstract science concepts (Govender, 2014). In the same vein, the national curriculum developers should reform and amend the Chemistry syllabus and textbooks to include SMK on IK to aid science teachers with the integration and implementation of such knowledge and skills in their lessons.
- Chemistry teachers should identify and invite local expert community members, as they are the custodians of this traditional knowledge (Klein, 2011; Lavallee, 2009).
- Teachers should form PLCs (Brodie, 2013) and communities of practices as a way of sharing best teaching practices involving the integration of IK in their teaching. Similarly, ongoing continuing professional development (CPD) (Denuga, 2019) on IK integration in science lessons should be introduced as a way of capacitating and encouraging science teachers to link science and culture. Such CPD programmes can be in the form of workshops, seminars and conferences (Desimone & Garret, 2015).
- Science teachers, particularly Chemistry teachers, should adopt a culture of using easily accessible materials (Asheela et al., 2021; Shinana et al., 2021) when mediating the learning/teaching of science concepts that integrate IK. They should also adopt the practical way of teaching science (SCORE, 2013) and should always elicit their learners' prior knowledge (Roschelle, 1995) that considers their socio-cultural backgrounds (Mavuru & Ramnarain, 2020).

## 8.5 Areas for Future Research

I propose that research on the same topic could be extended to Grade12 advanced subsidiary level teachers or learners since they deal with this topic in detail. In addition, another research study could be done on the same topic, where the community members could demonstrate to learners how a traditional soap is made to mediate the learning of saponification. Also, the research could be extended to more schools and Grade 11 chemistry teachers in towns, regions and the nation at large. Furthermore, this research could be extended on the same topic, where teachers could teach the co-developed exemplar lessons in their classrooms while they are

observed. Moreover, a further study could be conducted on how other Namibian cultures such as Kavango, Caprivi, Herero, Tswana and Baster/Coloureds make soap traditionally. Lastly, a study could be conducted whereby the expert community members are the focus and are interviewed about their views on integrating IK in science or how they think this integration should be done.

## **8.6 Limitations of the Study**

The research participants in this study were four Grade 11 chemistry teachers, a critical friend and two expert community members from the coastal town of Walvis Bay in the Erongo region. For this reason, the sample (population size) was small, and the findings of the study cannot be generalised. Nonetheless, the findings provided some useful insights on how soap is made traditionally using IK, and how that knowledge could be integrated to mediate scientific concepts like saponification in this context. Although the use of vernacular languages was beneficial (Mavuru & Ramnarain, 2020; Msimanga & Lelliot, 2014) for social interactions (Vygotsky, 1978) and active participation (Sedlacek & Sedova, 2017), however, I am cognisant of the fact that during the process of translating from Oshiwambo and Khoekhoegowab to English, some meanings of statements could have been distorted or even lost. To mitigate against that, member checking was done, and I also involved my critical friend. This was done for quality assurance and verification to enhance the validity and integrity of the data. The presence of COVID-19 also limited my study, especially the data collection processes, due to its accompanying restrictions such as curfew, social distancing and the number of people per gathering. To address such restrictions, I made sure that during my meetings with the participants I had all the necessary preventative measures like hand sanitiser, all members' wore masks and the workshops did not last long.

## **8.7 Personal Reflections**

My journey started in 2017 when I handed my admission application form for BEd (Hons) to a female friend of mine to submit for me. Unfortunately, it never materialised as she handed it in late after the due date had lapsed and I was not accepted for admission. Although this experience was heart-breaking, it never deterred me. As the saying goes 'you can't keep a good man down'. In 2019, for instance, I had an opportunity to apply for the course again. This time I left nothing to chance and took the application myself to the National Institute of Educational Development and submitted it personally. I was accepted and was called in to go write a two-

hour-long admission test which I passed with flying colours, and I was accepted to do a BEd honours degree in science education on a part-time basis.

In the second and final year of my BEd honours programme I was introduced to the concept of IK by my lecturer and now supervisor Prof Ngcoza. I found lessons on IK very interesting, partly because I could relate to them, especially when he taught us about traditional beliefs about lightning with the assistance of Dr Mutanho – this was very interesting to me. I got a distinction in my science honours elective results. This inspired and motivated me to continue with my master's degree in science education in 2021. My research focus was on using IK of making soap to mediate saponification. The research journey was challenging and the same time rewarding. It was challenging in the sense that I had a hard time striking a healthy balance between family, church, work, studies, sports and hobbies. Despite such challenges however what kept me going was my supervisors' mantra "*If you want to walk fast walk alone, but if you want to walk far walk together*" and the spirit of 'Ubuntu' among my masters' classmates.

Writing a research proposal went very smoothly without hiccups – this was due to the online research design course I attended that was presented by various scholars from Rhodes University including my supervisor. From there I handed it to the ethical committee of Rhodes University who approved it and gave me an ethical clearance certificate, which meant I could go and collect data. However, the deadly COVID-19 impeded and delayed my data collection process. The problem was even exacerbated further when Namibia was placed on lockdown. That, however, did not deter me. Instead, I tenaciously used the free time I had to improve the other parts (chapters) of my thesis.

On the other hand, the journey was also rewarding to me in many ways. For example, I learnt how to use IK to make soap which can be used to mediate saponification in organic chemistry. My computer and researching skills have improved tremendously. My interpersonal relations have also been enhanced as the study gave me the opportunity to engage and socialise with individuals from different backgrounds and spheres of life, like lecturers, masters' classmates, Chemistry teachers, expert community members, directors and principals. All this has led to the expansion of my educational network and for that, I am forever grateful.

## 8.8 Conclusion

This study sought to mobilise the indigenous technology of making soap to mediate learning on the topic of saponification in organic chemistry. To realise this goal, three research questions were answered using data collected from the following methods: semi-structured interviews, semi-structured questionnaires, workshop discussions, participatory observations, stimulated recall interviews and journal reflections. The first research question aimed at finding out Chemistry teachers' attitudes and pedagogical insight on the use of IK in their lessons. The findings derived from the semi-structured interviews and questionnaires revealed that teachers had a positive attitude towards the integration of IK in their lessons despite their limited pedagogical insight on how to do it. They also showed a good understanding of the concepts of IK and saponification. However, they demonstrated very little knowledge of how soap is made traditionally. Hence, two expert community members were invited to come to show how soap is made using IK.

Furthermore, the second research question aimed at finding out how the practical demonstration of making soap by the two expert community members enabled and/or constrained the Chemistry teachers to interact, participate and learn during the presentations. The data gathered from workshop discussions and participatory observation showed that there was active participation and interaction between all participants. For instance, the FECM practically involved the Chemistry teachers in pounding the Marula nuts to extract the oil that was needed to make soap. Also, the MECM asked the Chemistry teachers about how fire is made. Both expert community members presented the workshops in their vernaculars which played a pivotal role during the interactions and participation as it aided in the smooth communication during their presentations.

Finally, the third research question was aimed at supporting the Chemistry teachers in co-developing exemplar lessons. The data collected from the stimulated recall interviews and journal reflections exposed that there was a shift in the teachers' learning. This was seen in their ability to come up with concept maps and they successfully co-designed and co-developed a Chemistry lesson plan that integrated the IK of making soap in mediating the learning of saponification. Lastly, the study recommends that there is a need for science teachers to integrate IK into their lessons to mediate science concepts.

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## Appendices

### Appendix A: Ethical clearance certificate



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

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

9 December 2021

Prof Kenneth Ngcoza

Education Department

K.Ngcoza@ru.ac.za

Dear Prof Kenneth Ngcoza and Mr Johannes Neporo

**Re:** Exploring working with Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry

APPLICATION NUMBER: 2021-5241-6351

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

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

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

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

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

A handwritten signature in cursive script, appearing to read "E. Rosenberg", is centered on the page.

**Prof Eureka Rosenberg : Chair Education Faculty Research Ethics Committee**

## Appendix B1: Executive Directors consent letter



REPUBLIC OF NAMIBIA

### MINISTRY OF EDUCATION, ARTS AND CULTURE

Enquiries: Mr. G. Munene  
Tel: +264 61 -293 3202  
Fax: +264 61- 293 3922  
Email: Gibson.Munene@moe.gov.na  
File no: 13/2/9/1

Luther Street, Govt. Office Park  
Private Bag 13186  
Windhoek  
Namibia

Mr. Johannes Neporo  
Cell. Number: 0814549451  
Email: Johnneporo87@gmail.com

Dear Mr. Neporo

#### SUBJECT: PERMISSION TO CONDUCT ACADEMIC RESEARCH IN ERONGO REGION

The Ministry wishes to acknowledge receipt of your letter dated 01 October 2021 seeking for permission to conduct academic research in Erongo region for your Masters in Science Education Degree studies which is focusing on: "Exploring Working with Grade 11 Chemistry Teachers in Mobilizing the Indigenous Technology of Making Soap to Mediate Learning of Saponification in Organic Chemistry."

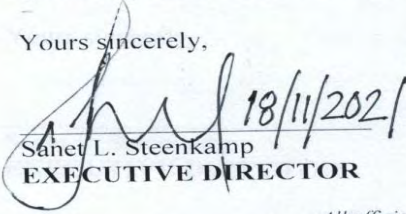
Permission has been granted to you. However, you have to seek for further clearance from the Erongo Regional Director of Education, Arts and Culture to ensure that:

- staff members' normal work is not disrupted during your interviews;
- participation is voluntary; and,
- parental consent should be granted by the parents / guardians of all participants who are under 16 years old.

Furthermore, you are kindly requested to share your research findings with the Ministry after completion of the research project. You may contact Mr G. Munene on the above provided contacts at the Directorate: Programmes and Quality Assurance (PQA) for submission of your research findings at the above indicated details.

We wish you the best in conducting your research and the Ministry looks forward to hearing from you upon completion of your studies.

Yours sincerely,

  
Sanel L. Steenkamp  
EXECUTIVE DIRECTOR



All official correspondence must be addressed to the Executive Director

## Appendix B2: Regional directors' consent letter



### ERONGO REGIONAL COUNCIL

#### DIRECTORATE OF EDUCATION, ARTS AND CULTURE

PRIVATE BAG 5024  
SWAKOPMUND

TELEPHONE: (064) 4105102

FAX: (064) 4105136

To: Mr. Johannes Neporo  
P.O. Box 8315  
Walvis Bay

22 November 2021

**RE: PERMISSION TO CONDUCT ACADMIC RESEARCH IN ERONGO REGION**

Permission is hereby granted to **Mr. Johannes Neporo** to conduct research at **De Duine SS, Duinesig HS, Kuisebmond SS and Tataleni SS** in Walvis Bay, Erongo Region. Permission is granted on condition that:

- Research ethics are adhered to
- Participation by individual teachers/learners are voluntarily
- Disruption of curriculum delivery is avoided
- Once completed a copy of the thesis be deposited with the Teachers Resource Centre.

The Erongo Regional Council, Directorate of Education wish you all the best in conducting your research and look forward to the findings and possible recommendations of your research.

Yours sincerely,

  
MS. E.J. STEPHANUS  
REGIONAL DIRECTOR  
OFFICE OF THE DIRECTOR  
BAG 5024 SWAKOPMUND

Cc: Mr. K. Menthik - Acting Inspector: Walvis Bay Circuit

## Appendix B3: Circuit inspectors' consent letter



ERONGO REGIONAL COUNCIL



**DIRECTORATE OF EDUCATION, ARTS & CULTURE**

**WALVIS BAY CIRCUIT OFFICE**

PRIVATE BAG 5008  
WALVIS BAY

TELEPHONE: (064) 200218  
FAX: (064) 200205

**30 November 2021**

To: Mr. Johannes Neporo  
P.O. Box 8315  
Walvis Bay


**RE: PERMISSION TO CONDUCT ACADEMIC RESEARCH IN ERONGO REGION**

With reference to the letter issued by the regional director dated **22 November 2021**, permission is hereby granted to **Mr. Johannes Neporo** to conduct research at **De Duine SS, Duinesig HS, Kuisebmond SS and Tataleni HS** in Walvis Bay, Erongo Region. Permission is granted on condition that:

- Research ethics are adhered to
- Participation by individual teachers/learners are voluntarily
- Disruption of curriculum delivery is avoided
- Once completed a copy of the thesis be deposited with the Teachers Resource Centre.

The Erongo Regional Council, Directorate of Education wish you all the best in conducting your research and look forward to the findings and possible recommendations of your research.

Yours sincerely

  
2021/11/30  
Mr J. Marthin  
Acting Inspector  
Walvis Bay Circuit Office

## Appendix B4: S.S Duine principals' consent letter

Secondary School De Duine

Telephone 064-202503, Fax 064-205688, International Code 00-264-64  
Kruis Street, P.O. Box 8315, Narraville, Walvis Bay, Namibia  
E-mail: ssdeduine@gmail.com

01 December 2021

To: Mr. Johannes Neporo

P.O. Box 8315

Walvis Bay

RE: PERMISSION TO CONDUCT ACADEMIC RESEARCH AT S.S DE DUINE

With reference to the letter by the Walvis Bay inspector dated 30 November 2021, permission is hereby granted to **Mr. Johannes Neporo** to conduct research at S.S De Duine in Walvis Bay Circuit, Erongo Region. Permission is granted on condition that:

- o Research ethics are adhered to
- o Participation by individual teachers/learners are voluntarily
- o Disruption of curriculum delivery is avoided
- o Once completed a copy of the thesis be deposited at the school library for references

The school management wish you all the best in conducting your research and look forward to the findings and possible recommendations of your research.

Yours sincerely

  
.....  
SECONDARY SCHOOL DE DUINE  
PRINCIPAL

Mr. J.A. Van Wyk

Principal

2021 -12- 01

Tel. 064-202503  
Fax 064-205688  
Email: ssdeduine@gmail.com  
P.O. Box 8315, Narraville

## Appendix B5: Tataleni H.S principals' consent letter



### **TATALENI HIGHSCHOOL**

P.O. Box 1069, Walvis Bay, Namibia

JOHANNA BENSON STREET

Tel no: 064 - 200 102, Fax no: 064 - 200 922

Email: [totaleni@school123@gmail.com](mailto:totaleni@school123@gmail.com)

1 December 2021

To Mr Johannes Neporo  
P.O Box 8315  
Walvis Bay

#### **Re: Permission to conduct academic research at Tataleni High School.**

With reference to the letter by the Walvis Bay Inspector of Education dated the 30<sup>th</sup> of November 2021, permission is hereby granted to Mr. Johannes Neporo to conduct research at Tataleni High School in Walvis Bay Circuit, Erongo Region. Permission is granted on condition that:

- Research ethics are adhered to.
- Participation by individual teachers/learners are voluntary.
- Disruption of curriculum delivery is avoided.
- Once completed a copy of the thesis be deposited at the school library for reference.

The school management wish you all the best in conducting your research and look forward to the finding on possible recommendations of your research.

Yours in Education

  
GIDEON VV (Mr.)  
PRINCIPAL

  
TATALENI HIGH SCHOOL  
P.O BOX 1069 WALVIS BAY  
01 DEC 2021  
TEL: 064 200102  
FAX: 064 200922  
Email: [totaleni@school123@gmail.com](mailto:totaleni@school123@gmail.com)

## Appendix B6: Kuisebmond S.S principals' consent letter



# KUISEBMOND SECONDARY SCHOOL

P.O. Box 84  
Walvis Bay, Namibia  
Telephone 064-205329  
Fax 064-206780  
[kuisebmondss.edu@gmail.com](mailto:kuisebmondss.edu@gmail.com)

ERONGO REGIONAL COUNCIL

---

DIRECTORATE OF EDUCATION  
WALVIS BAY CIRCUIT OFFICE

---

2<sup>nd</sup> December 2021

Dear Mr.J. Neporo

**Re: CONSENT TO CONDUCT YOUR RESEARCH AT KUISEBMOND SECONDARY SCHOOL**

Approval is hereby granted for you to conduct the research on *"Exploring working with the grade 11 chemistry teachers in mobilizing the indigenous technology of making soap to mediate learning of saponification in organic chemistry."*  
The results on this study should be shared with the science department at our school.

Wishing you all the best with your research.

Yours in Education

Mr. J. Maswahu  
Principal



Appendix B7: Duinesig H.S principals' consent letter



# Duinesig High School

P.O. BOX 2911  
WALVIS BAY  
NAMIBIA  
TEL: 064 - 205311  
FAX: 064 - 205570

E-MAIL: [duinesig@mweb.com.na](mailto:duinesig@mweb.com.na) / [duinesighigh@gmail.com](mailto:duinesighigh@gmail.com)

02 December 2021

Mr. Johannes Neporo  
P.O. Box 8315  
Walvis Bay

Mr. Neporo

## PERMISSION TO CONDUCT ACADEMIC RESEARCH AT S.S DE DUINE

With reference to the letter by the Acting Inspector of Education of the Walvis Bay Circuit dated 30 November 2021, permission is hereby granted (to you, **Mr. Johannes Neporo**) to conduct research at this institution.

### *Permission is granted on condition that:*

- Research ethics are adhered to
- Participation by individual teachers/learners are voluntarily
- Disruption of curriculum delivery is avoided
- Once completed a copy of the thesis be deposited at the school library for references

We wish you all the best in conducting your research and look forward to the findings and possible recommendations of your research.

Kind regards,

Mr. SG Uri-Khob  
Principal



ERONGO REGIONAL COUNCIL  
DIRECTORATE OF EDUCATION, ARTS & CULTURE  
WALVIS BAY CIRCUIT

## Appendix C1: Letter to the executive directors of education

P.O. Box 8315  
Walvis Bay  
17 November 2021

The Executive Director  
Ministry of Education Arts and Culture  
Government Office park  
Private Bag 13186  
Windhoek

Dear Mrs. Steenkamp

**Re:** Request for permission to conduct educational research study at De duine S.S, Duinesig High School, Kuisebmond Secondary School and Tataleni Secondary School in Walvis Bay circuit within the Erongo region.

I am Johannes Neporo, a part-time master in science education student at Rhodes University with student number (19N9570) and a Physics and Chemistry grade 10-11 teacher at De duine S.S. I hereby humbly request from your highly esteemed office to grant me permission to conduct research studies at the schools mentioned above for a duration of three weeks during the period of (March 2022). All activities will be conducted during after school hours to avoid disrupting the normal school lessons.

The title of my study is *exploring working with grade 11 chemistry teachers in mobilizing the indigenous technology of making soap to mediate learning of saponification in organic chemistry*. The study is motivated and inspired by the fact that this topic saponification in organic chemistry is poorly performed by learners as reflected in the chemistry examiners reports of the past five years. My assumption is that this might be linked to the limited understanding and interpretation of its learning objectives and basic competencies from the side of the teachers. Another contributing factor might be due to the fact that teachers don't use learners' indigenous local knowledge.

The purpose and significance of this study is mainly to make science accessible and relevant to teachers by ensuring that they are able to integrate indigenous knowledge in their chemistry

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lessons. Notably with regards to the Covid-19 backdrop one method of reducing the spread of the virus is the regular washing of hands with soap for about 30 seconds. As a mitigation this study will look into a traditional way of making soap for those who can't afford the commercial ones in efforts to help reduce the spread of this deadly virus that has become a pandemic.

I will conduct this research study in three phases. The first phase will be the induction and orientation to the study. The second phase will be the practical workshop presentation on the making of soap by an expert community member. Lastly the third phase will be the designing of exemplar lesson plans and reflections. All ethical consideration as per the university's' protocols will be adhered to at all times, Looking forward to hear from your office with kind regards.

Yours Sincerely

J. Neporo

For more information contact me on:

(0814549451/ [johnneporo87@gmail.com](mailto:johnneporo87@gmail.com) or my supervisor +27788852143 / [k.ngcoza@ru.ac.za](mailto:k.ngcoza@ru.ac.za)) or alternatively ([ethicscommitee@ru.ac.za](mailto:ethicscommitee@ru.ac.za))

## Appendix C2: Letter to the Erongo regional director of education

The director of education

P/Bag 5024

Swakopmund

Dear sir / madam

Subject: Request for permission to conduct educational research study at De duine S.S, Duinesig, Kuisebmund Secondary School and Tataleni Secondary School in Walvis Bay circuit with in the Erongo region.

I am Johannes Neporo, a part- time master in science education student at Rhodes University with student number (19N9570) and a Physics and Chemistry grade 10-11 teacher at De duine S.S. I hereby humbly request from your highly esteemed office to grant me permission to conduct research studies at the schools mentioned above for a duration of three weeks during the period of (March 2022). All activities will be conducted after school hours to avoid disrupting the normal school lessons.

The title of my study is *exploring working with Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry*. The study is motivated and inspired by the fact that this topic saponification in organic chemistry is poorly performed by learners as reflected in the chemistry examiners reports of the past five years. My assumption is that this might be linked to the limited understanding and interpretation of its learning objectives and basic competencies from the side of the teachers. Another contributing factor might be due to the fact that teachers don't use learners' indigenous local knowledge. The purpose and significance of this study is mainly to make science accessible and relevant to teachers by ensuring that they are able to integrate indigenous knowledge in their chemistry lessons. Notably with regards to the Covid – 19 backdrop one method of reducing the spread of the virus is the regular washing of hands with soap for about 30 seconds. As a mitigation this study will look into a traditional way of making soap for those who can't afford the commercial ones in efforts to help reduce the spread of this deadly virus that has become a pandemic.

I will conduct this research study in three phases. The first phase will be the induction and orientation to the study. The second phase will be the practical workshop presentation on the making of soap by an expert community member. Lastly the third phase will be the designing of exemplar lesson plans and reflections. All ethical consideration as per the university's protocols will be adhered to at all times. Looking forward to hear from you through the completion of the reply slip below. I hereby grant permission to the researcher to conduct the educational research.

Name.....Signature.....Date.....

Yours Sincerely

J. Neporo (0814549451/ [johnneporo87@gmail.com](mailto:johnneporo87@gmail.com) or my supervisor +27788852143 / [k.ngcoza@ru.ac.za](mailto:k.ngcoza@ru.ac.za)) or alternatively ([ethicscommittee@ru.ac.za](mailto:ethicscommittee@ru.ac.za))

### Appendix C3: Letter to the Walvis Bay inspector of education

The inspector of education

Walvis Bay circuit office

Dear sir / madam

Subject: Request for permission to conduct educational research study at De duine S.S, Duinesig, Kuisebmond Secondary School and Tutaleni Secondary School in Walvis Bay circuit which are under your jurisdiction.

I am Johannes Neporo, a part- time master in science education student at Rhodes University with student number (19N9570) and a Physics and Chemistry grade 10-11 teacher at De duine S.S. I hereby humbly request from your highly esteemed office to grant me permission to conduct a research studies at the schools mentioned above for a duration of three weeks during the period of (March 2022). All activities will be conducted after school hours to avoid disrupting the normal school lessons.

The title of my study is *exploring working with Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry*. The study is motivated and inspired by the fact that this topic saponification in organic chemistry is poorly performed by learners as reflected in the chemistry examiners reports of the past five years. My assumption is that this might be linked to the limited understanding and interpretation of its learning objectives and basic competencies from the side of the teachers. Another contributing factor might be due to the fact that teachers don't use learners' indigenous local knowledge. The purpose and significance of this study is mainly to make science accessible and relevant to teachers by ensuring that they are able to integrate indigenous knowledge in their chemistry lessons. Notably with regards to the Covid – 19 backdrop one method of reducing the spread of the virus is the regular washing of hands with soap for about 30 seconds. As a mitigation this study will look into a traditional way of making soap for those who can't afford the commercial ones in efforts to help reduce the spread of this deadly virus that has become a pandemic.

I will conduct this research study in three phases. The first phase will be the induction and orientation to the study. The second phase will be the practical workshop presentation on the making of soap by an expert community member. Lastly the third phase will be the designing of exemplar lesson plans and reflections. All ethical consideration as per the university's protocols will be adhered to at all times. Looking forward to hear from you through the completion of the reply slip below.

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

Name.....Signature.....Date.....  
.....

Yours Sincerely

J.Neporo (0814549451/ [johnneporo87@gmail.com](mailto:johnneporo87@gmail.com) or my supervisor +27788852143 [k.ngcoza@ru.ac.za](mailto:k.ngcoza@ru.ac.za)) or alternatively ([ethicscommittee@ru.ac.za](mailto:ethicscommittee@ru.ac.za))

## Appendix C4: Letter to Various school principals' within Walvis Bay circuit

The principal of Deduine, Duinesig, K.S.S, Tataleni high schools

Dear sir / madam

Subject: Request for permission to conduct a science educational research study at De duine S.S, Duinesig, Kuisebmond Secondary School and Tataleni Secondary School with your chemistry teacher(s).

I am Johannes Neporo, a part- time master in science education student at Rhodes University with student number (19N9570) and a Physics and Chemistry grade 10-11 teacher at De duine S.S. I hereby humbly request from your highly esteemed office to grant me permission to conduct a research studies at your school for a duration of three weeks during the period of (March 2022). All activities will be conducted after school to avoid disrupting the normal school lessons.

The title of my study is *exploring working with Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry*. The study is motivated and inspired by the fact that this topic saponification in organic chemistry is poorly performed by learners as reflected in the chemistry examiners reports of the past five years. My assumption is that this might be linked to the limited understanding and interpretation of its learning objectives and basic competencies from the side of the teachers. Another contributing factor might be due to the fact that teachers don't use learners' indigenous local knowledge and they at times use the same teaching pedagogies.

The purpose and significance of this study is mainly to make science accessible and relevant to teachers by ensuring that they are able to integrate indigenous knowledge in their chemistry lessons. Notably with regards to the Covid-19 backdrop one method of reducing the spread of the virus is the regular washing of hands with soap for about 30 seconds. As a mitigation this study will look into a traditional way of making soap for those who can't afford the commercial ones in efforts to help reduce the spread of this deadly virus that has become a pandemic.

I will conduct this research study in three phases. The first phase will be the induction and orientation to the study. The second phase will be the practical workshop presentation on the making of soap by an expert community member. Lastly the third phase will be the designing of exemplar lesson plans and reflections. All ethical consideration as per the university's' protocols will be adhered to at all times. Looking forward to hear from you through the completion of the reply slip below. I hereby grant permission to the researcher to conduct the educational research.

Name.....Signature.....Date.....  
....

Yours Sincerely

J.Neporo (0814549451/ [johnneporo87@gmail.com](mailto:johnneporo87@gmail.com) or my supervisor +27788852143 [k.ngcoza@ru.ac.za](mailto:k.ngcoza@ru.ac.za)) or alternatively ([ethicscommittee@ru.ac.za](mailto:ethicscommittee@ru.ac.za))

## Appendix C5: Letter to Participating chemistry teachers

Dear Sir / Madam

Subject: Invitation to participate in a science educational research study.

I, Johannes Neporo of student no (19N9570) a part-time masters' in science education student at Rhodes University, South Africa and a Physics and Chemistry Grade 11 teacher at S.S de duine hereby humbly invite you to be a participant in my study for a duration of about three weeks in (March 2022).

My research is about exploring working with Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry. In this study you will be a co-researcher and your roles among others are: to share with me your attitudes and pedagogical insights on the use of indigenous knowledge in your science class, to partake in all data gathering methods, to visit expert community members who will show us how soap is made traditionally while you observe, take notes in your journal that I will provide and partake in discussions as to visualize and make sense of saponification. Lastly to reflect and partake in the design of exemplar lessons plans that integrates indigenous knowledge. This research study will not interfere with your normal teaching time as all activities will be done after school at a time convenient with your schedule.

Kindly note that your participation in this study is voluntary, you can withdraw at any time. Also be assured that your identity, views and opinions will be treated with the highest degree of confidentiality and anonymity. All data gathered will be captured with a video recorder and will be transcribed with your written consent and used only for the purpose of this study. If you are interested in being part of this enjoyable and educative experience please do not hesitate in completing the declaration reply slip below thanks.

Declaration by participant (chemistry teacher)

I agree to participate in the research and I understand that I am doing so voluntary and that I am at liberty to withdraw at any time without any fear of intimidation.

Name.....signature.....date.....cell  
no.....

Yours Sincerely

J.Neporo

For any queries contact:

(0814549451/ [johnneporo87@gmail.com](mailto:johnneporo87@gmail.com) or my supervisor at +27788852143 [k.ngcoza@ru.ac.za](mailto:k.ngcoza@ru.ac.za)) or alternatively (ethicscommittee@ru.ac.za)

## Appendix C6: Letter to critical friend

Dear sir / madam

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

I, Johannes Neporo of student no (19N9570) a part-time masters' in science education student at Rhodes University, South Africa and a Physics and Chemistry Grade 11 teacher at S.S de duine hereby humbly invite you to be a participant in my study as a critical friend for a duration of about three weeks in (March 2022).

My research is about exploring working with Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry. I am requesting you to be my co-researcher and assistant, your roles will be among others: to record all activities with a video recorder, to take pictures of all activities and to help me in collecting, transcribing and analysing data. Additionally I would need you to translate from Oshiwambo and Khoekoegowab into English during the two expert community members' presentations on soap making.

Kindly be informed that your participation in this study is voluntary and you're free to withdraw at any time as per your wish. Your identity, views and opinions will be treated with anonymity and confidentiality. All data collected will be used for academic purposes only. Should you need more information contact me on (0814549451/ [johnneporo87@gmail.com](mailto:johnneporo87@gmail.com) or my supervisor at +27788852143 [k.ngcoza@ru.ac.za](mailto:k.ngcoza@ru.ac.za)) or alternatively ([ethicscommitee@ru.ac.za](mailto:ethicscommitee@ru.ac.za)). Feel free to complete the declaration slip below if you wish to partake in this research journey with me, thanks.

Declaration by participant (critical friend)

I agree to participate in the research study and I understand that I am doing so voluntary and that I am at liberty to withdraw at any time without any fear of intimidation.

Name.....signature.....date.....cell  
no.....

Yours Sincerely

J.Neporo

## Appendix C7: Letter to expert community member

Dear Sir / Madam

Subject: Request to voluntarily present how soap is made traditionally to Grade 11 chemistry teachers.

I, Johannes Neporo of student no (19N9570) a part-time masters' in science education student at Rhodes University, South Africa and a Physics and Chemistry Grade 11 teacher at S.S de duine hereby humbly invite you to be a participant in my study as an expert community member for a duration of about three weeks in (March 2022).

The title of my study is *exploring working with Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry*. Since my research is about saponification (soap making) your role will be to prepare all the tools, materials and ingredients needed to make a traditional soap. Your other role is to practically demonstrate to us how soap is made using your indigenous knowledge and to answer questions from the chemistry teachers in the form a discussion.

Kindly be informed that you are voluntarily participating in this study as there will be no payment of any kind. Thus you're at liberty to withdraw from the study at any time if you wish. Be assured that I will ensure to it that your identity, views and opinion are confidential. Data to be collected will be used solely for academic purpose only and will not be shared to anyone without your consent. I will also ask for your permission to video tape all activities. The fund of knowledge and skills you are going to share with us will be used to design and develop exemplar lessons which teachers are going to use. If you are agreeing to come share your wisdom on soap making with us please complete the declaration below thanks.

Declaration by participant (expert community member)

I agree to participate in the research and I understand that I am doing so voluntarily and that I am at liberty to withdraw at any time without any fear of intimidation.

Name.....signature.....date.....cell  
no.....

Should you need more information contact me on (0814549451/ [johnneporo87@gmail.com](mailto:johnneporo87@gmail.com) or my supervisor at +27788852143 [k.ngcoza@ru.ac.za](mailto:k.ngcoza@ru.ac.za)) or alternatively ([ethicscommittee@ru.ac.za](mailto:ethicscommittee@ru.ac.za)).

Yours Sincerely

J. Neporo

## **Appendix C.7.1: Translated expert community members letter (Oshiwambo version)**

**Ko: Munekuto / Mugolikadi**

### **01 Sikukutu 2021**

Siparatjiangwa selirongo lyange: “ kupapara nokurugana novarongi wo Harade 11 ava rongo sirongwa soukonentu mokuvahameseramo, mokuruganesa yiruganesa nounongo wopampo mongendeseso zokurugana mfewa”

Ame Johannes Neporo, nomora zomurongwa (19N9570) nakulirongera sirongwa so pasiruwo so Masters mo ukonentu melirongi. Nimurongwa po Rhodes University, South Africa. Ntani hena nimurongi ngosirongwa soukonentu harade 11 posure za de duine S.S. Nelinunupiko Kwaku muhondira mukare muhameni melirongo laynaga ngomu divi gomomukunda. Sirugana esi Kwaku singungunyikira asi ngasi gusa ruveze rokusika koyivike yitatu mazuva (Nsinano 2022)

Siparatjiangwa selirongo lyange sokuhamena: kupapara nokurugana novarongwa wo harade 11 mosirongwa soukonentu mokuhameseramo yiruganeso yopampo mongendeseso zokurugana mfewa kuruganesa udivi, magano nounongo womudivi gomomukunda.

Kukwama elirongo lyange eli lyokuhamena (erugano mfewa) sitambo seni melirongo eli sokulikida mfewa omu ava zirugana kuruganesa unongo noukonentu wopampo. Nokulimbura mapuro govarongi / vamitilli wosirongwa soukonentu morupe ronzogera nokulipa magano.

Kareni munapukurukwa elihameseramo lyeni melirongo eli selizambo kwato mfuto. Yiyo nye yina karere asi muna manguruka pwankenye ruveze nsene kapi muna hara kulihameseramo hena melirongo eli kuhageka.

Yimo hena nahara kumupukurura asi magano nounongo noudivi owu muna kupanga tayikara ehoramo. Magano, unongo, noudivi nina kugwana kweni ngatu yiruganesa melirongo lyovarongwa tupu, nsene pwele anahepa magano geni ngani pitira mweni nsene mwagava

epulisiro ndi hawe. Simpe hena ngani pura epulisiro kweni nature nongendeseso nadi nye moteyipa zoyidiyo.

Magano, udivi nounongo geni ngatu ngaruganesa moku wizapo nosihonena sosirongwa esi ngava karuganesa varongi. Nsene muna yipanda moku wiza muya tupeko unongo weni. Nelinunupiko Kwaku muhundra muzwide etokoro lyokulihame seramo ngo (mudivi ngomomukunda).

Natambura kulihameseramo melirongo ntani nina yitambura nokuyizuvha asi sirugana esi selizambo ame hena nina manguruka pwakenye ruveze kuhageka nsene kapi nahara kutwikira kulihameseramo nahana utjirwe. Mauzera nkenye kuhamena makonakono aga, gwanekereni name kongodi ozo: 0814549451.

Edina.....Esayino.....Mazuva.....  
...Ngodi zokomawoko.....

Epakero mbili lyeni tani lipanda unene

Gweni

J.Neporo

## Appendix C.7.2: Translated expert community members letter (Khoekhoegowab version)

Kai!goa-esab/!ga-esas

Dana #hams: Elf //khau-!ga!ubis /ghoana //gha-//gha se gurus //a

Ti da gea Johannes Neporo,!noas 19N9570, Rhodes /ghabi //gau-!na!kheib ei Physics I tsi Chemistry era //gha-//ghasen ta. Gera //ghau du /ghu-hasib!na#gan sa u ha khae du a se,!naona wekegu //geiba.

Dana #gams ne //ghau #guis tis ge 11!ghubis Chemistry //ghau!na aona /oro //geib ei I ge see gere gurue /haub xa //gha-//gha sa. Sa du!erems ge se I nii ra guru-u he xuna ei-#humisa. Nau!erems ge //au sa se I mati ra kuru esa sa du #gans /ga, Chemistry //ghau-!na aan /ga.

Sa du ge ei-tsama go ma- amsen ne //gha-//gheis!na sa, ma-tare e damase. Sa du ge a #ei #uisen xa.sa du informoseib ge khoena mai-!ga e tide. Ne //ghou!nas ti #gans ge akademieb!garoma /ui ni sisen u e. Ne //gau-!nas sadu ra mas ge, #gams sara ma. Ma-amsen du ga-ra 0,!gaga ha declarationsa // gara!gao re. dan-gans

//hao //uis

Ne //gha-//gha #guis!na tage masens /ga go!na

/nesns.....//gara!gaos.....Tses.....  
.....

!gaos.....

J.Neporo

## Appendix D: Participants consent form



**RHODES UNIVERSITY**  
*Where leaders learn*

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### RESEARCH PARTICIPANT INFORMED CONSENT LETTER (PARTICIPANT)

**PROJECT TITLE:** Exploring working *with* Grade 11 chemistry teachers in mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry

Johannes Neporo (19N9570), currently a Master's student at Rhodes University, has requested my permission to participate in the abovementioned research project.

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

**I am therefore aware that:**

1. The purpose of this study is to explore working with four Grade 11 chemistry teachers to mobilise the indigenous technology of making soap to mediate learning of the topic saponification in organic chemistry. The main for this is with to make science accessible and relevant to teachers who are regarded as learners in this study.
2. The intervention for this study will be composed of about four two-hour long workshops and practical demonstrations by expert community members. During the workshops and practical demonstrations, data will be gathered

through; videotaping, participant observation, reflective journaling and document analysis. The workshops will be conducted at a place and time that is convenient to me and the other participants.

3. I will be interviewed individually and/or in a focus group interview format whereby all the COVID-19 protocols will be observed. Should the COVID-19 restrictions be in force, Google Meeting or Zoom or WhatsApp will be used with my permission. The interview will take approximately 30-45 minutes and will be audio recorded with my permission.
4. By participating in this research project, I will contribute to knowledge and understanding in the mediation of learning of the topic saponification in organic chemistry.
5. My participation is entirely voluntary and should I at any stage wish to withdraw from further participation, I may do so without any prejudice.
6. I understand that participating in this study is voluntary and that I will not be compensated for participating.
7. There may be risks associated with my participation in the project. I am therefore aware that of the following steps:
  - a) All information shared in the group is strictly confidential and will not be used for purpose other than of the above mentioned research project.
  - b) All the data collected will be kept in a locked cupboard and electronic data will be kept in a computer only accessible through a secure password.
  - c) The researcher intends to publish the research findings in the form of a thesis towards a Master's degree in Science Education, and later present it

in papers conferences or journal articles. However, confidentiality will be maintained.

8. Any further questions that I might have concerning the research or my participation will be answered by the Rhodes Master's student (johnneporo87@gmail.com) or the supervisor Professor Kenneth Mlungisi Ngcoza ([k.ngcoza@ru.ac.za](mailto:k.ngcoza@ru.ac.za)).
9. By signing this informed consent declaration, there are no legal implications.
10. A copy of this informed consent declaration will be kept in a safe place by the researcher.

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

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

.....

Participant's signature Witness

Date .....

Date .....

**Rhodes University, Research Office, Ethics**

Ethics Coordinator: [ethics-committee@ru.ac.za](mailto:ethics-committee@ru.ac.za)

T: +27 (0) 46 603 7335 F: +27 (0) 82 739 4378

Room 220, Main Admin Building, Drostdy Road, Makhanda, 6139

## Appendix E: Differences between IK and WS

**Table 2.1:** Showing difference between IK and WS adopted from Abah, Mashebe & Denuga, 2015, p. 672)

Aspect	IK	WS
1. View of knowledge	<p>Sacred, spiritual &amp; secular</p> <p>Holistic, integrated &amp; intuitive</p> <p>Stored orally</p> <p>Powerful, local, less valued</p> <p>Distantly</p>	<p>Secular excludes spirituality</p> <p>Scientific, analytical, reductionist</p> <p>Stored in books, library, computers</p> <p>Rational, valid, global</p> <p>Weak locally</p>
2. Objective	<p>Long term recall</p> <p>Cultural &amp; ecological</p> <p>Practical</p> <p>Involves critical thinking</p>	<p>Short term recall</p> <p>Economical</p> <p>Abstract</p> <p>Involves logic thinking</p>
3. Methods of teaching and learning	<p>Lengthy period of acquisition</p> <p>Learning through experience</p> <p>Teaching methods: examples, rituals, storytelling, modelling</p> <p>Tested in practical life situations</p>	<p>Rapid acquisition</p> <p>Learning by formal education</p> <p>Teaching methods: didactics</p> <p>Tested are artificial involving simulations</p>

## Appendix F: Semi-structured interview schedule

**Proposed research title:** Mobilising the indigenous technology of making soap to mediate learning of saponification in organic chemistry.

**Preamble:** Thank you very much sir/madam for making time from your busy schedule to answer my interview questions. The purpose of this interview is for us to discuss the integration of indigenous knowledge in science lessons. We will focus specifically on saponification in organic chemistry.

### Questions:

1. Could you please tell me how long you have been teaching chemistry in grade 11?
  - (i) What is your views about teaching chemistry in your grade 11 class?
  - (ii) Could you tell me what your experiences are of teaching the topic saponification in your grade 11 class?
  - (iii) What prior knowledge do you expect grade 11 learners to have about saponification?
  
2. What teaching strategy, style or approach do you use when teaching the topic saponification?
  - (i) How do you your learners to see whether they understand the topic of saponification?
  - (ii) Are the challenges or limitations when you teach saponification, if yes could you please elaborate what they are and how you manage them.
  
3. What do you understand by the term Indigenous Knowledge (IK)?
  - (i) Do you use IK in your class when teaching saponification, if yes could you please elaborate how?
  - (ii) From what culture / tribe are you from, do people make soap traditionally in your culture, if yes could you please share how they make soap.

## Appendix F1: Inductive-deductive analysis / thematic approach from collated semi-structured interviews (participants' responses)

Teacher code: T1-T4

**GREEN**: good understanding of question

**BLUE**: fair understanding of question

**RED**: poor understanding of question

### INDUCTIVE-DEDUCTIVE ANALYSIS/THEMATIC APPROACH

<p>1. What are Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of local or indigenous knowledge in their chemistry lessons?</p>	<p><b>T.1</b> Thank you very much sir, my view on that question is that it depends on the individual and there background which he came from and also how he grew up, those things are not taught in schools. So somehow they might lack the pedagogical insight on indigenous knowledge and how they can apply it in their chemistry lessons, but then teachers should try and educate themselves on how to apply and use local indigenous knowledge in their classes to make things better for learners to understand.</p> <p><b>T.2</b> The problem is that we want to incorporate it, however the problem is that we don't know the indigenous knowledge, we have limited understanding about IK.</p> <p><b>T.3</b> Helpful indeed in the sense that some of them are locally available and accessible to the learners and teachers in general.</p> <p><b>T.4</b> Not really because some of the materials we use are not scientifically proven and no accurate measurements.</p>
<p>2. Could you please tell me how long you have been</p>	<p><b>T 1:</b> For three years now sir.</p> <p><b>T 2:</b> Eight years now.</p>

teaching chemistry in grade 11?	<p><b>T 3:</b> Two good years.</p> <p><b>T 4:</b> Five years now.</p>
(i)What is your view(s) about teaching chemistry in your grade 11 class?	<p><b>T.1</b>Thank you once more sir, my view of teaching chemistry is that, the subject is quite interesting. However I see there is a gap of when the learners come from grade, I feel there is a very big gap that’s why for now it becomes challenging because so many new content are introduced in grade 10-11 so we need to fill in that gap.</p> <p><b>T.2</b>The thing is it a continuous as you know we started off from grade 10 already. So ya its fine we are doing well, the learners love it and they are always amused to find out and try new things.</p> <p><b>T.3</b>Chemistry in general has been part of our old curriculum physical science so, I personally don’t have a bad view about it. I have actually have a good view about.</p> <p><b>T.4</b>Interesting and enjoyable because we learn more ideas from different cultures,</p>
(ii) Could you tell me what your experiences are of teaching the topic saponification in your grade 11 class?	<p><b>T.1</b>My experience is that saponification is a quite challenging when we approach that topic. Like I said previously because of the gap between grade 10-11 and grade 9 in terms of the content and for saponification is abit challenging for this learners because of so many things that are missing.</p> <p><b>T.2</b>As I said before we started with this topic already in grade 10, under cleaning materials and it goes over to grade 11 where we just repeat what they have done already.</p> <p><b>T.3</b>Hum great experience in the sense that mostly I teach it through practical’s, where I make students prepare their own soaps using different flavours of their</p>

	<p>choice and what I provide for them is sodium hydroxide and potassium hydroxide which is the alkali which is not accessible to them.</p> <p><b>T 4:</b> Getting new ideas from different cultures.</p>
<p>(iii) What prior knowledge do you expect grade 11 learners to have about Saponification?</p>	<p><b>T.1</b> Prior knowledge such as base, alkali because these are things used in the process of saponification equation, they should know emulsification, chemical reactions done in previous grades.</p> <p><b>T.2</b> What they need to know is the reactions, what we need to put together and the types of reactions needed to make the soap.</p> <p><b>T.3</b> Students or grade 11's they need to know more about alkalis, bases or chemical reactions as well as cleaning materials, common or household cleaning materials and many more.</p> <p><b>T.4</b> Know how to make soap in their cultures using indigenous knowledge.</p>
<p>3. What teaching strategy, style or approach do you use when teaching the topic saponification?</p>	<p><b>T.1</b> So because saponification itself is a complex topic so, in my case I don't really use so many strategies because I teach based on the syllabus and we just need to know or learners to know the general reaction of saponification or how saponification occur, so materials are lacking.</p> <p><b>T.2</b> I use videos that are on saponification, actually the soap part I play this videos to them and then explain the components they need to know.</p> <p><b>T.3</b> As I mentioned earlier I use a practical based approach, accompanied by a little demonstration.</p> <p><b>T.4</b> Asking how do they call soap in their culture and ask them how old people use to clean their things.</p>

<p>(i) How do you assess your learners to see whether they understand the topic of saponification?</p>	<p><b>T.1</b> I assess them informally or formal assessment just by asking a few individual learners to give the general equation or reaction for saponification, or in the formal way in a test to write the products of the reaction, for example between ester and an alkali.</p> <p><b>T.2</b> Like I mentioned before I play a video and then it comes with questionnaires. They look at the video, they watch it and then answer the questions, after that I go into detail teaching and then give them a test.</p> <p><b>T.3</b> Upon preparing their soap, I will make them test the effectiveness of their cleaning materials which is the soap and by cleaning some of the oil stains on the floor. And to assess the I have to ask questions after the lesson or giving them a topic task.</p> <p><b>T.4</b> Asking learners to bring along indigenous materials to make soap as a practical activity.</p>
<p>(ii) Are there challenges or limitations when you teach saponification, if yes could you please elaborate what they are and how you manage them.</p>	<p><b>T.1</b> There are quite a lot of challenges and that challenges are again referring back to the gap that is created because saponification is supposed to be a topic on its own not really a sub-topic or in another topic and it's a topic that needs to be introduced in earlier classes where you start with basics of acids and bases in grade 9, than in grade 11 that is when now the mechanism of how the reaction occurs is taught because things like for example esterification which the foundation of products needed for saponification another thing is that learners don't know about substitution reactions that leads to neutrophils, so the main thing is to introduce saponification in grade 9.</p> <p><b>T.2</b> The main challenge is actually the chemical parts or components needed for the soap production. Since we don't have them we do the lesson theoretically, or else we have to try and bring in chemicals. Sometimes we cannot do the practical individually due to the large number of kids we rather seat in groups or I have to do it while they watch due to the scarcity of chemicals. The</p>

	<p>classroom set-up is not conducive, we don't have a lab we only have a class this are some of the challenges.</p> <p><b>T.3</b>Yes there is some difficulties, because sometimes it is very hard to persuade the students that soap can also be made using local available compartments for example fruits to increase the flavour or to change flavour or you can use animal fat, which you can get from a local butchery or any other locally available alkali.</p> <p><b>T.4</b>Yes, especially the time to allow the soap to get dry and materials are hard to find.</p>
<p>4. What do you understand by the term indigenous knowledge (IK)?</p>	<p><b>T.1</b>This is knowledge that is related or referred to as cultural traditions found in our local communities.</p> <p><b>T.2</b>My understanding of that is, IK is the local information, the practices that our ancestors used. Things older generations used to do and passed it on from one generation to another.</p> <p><b>T.3</b>IK or indigenous knowledge is the knowledge we acquire when interacting with the environment or surrounding or from local available learning source.</p> <p><b>T.4</b>The use of indigenous ideas to come up with something like soap in our case.</p>
<p>(i) Do you use IK in your class when teaching saponification, if yes could you please elaborate how?</p>	<p><b>T.1</b>Yes, we use or we try to borrow ideas from our local culture such as the use of plant leaves and some wood ash because normally when you combine them with water they can produce some soap that can make things clean that is how I try to make use of IK in the class.</p> <p><b>T.2</b>Okay, ya, I try as much as possible, because saponification is all about soap production so I tend to start off by asking the learners to mention the local things they use for cleaning purposes instead of using soap. They have to bring up the plants used by their elders and then we try and identify the chemical components in the plant needed to make soap.</p>

	<p><b>T.3</b>I am sorry I don't integrate IK in my lessons, I was not taught about it at university. But I am willing to learn.</p> <p><b>T.4</b>Yes, I usually tell my learners to go home and ask their parents and grandparents what they used to use to clean their bodies and clothes.</p>
<p>(ii) From what culture / tribe are you from, do people make soap traditionally in your culture, if yes could you please share how they make soap.</p>	<p><b>T.1</b>I am from the Ovambo culture, but then I cannot really fully explain how it happens, because we are not taught this things, we just see them doing this things. They take leaves put it in water than soak things in in for the whole night the next day it is clean.</p> <p><b>T.2</b>I am Ovambo, however I have not seen them make soap per se, but I can tell they use specific plants for cleaning, they would use leaves especially during rainy seasons.</p> <p><b>T.3</b>I am from Okavango tribe, I am not really sure of what they use traditionally, but I do believe they have a soap they know how to prepare.</p> <p><b>T.4</b> I am a Herero, a Himba to be specific, yes we use Otjive (reddish cream) to clean our bodies, it usually comes from oil obtained from milk.</p>

**Continuation with the formation of categories; sub-themes; themes; literature and theory**

Categories	Sub-themes	Themes	Literature & theory
<p><b>T.3</b>Hum great experience in the sense that mostly I teach it through practical's, where I make students prepare their own</p>	<p>-Teachers views of practical activities</p>	<p>-Teachers' attitudes and pedagogical insight on teaching saponification</p>	<p>-Vygotsky (1978); Shulman (1987); Nyambe (2008); Millar (2010); Ongunleye (2010) Nyambe</p>

<p>soaps using different flavours of their choice and what I provide for them is sodium hydroxide and potassium hydroxide which is the alkali which is not accessible to them.</p> <p><b>T.1</b>My experience is that saponification is a quite challenging when we approach that topic. Like I said previously because of the gap between grade 10-11 and grade 9 in terms of the content and for saponification is abit challenging for this learners because of so many things that are missing</p> <p><b>T.4</b>Yes, I send learners to go ask their parents how people used to clean their clothes or bodies in the past.<b>Getting new ideas from different cultures.</b></p>	<p>-Teachers attitudes on learner-centred education</p> <p>Importance of culture in teaching</p>		<p>&amp;Wilmot (2012); Mavhunga &amp; Rollnick (2013); Ajayi et al., (2018) Asheela et al., (2021); Shinana et al., (2021)</p>
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<p><b>T.1</b>This is knowledge that is related or referred to as cultural traditions found in our local communities.</p> <p><b>T.2</b>My understanding of that is, IK is the local information, the practices that our ancestors used. Things older generations used to do and passed it on from one generation to another.</p> <p><b>T.3</b>IK or indigenous knowledge, is the knowledge we acquire when interacting with the environment or surrounding or from local available learning source.</p> <p><b>T.4</b>The use of indigenous ideas to come up with something like soap in our case.</p>	<p>-Understanding the concept IK</p> <p>-IK as prior knowledge</p>	<p>-Chemistry teachers' understanding of IK</p>	<p>-Vygotsky (1978); Roschelle (1995); Hoppers (2005); Kibirige &amp; Van Rooyen (2006); Senanayekes (2006); Ogunniyi (2007a); Nyika (2017); Chilisa (2012)</p>

<p><b>T.1</b>Yes, we use or we try to borrow ideas from our local culture such as the use of plant leaves and some wood ash because normally when you combine them with water they can produce some soap that can make things clean that is how I try to make use of IK in the class.</p> <p><b>T.2</b>Okay, ya, I try as much as possible, because saponification is all about soap production so I tend to start off by asking the learners to mention the local things they use for cleaning purposes instead of using soap. They have to bring up the plants used by their elders and then we try and identify the chemical components in the plant needed to make soap.</p>	<p>-Teaching styles, methods &amp; approaches</p>	<p>-The integration of IK in chemistry lessons to mediate saponification</p>	<p>-Shulman (1987); Millar (2010); Arasaretnam &amp; Venujah (2019); Kowalski (2015); Onyegbado et al., (2002); Warra (2013); Aikenhead &amp; Jegede (1999); Govender (2014); NCBE (2016); Asheela at al., (2021); Mavhunga &amp; Rollnick (2013)</p>
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<p><b>T.3</b>I am sorry I don't integrate IK in my lessons, I was not taught about it at university. But I am willing to learn.</p> <p><b>T.4</b>Yes, I usually tell my learners to go home and ask their parents and grandparents what they used to use to clean their bodies and clothes.</p>			

## Appendix G: Semi-structured questionnaire schedule

### Questions:

1. Could you please tell me how long you have been teaching chemistry in grade 11?
  - (i) What is your views about teaching chemistry in your grade 11 class?
  - (ii) Could you tell me what your experiences are of teaching the topic saponification in your grade 11 class?
  - (iii) What prior knowledge do you expect grade 11 learners to have about saponification?
  
2. What teaching strategy, style or approach do you use when teaching the topic saponification?
  - (i) How do you assess your learners to see whether they understand the topic of saponification?
  - (ii) Are there challenges or limitations when you teach saponification, if yes could you please elaborate what they are and how you manage them.
  
3. What do you understand by the term Indigenous Knowledge (IK)?
  - (i) Do you use IK in your class when teaching saponification, if yes could you please elaborate how?
  - (ii) From what culture / tribe are you from, do people make soap traditionally in your culture, if yes could you please share how they make soap.

## Appendix G1: Inductive-deductive analysis / thematic approach from collated semi-structured questionnaires (participants' responses)

Teacher code: T1-T4

**GREEN**: Good understanding of question

**BLUE**: fair understanding of question

**RED**: poor understanding of question

### INDUCTIVE-DEDUCTIVE ANALYSIS/THEMATIC APPROACH

<p>1. What are Grade 11 chemistry teachers' attitudes and pedagogical insights on the use of local or indigenous knowledge in their chemistry lessons?</p>	<p><b>T.1</b> Positive attitudes because during teaching / lesson presentations, teachers can relate to the application that will assist the learners to grasp and understand the work better.</p> <p><b>T.2</b> Incorporating indigenous knowledge is a challenge because it entirely depends on how the teacher is exposed to local information, however it is always a good starting point when one is equipped with right information.</p> <p><b>T.3</b> This depends to individual teachers and where they come from and how they grow up. Knowledge on the use of local or indigenous knowledge may be lacking as most of these things are not taught in schools. So teachers should educate themselves on the use of local IK in their classes for better understanding of the learners.</p> <p><b>T.4</b> Their attitudes are positive because it's a way of exploring the society and help the locals acquire the knowledge.</p>
<p>2. Could you please tell me how long you have</p>	<p><b>T.1</b> Three years (physical science for 14 years)</p> <p><b>T.2</b> One year (physical science for 8 years)</p>

<p>been teaching chemistry in grade 11?</p>	<p><b>T.3</b> Two years</p> <p><b>T.4</b> Five years.</p>
<p>(i)What is your view(s) about teaching chemistry in your grade 11 class?</p>	<p><b>T.1</b> It is a good method to bring home science to class as it will help in merging theory to practice.</p> <p><b>T.2</b> Teaching it in grade 11 is but a continuation from grade 10, the learners love it and are always amused by new findings.</p> <p><b>T.3</b> My view about teaching chemistry is that the subject is very interesting in a sense that we get to learn new content to the learners, but it's quiet challenging to the learners because of the new content.</p> <p><b>T.4</b> It is a great opportunity.</p>
<p>(ii)Could you tell me what your experiences are of teaching the topic saponification in your grade 11 class?</p>	<p><b>T.1</b> Very interesting because learners can produce their own using fat and sodium hydroxide.</p> <p><b>T.2</b> I have been teaching this topic ever since in grade 10 under cleaning materials and the learners love it, intrigued to go practice it.</p> <p><b>T.3</b> Saponification is the hydrolysis of fats or oil using an alkali such as NaOH. This is done through a nucleophilic attack of a hydroxide in a C=C of the ester.</p> <p><b>T.4</b> This motivates me that teaching this topic, to make teaching effective, we must use local materials and should be learner-centred teaching methods.</p>
<p>(iii)What prior knowledge do you</p>	<p><b>T.1</b> Before I start teaching about saponification I normally ask them what they have learnt in grade 9 about chemical reactions,</p>

<p>expect grade 11 learners to have about Saponification?</p>	<p>acids and bases because this topics are the building blocks to understanding saponification</p> <p><b>T.2</b> They ought to know the types of reactions e.g. hydration reaction that is part of saponification.</p> <p><b>T.3</b> Emulsification from the biology class, base and alkalis from grade 9 and grade 10 class.</p> <p><b>T.4</b> I normally ask them how they make soap in their cultures using indigenous knowledge; this is how I check their prior knowledge.</p>
<p>3. What teaching strategy, style or approach do you use when teaching the topic saponification?</p>	<p><b>T.1</b> Relate to what learners already know, demonstrate let them watch a video that explains all the process involved in making the soap.</p> <p><b>T.2</b> First I introduce the topic by showing them a video on how soap is made. Then we identify and link the common names to scientific terms.</p> <p><b>T.3</b> Due to lack of content in the grade 11 learners, it is really hard to use as many teaching strategies or approach and there for, I give a general equation of how saponification occur. More details of saponification can be explained in grade 12, where learners have better understanding on esterification and nucleophilic reactions.</p> <p><b>T.4</b> Learner-centred teaching method, involve learners to carry out the practical activities themselves and monitor them.</p>

<p>(i)How do you assess your learners to see whether they understand the topic of saponification?</p>	<p><b>T.1</b> Set up quizzes, worksheets based on the topic covered</p> <p><b>T.2</b> Through written tests, dialogues where they tell you how soaps are made practically.</p> <p><b>T.3</b> Informal assessment on asking the general reaction of saponification. Formal assessment in a test to write down the products of the reaction between an ester and alkali.</p> <p><b>T.4</b> Giving them the test, after the topic is discussed.</p>
<p>(ii)Are there challenges or limitations when you teach saponification, if yes could you please elaborate what they are and how you manage them.</p>	<p><b>T.1</b> Yes the availability of materials is a challenge especially at schools in remote areas.</p> <p><b>T.2</b> I want to incorporate IK in my lessons but I don't how as me myself I was not taught about it at varsity, it is also not found in our syllabus and books, you see there are no examples for us to use.</p> <p><b>T.3</b> The classroom set-up is not conducive for practical's of this nature and we need a lab.</p> <p><b>T.4</b> Yes, cause of our school we don't have a laboratory to carry out the practicals, then you explain in more details to make them understand the molecules of soap.</p>
<p>4. What do you understand by the term indigenous knowledge (IK)?</p>	<p><b>T.1</b> Knowledge learnt from home, applying knowledge learnt from our parents and grandparents or even ancestors.</p> <p><b>T.2</b> Local knowledge that might not have been documented but passed on from generations through practices.</p> <p><b>T.3</b> Knowledge embedded in the cultural traditions of local communities.</p>

	<p><b>T.4</b> Refers to understanding and skills that developed by local communities with long history and experiences of interactions with their natural surroundings.</p>
<p>(i)Do you use IK in your class when teaching saponification, if yes could you please elaborate how?</p>	<p><b>T.1</b> Yes, because in the past people could use wood ash to wash instead of soap that will help the learners to understand the importance of making soap.</p> <p><b>T.2</b> Yes, for example use of plants leaves, herbs for instance and also ashes, these components can be added to any fat or oil material and the emulsification can occur.</p> <p><b>T.3</b> No I was not trained about the integration of IK in my class at the university.</p> <p><b>T.4</b> Yes, learners have to go ask their parents how people used to clean their clothes and bodies in the past.</p>
<p>(ii)From what culture / tribe are you from, do people make soap traditionally in your culture, if yes could you please share how they make soap.</p>	<p><b>T.1</b> Herero (Himba), yes we use Otjive to clean our bodies (Otjive is the oil coming from milk).</p> <p><b>T.2</b>Kavango, yes mix wood ash, water and some leaves but I am not very sure from there as to what they do.</p> <p><b>T.3</b> Oshiwambo, I really don't know maybe I can learn.</p> <p><b>T.4</b> Oshiwambo, I am not really sure what they use traditionally, but I believe they do.</p>

**Continuation with the formation of categories; sub-themes; themes; literature and theory**

Categories	Sub-themes	Themes	Literature & theory
<p><b>T.1</b> It is a good method to bring home science to class as it will help in merging theory to practice.</p>	<p>-Increased learner motivation and participation.</p> <p>-Comprehension of scientific concepts</p> <p>-Merger of theory and practice</p>	<p>-The benefits of integrating IK in science when teaching saponification</p>	<p>Vygotsky (1978); Aikenhead &amp; Jegede (1999); Kibirige &amp; Van Rooyen (2006); Mukwambo et al.,(2014); Naidoo &amp; Vithal (2014); Govender (2014); Mawere (2015); Sedlacek &amp; Sedova (2017); Seehawer &amp; Breidlid (2021)</p>
<p><b>T.1</b> Yes the availability of materials is a challenge especially at schools in remote areas.</p> <p><b>T.2</b> I want to incorporate IK in my lessons but I don't how as me myself I was not taught about it at</p>	<p>-Lack of pedagogical insights by teachers.</p> <p>-Lack of teaching materials / chemicals.</p> <p>-Lack of laboratory facilities.</p>	<p>-Challenges on the integration of IK in chemistry lessons on saponification</p>	<p>Kandjeo-Marenga (2011); NCBE (2016); Nikodemus (2017); Seehawer (2018a); Asheela et al., (2021)</p>

<p>varsity, it is also not found in our syllabus and books, you see there are no examples for us to use.</p> <p><b>T.3</b> The classroom set-up is not conducive for practical's of this nature and we need a lab.</p> <p><b>T.4</b> Yes, cause of our school we don't have a laboratory to carry out the practical's, then you explain in more details to make them understand the molecules of soap.</p>			
<p><b>T.1</b> Before I start teaching about saponification I normally as them what they have learnt in grade 9 about chemical reactions, acids and bases because this topics are the building blocks to</p>	<p>-Topics / concepts taught in previous grades</p> <p>- The use of learners IK on soap making as prior knowledge</p>	<p>-Teachers eliciting learners' prior knowledge about saponification</p>	<p>Aikenhead &amp; Jegede (1999); Taylor (1999); Roschelle (1995); Mavhunga &amp; Rollnick (2013) Abah et al. (2015); Mavuru &amp; Ramnarain (2020)</p>

<p>understanding saponification</p> <p><b>T.2</b> They ought to know the types of reactions e.g. hydration reaction that is part of saponification.</p> <p><b>T.3</b> Emulsification from the biology class, base and alkalis from grade 9 and grade 10 class.</p> <p><b>T.4</b> I normally ask them how they make soap in their cultures using indigenous knowledge, this is how I check their prior knowledge.</p>			
<p><b>T.1</b> Herero (Himba), yes we use Otjive to clean our bodies (Otjive is the oil coming from milk).</p> <p><b>T.2</b> Kavango, yes mix wood ash, water and some leaves but I am not very sure from</p>	<p>- Limited knowledge on soap making by teachers from different cultures</p>	<p>-Teachers cultural / traditional knowledge on soap making</p>	<p>Chauraya &amp; Brodie (2018); Ngcoza &amp; Southwood (2019); Mutanho (2021)</p>

<p>there as to what they do.</p> <p><b>T.3</b> Oshiwambo, I really don't know maybe I can learn.</p> <p><b>T.4</b> Oshiwambo, I am not really sure what they use traditionally.</p>			
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## **Appendix H: Workshop discussions schedule**

### **Workshop: OnSoap Production**

Questions:

1. What is your understanding of indigenous knowledge?
2. What is your view of indigenous knowledge integration in science lessons like saponification?
3. How did you understand IK before the presentation by the expert community member?
  - (i) How was your experience with the expert community member?
  - (ii) What did you learn new about IK after the presentation?
  - (iii) What did you enjoy or not during the presentation by the expert community member?
4. Do you consider IK important at schools, if yes please elaborate?
5. Any other contribution regarding the integration of IK in science lessons.

## Appendix I: Participatory observation schedule

Aspect	Remark / comment
<b>1. Organization</b>	
(a) Expert community member well prepared for presentation.	
(b) Expert community member has all necessary tools, materials and ingredients for soap making.	
<b>2. Methods</b>	
(a) Expert community member shows how to make soap efficiently and effectively.	
(b) Expert community member allows for interactions and questions from teachers.	
(c) Expert community member props and encourages teachers to ask questions.	
(d) Expert community member allows teachers to help out during the soap-making process.	
(e) Expert community member uses time effectively.	
<b>3. Language</b>	

(a) Expert community member and teachers uses English for communication.	
(b) Expert community member and teachers uses local indigenous language for communication.	
(c) Translating, code switching and bilingual is used.	
<b>4. Sense making / visualization</b>	
(a) Teachers everyday ways of reasoning is scientific.	
(b) Teachers constructs clear scientific explanations.	
(c) Teachers sense making / visualization of saponification is seen.	
(d) Teachers arguing and presentation of information.	
(e) Teachers interpretation of concepts and ideas.	
(f) Teachers exploring of ideas.	
<b>5. Engagement</b>	
(a) Teachers are all actively involved.	
(b) Teachers talk and act more than they sit and listen.	

<p>(c) Teachers share their own experiences about soap making.</p>	
<p>(d) Teachers actively, study, use the tools, materials and ingredients used in making soap.</p>	
<p>(e) Teachers communicate openly and shows genuine interest in the presentation / workshop.</p>	
<p>(f) Teachers are involve practically in the soap-making process.</p>	
<p>(g) Teachers talk to the expert community members and with other teachers.</p>	
<p>(h) Teachers make notes in their personal reflective journals.</p>	

## **Appendix J: Stimulated recall interviews schedule**

### **Questions**

1. How was the experience with the expert community member's presentation on soap making?
2. What do you think is indigenous knowledge?
3. Can knowledge from home or community be used at school, if yes how?
4. Do you consider traditional knowledge important, if yes please elaborate?
5. What were your thoughts before the presentation on soap making?
6. Are there any other contributions you would like to make?

## **Appendix K: Journal reflection schedule**

### **Questions**

1. What is your current views on indigenous knowledge?
2. What did you understand traditional knowledge to be before the soap-making process?
3. What did you enjoy (or not) during the presentation by expert community member?
4. What have you learnt (or not) from the expert community members presentations?
5. Do you think traditional knowledge is important at schools, if yes please elaborate?
6. Any other contributions.

**Appendix L:TSPCK translation device (Adapted from Mavhunga et al., 2016, pp. 312-313)**

COMPONENTS	DESCRIPTION	LP <sup>-</sup> (Weak)	LP <sup>-</sup> (Moderate)	LP <sup>+</sup> (Strong)	LP <sup>++</sup> (Very strong)
<b>Learner Prior Knowledge</b>	<p>Includes what was taught in the previous grade or lesson.</p> <p>Includes common learner misconceptions known in a topic.</p> <p>This also includes everyday knowledge from home and community</p>	No identification or no acknowledgment or no consideration of learners' prior knowledge or misconceptions; no attempt to address the learners' misconceptions.	Identifies prior knowledge or misconceptions; provides standardized definition as a means to counteract the misconception; no evidence of drawing on other TSPCK.	Identifies prior knowledge or misconceptions; provides standardized knowledge as definition; expands and re-phrases explanations using one other component of TSPCK interactively.	Identifies prior knowledge or misconceptions; provides standardized knowledge as definition; expands and re-phrases explanation correctly; confronts misconceptions or confirms accurate understanding drawing on two or more other components of TSPCK interactively.
<b>Comments:</b>					
		CS <sup>-</sup> (Weak)	CS <sup>-</sup> (Moderate)	CS <sup>+</sup> (Strong)	CS <sup>++</sup> (Very strong)
<b>Curriculum Saliency</b>	Refers to the identification of the most important meaning of major concepts of a topic, without which understanding of the topic would be difficult for learners. It also includes the knowledge to logically sequence the	Identified concepts are a mix of Big ideas and subordinate ideas; identified pre-concepts are far from topic; sequencing no value due to mixed concepts; reasons given are generic benefit of education.	Identifies at least 3 Big ideas; not all 3 Big ideas and subordinate ideas identified; identified pre-concepts are far from the current topic; suggested sequencing has one or two illogical placing of Big ideas;	Identifies at least 3 Big ideas; subordinate concepts correctly identified for all Big ideas; identifies pre-concepts relevant to the topic; provides logical sequence; reasons given for importance of the topic include reference to conceptual scaffolding/sequential development draws on other TSPCK components, e.g.,	Identifies at least 3 Big ideas; subordinate concepts correctly identified for all Big ideas with explanatory notes; identifies pre-concepts relevant to the topic and explanatory notes given; provides logical sequence of all Big ideas and with logical reasons; reasons given for importance of the topic include

	learning and knowledge of pre-concepts needed prior to teaching a topic		reasons exclude conceptual considerations and show no evidence of drawing on other TSPCK components.	what makes topic difficult.	reference to conceptual scaffolding/sequential development draws on other TSPCK components, e.g., what makes topic difficult.
<b>Comments:</b>					
		<b>WDU<sup>-</sup> (Weak)</b>	<b>WDU<sup>-</sup> (Moderate)</b>	<b>WDU<sup>+</sup> (Strong)</b>	<b>WDU<sup>++</sup> (Very strong)</b>
<b>What is Difficult to Understand (WDU)</b>	Refers to gatekeeping concepts which are difficult to understand often because they cause conflict with previously established understanding	Identifies broad topics without reason and specifying the actual subordinate sub-concepts that are problematic	Identifies specific concepts but provides broad generic reasons such as abstract concepts.	Identifies specific concepts leading to learner difficulty; reasons given relate to one other TSPCK component.	Identifies specific concepts with reasons linking to specific gate keeping concepts and to TSPCK components such as prior knowledge and aspects of curricular saliency.
<b>Comments:</b>					
		<b>RP<sup>-</sup> (Weak)</b>	<b>RP<sup>-</sup> (Moderate)</b>	<b>RP<sup>+</sup> (Strong)</b>	<b>RP<sup>++</sup> (Very strong)</b>
<b>Representations (RP)</b>	Refers to a combination of representations at macro, symbol and sub-microscopic levels that may be employed to support an explanation	Limited to use of only macroscopic representation (analogies, demos etc.) with no explanation of specific links to the concepts represented	Use of macroscopic representation (analogies, demos etc.) and use of scientific symbolic representation without explanatory notes to make the links to the aspects of the concept	Use of macroscopic representation (analogies, demos etc.) and use of scientific symbolic representation with explanatory notes linking the two representations to the aspect(s) of the concept being explained; use of above combination of representations with reference to one other TSPCK components,	Use of macroscopic or symbolic representation with sub-microscopic representation to enforce a specific aspect; Explicit link with other components of TSPCK, e.g., emphasis on core aspect of content knowledge demonstrated in the representations and

			being explained.	e.g., prior knowledge.	learner prior knowledge.
<b>Comments:</b>					
		<b>CST<sup>-</sup> (Weak)</b>	<b>CST<sup>-</sup> (Moderate)</b>	<b>CST<sup>+</sup> (Strong)</b>	<b>CST<sup>++</sup> (Very strong)</b>
<b>Conceptual Teaching Strategies</b>	Refers to teaching strategies derived from the considerations made from the other four components and excludes general teaching methodologies	No evidence of acknowledgment of learner prior knowledge and misconceptions; lacks aspects of curriculum saliency; use of representations limited to macroscopic or symbolic scientific symbolic representation.	Acknowledges learner misconceptions verbally with no corresponding confrontation strategy; lacks aspects of curriculum saliency; use of macroscopic or symbolic representation with no linking explanatory notes.	Considers confirmation/confrontation of learner prior knowledge and/or misconceptions; considers at least one aspect related to curriculum saliency, e.g., sequencing or what not to discuss yet or emphasis of important aspects; uses at least two different levels of representation to enable understanding.	Considers learner prior knowledge and evidence of confrontation of misconceptions; considers at least two aspect related to curriculum saliency, e.g., sequencing or what not to discuss yet or emphasis of important aspects; uses either the macroscopic or symbolic representation with sub-microscopic representation to enable understanding.
<b>Comments:</b>					

**Appendix M: Analytical framework (adapted from Atallah et al., 2010, p. 48)**

<b>Conceptions</b>	
C1	Describing what is the purpose of learning science.
C2	Describing what they believe is required to teach science.
C3	Describing the perceived value of integrating indigenous knowledge when teaching science.
C4	Describing what they believe indicates that they learnt science during the presentation by the expert community member on indigenous knowledge and traditional practice of making soap.
<b>Dispositions</b>	
D1	Describing their ability in teaching science during the integration of indigenous knowledge when teaching the concept of saponification.
D2	Describing their attitudes towards learning / teaching science during the presentation by the community members on indigenous knowledge and traditional practice of making soap.
D3	Describing the learning / teaching approaches during the integration of indigenous knowledge when teaching the concept of saponification.
D4	Describing their perceived value and evidence of teaching science during the integration of indigenous knowledge when teaching the concept of saponification.

## Appendix N: Research processes / phases (stages)

Phase / stage	Method of data collection	Purpose	Research question to be addressed
1	Semi-structured interviews	To find out teachers attitudes and pedagogical insights on the use of IK in their science lessons when teaching saponification.	1
1	Semi-structured questionnaires	To find out teachers attitudes and pedagogical insights on the use of IK in their science lessons when teaching saponification.	1
2	Workshop discussions	To see whether the teachers have learnt or not, interacted and participated during the presentation by the expert community member.	2
2	Participatory observation	To see how teachers interact, participate during the soap-making process.	2
3	Stimulated recall interviews	To examine teachers thoughts, decisions and actions. To develop concept maps and co-develop an exemplar lesson plan.	3
3	Journal reflections	To see whether there are changes or shifts in teachers ZPD and to reflect on the entire research process. Ultimately develop concept map and exemplar lesson plan.	3

## Appendix O: Proposed time frame

Date	Targeted activity
January - October 2021	Research proposal.
November 2021	Submission of research proposal to the education high degree committee for ethical clearance.
November 2021	Writing of chapter 1-4 & Designing of data gathering tools.
December 2022	Piloting of data gathering tools.
December 2021	Data gathering.
January 2022	Data analysis.
February 2022	Discussion of findings.
March 2022	Write up of all chapters & submission of first draft.
April 2022	Correction, editing & submission of second draft.
May 2022	Proof reading and editing of write up thesis.
June 2022	Submission of final thesis for examination.

**Appendix P: The exemplar lesson plan on saponification that integrates indigenous knowledge of soap making.**

<b>SUBJECT:</b> <i>Chemistry</i> <b>GRADE:</b> <i>11</i> <b>DATE:</b> <i>01/12/2021</i> <b>DURATION:</b> <i>45 min -1 hour</i>
<b>THEME:</b> <i>Organic Chemistry</i> <b>TOPIC:</b> <i>Saponification</i>
<b>TEACHING RESOURCES &amp; MEDIA :</b> <i>Marula oil, wood ash water, salt, traditional pot, spoon, bowl, fire</i>
<b>LEARNING OBJECTIVE OF THE LESSON:</b> Learner will:
<i>Understand the structure, properties and formation of soaps and detergents</i>
<b>BASIC COMPETENCIES:</b> Learners should be able to:
<i>Outline the preparation of soap through hydrolysis of oil or fat</i>
<b>INDIGENOUS KNOWLEDGE TO BE INTEGRATED</b>
<i>How to make soap using Marula oil, wood ash water and salt</i>

**PRESENTATION OF THE LESSON:**

- 1. Monitoring of homework done:** *New lesson on IK*
- 2. An appropriate short introduction:** *Ask learners how soap is called in their different languages*
- 3. Presentation of subject content and learning tasks**
  - 3.1 Teacher activities**
    - \* *Asks learners to identify teaching resources / utensils brought to class*
    - \* *Theoretically explain the concept of saponification*
    - \* *Practically demonstrates how soap is made using indigenous knowledge (ingredients & utensils) with learners' assistance.*
  - 3.2 Learner activities**
    - \* *Identifies the utensils*
    - \* *Listens attentively to the explanations*
    - \* *Partakes in the practical demonstrations on soap making using IK*
- 4. Conclusion:** *Recaps and summarises lesson on soap making using IK*

**ASSESSMENT/HOMEWORK/ TASK GIVEN TO LEARNERS**

**Assessment** = *Oral questions on the IK of making soap*

**Homework**= *Asks learners to go home and ask their parents how soap is made in their cultures / traditions*

**Task**= *Group learners and give them a project on how to make their own soaps*

**OPPORTUNITIESTO DEVELOP LEARNER’S ENGLISH READING AND WRITING SKILLS IN THE SUBJECT**

**Reading:** *Books, articles and publications on soap made using IK*

**Writing:***Notes from the chalkboard and how soap is written in their languages*

**Lesson reflections:** *teacher asks learners to write in their journals or books what they have learnt or not about saponification (soap making) using indigenous knowledge*

## Appendix Q: Chemistry content associated with Saponification, as defined by the curriculum expectations. (Source, Ajayi et al., 2018).

**TOPIC 3**

### Cleaning materials

General objectives	Specific objectives
Understand how the properties of soaps and detergents are related to their generalised structures and understand their impact on the environment	<ul style="list-style-type: none"><li>• outline and sketch the generalised structure of a soap or detergent</li><li>• explain how the structure allows the soap or detergent to act as an emulsifying agent</li><li>• identify common cleaning materials such as soaps or detergents</li><li>• outline the preparation of soap through hydrolysis of fat or oil</li><li>• interpret the meanings of the terms biodegradable and non-biodegradable in relation to the impact on the environment</li><li>• outline the advantages and disadvantages of the use of soaps and detergents</li></ul>

### The chemistry of soaps and detergents

The regular soaps that we use at home are sodium salts of fatty acids. They are produced by boiling a fat or oil in an alkali, such as sodium hydroxide, according to this word equation:

**Key word**

**saponification:** the reaction of a fat and an alkali to produce a soap plus glycerol

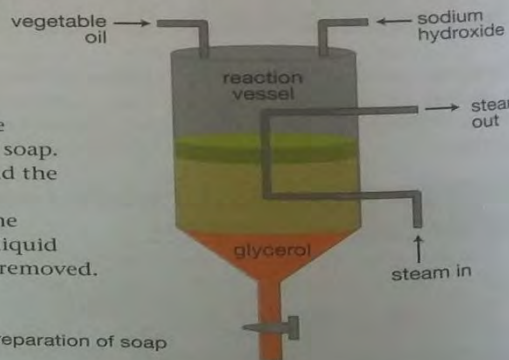
$\text{fat} + \text{alkali} \rightarrow \text{soap} + \text{glycerol}$

As you can see, the reaction also produces glycerol – a clear, sweet-tasting liquid that has a range of uses in the food and pharmaceutical industries. The process described by the word equation above is called **saponification**.

While soap is made from natural substances, detergents are synthetically produced. In other words, detergents are synthetic cleaning products that are made from a combination of petroleum products, alcohol and foaming agents, not fats and alkalis.

### How soap is made

Figure 3.8 shows a schematic diagram of the industrial preparation of soap. Both the vegetable oil and the sodium hydroxide are continuously added to the reaction vessel, and the liquid product is continuously removed.



**Figure 3.8** The industrial preparation of soap

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