GRADE 10 LIFE SCIENCES LEARNERS' VIEWS ON THE INTEGRATION OF INDIGENOUS KNOWLEDGE- RELATED TOPICS USING A COOPERATIVE LEARNING APPROACH

By

SEFOKA THABELANG SEGOPOTSE

DISSERTATION

Submitted in the fulfilment of the requirements for the degree of

MASTER OF EDUCATION

In

SCIENCE EDUCATION

(LIFE SCIENCES)

In the

FACULTY OF HUMANITIES

School of education

At the

UNIVERSITY OF LIMPOPO

SUPERVISOR: Dr Chuene K.J.

2024

DECLARATION

I declare that the dissertation hereby submitted to the University of Limpopo, for the degree of Master of education has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

Surname, Initials: Sefoka T. S Date: July 2024

DEDICATION

This dissertation is dedicated to the following beloved individuals who have meant and still mean so much to me: Firstly, Sefoka Mokganyetsi, my late maternal grandmother, raised me from a tender age and sent me to the university. You provided me with the basis for something you never had. Your unending love was for me. Thank you so much for everything; you will always be in my memory.

Secondly, my mother, Sefoka Makgwakgwane Margaret, your passion for education have inspired me to pursue knowledge. You instilled in me the values of responsibility, self-belief, determination, and perseverance. I sincerely appreciate the sacrifices you and my grandma made so I could acquire a better education and develop into a better person. I am grateful for all of your unwavering prayers, love, support, and encouragement throughout my life and academic pursuits. Without you, I would not have progressed as far as I have. Thank you, mama. I love you.

Thirdly, my three younger brothers, Sefoka Director, Sefoka Nevans, and Sefoka Enjoy, have been my greatest cheerleaders. I appreciate your understanding that I could not be with you as much due to my academic work. This is for us, and hopefully Sesi has made you proud. Much love, brothers.

Lastly, for my two adorable sons, Sefoka Bejoy and Sefoka Ditshegofatso, I apologise for my temporary absence due to my academic pursuits. But finally, mommy has made it. Your charming smiles, even though they were far away, made my long days worthwhile. You are the reason for everything I do. You are loved.

ACKNOWLEDGEMENT

First and foremost, I am grateful to God, the Almighty Man. I give you thanks for giving me life, as well as the courage, strength, and wisdom to begin and complete this journey.

I express my gratitude to Mr. K.J. Chuene, my supervisor, for all of your academic guidance for the success of this study. Since the beginning of my first postgraduate journey, you have been there. I was inspired to enjoy education and to be committed to my work by your expert leadership, tenacity, and determination. In addition to imparting knowledge, your commitment has given me a strong drive to continue learning and developing. The restless days you have spent waiting for my work and our academic discussions are well recognised. Through you, I have realised my potential. May God bless you and your family plentifully.

My academic brother, my masters buddy, Teffo Victor, I appreciate your help and listening to my academic issues. Together, we have been through, and together, we have won.

From my undergraduate years until the present, my friend Selepe Mmakgabo Angelina has been my study partner. I appreciate all of your help with my academic endeavours and, above all, your kind words of encouragement.

I am grateful for Nkosi Kgomotso, my source of endless laughter. The good times and bad have been made bearable by your friendship. I appreciate you sticking by me and going on this life journey with me.

Mlondolosi Matimba, thank you very much. I was motivated to work even harder by your words of encouragement and support.

To the Limpopo Department of Education, my principal, and my beautiful learners, thank you for granting me an opportunity to learn from you. I further extend my gratitude to the Limpopo Department of Education for the bursary.

To my colleagues, relatives, and friends that I have not mentioned by name, I appreciate your support.

LIST OF ABREVIATIONS

CAPS	Curriculum and Assessment Policy Statement
DBE	Department Of Basic Education
DOE	Department Of Education
IK	Indigenous knowledge
IPUF	Indigenous Plant Use Forum
LDoE	Limpopo Department of Education
LFSC	Life Sciences
NCS	National Curriculum Statement
NOIK	Nature of Indigenous Knowledge
NOS	Nature of Science
TREC	Turfloop Research Ethics Committee
UNESCO	United Nations Educational Scientific and Cultural Organization
WS	Western Science
ZPD	Zone of proximal development

ABSTRACT

The focus of this study was to explore Grade 10 Life Sciences learners' views on the integration of indigenous knowledge-related topics using a cooperative learning approach. The study was underpinned by social constructivism theory, whereby a qualitative single-case study design was used. Eight Grade 10 Life Sciences learners from a school in Moroke Circuit, Sekhukhune East District, Limpopo Province, participated in the study. Document reviews, observations (participation observer), and focus group interviews were used to collect data. Additionally, data was analysed using categorical aggregation, and an inductive approach was also used.

The findings of this study revealed that the adapted teaching methods under the cooperative learning approach, the jigsaw and De Bono's thinking hats, are efficacious in integrating indigenous knowledge (IK) in the Life Sciences (LFSC) classroom. These methods enabled learners to engage in constructive dialogues that required each of them to bring out and relate to their IK related to the LFSC topics. This has caused the IK that is held by each individual to be easily accessible and used in the classroom. As such, the IK that has emanated from the learning groups has allowed the teacher and the learners to learn and acquire important knowledge from each other. Additionally, these learning methods have developed and enhanced important 21st century skills in the learners, which include critical thinking, social, and interpersonal skills.

The findings further revealed that the integration of IK in LFSC classrooms improved participation, learning, and comprehension of LFSC topics. IK served as the prior knowledge through which teaching and learning were based and enabled the use of vernacular language. It also allowed learners to see the relationship between LFSC topics and their IK, resulting in more meaningful and enhanced learning. Hence, they advocate for learning all their school subjects this way. Furthermore, it allowed the teacher to draw out important IK from the learners that can be used in the LFSC classroom, such as indigenous medicines, nutrition, traditional technology, and skills.

Interestingly, this study has revealed that when learners are given space and a voice, they are able to express critical, confident, and independent views from which

teachers can draw a lot. Therefore, the study recommended that teachers create learning contexts that allow learners to talk about their IK. Hence, a cooperative learning approach is recommended for such a space.

Key words: *Indigenous knowledge, cooperative learning, life sciences, and social constructivism*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: OVERVIEW OF THE STUDY

1.1 Background and motivation

The lack of clarity from Curriculum and Assessment Policy Statement (CAPS) on how Indigenous Knowledge (IK) (Department of Basic Education [DBE], 2011) should be integrated in Grade 10 Life Sciences (LFSC) classroom is an impediment to native learners. This is due to them receiving western inclined learning that provides little to no room for the presentation of context that the learners are familiar with and are able to express their views (Cronje et al., 2015). The need for learners to have a familiar context that allows them to express their views within the midst of IK that is integrated during their learning stems from the notion that: IK is viewed as the knowledge that local communities have accumulated through daily observations, experimentation, and interactions with their surroundings (Rankoana, 2017). It is passed down orally from generation to generation and is specific to each culture (Senanayake, 2006). According to Zidny and Eilks (2018), this type of knowledge is critical for the local people's livelihood and survival. Therefore, learners, as members of their communities, carry this knowledge to their LFSC classrooms (Mawere, 2015).

The LFSC studies living organisms and their interactions with one another and their environment. Learners are expected to learn about and bring forth their IK during teaching and learning of this subject as emphasised in LFSC CAPS document (DBE, 2011). According to Barnhardt (2014), integration of IK in the classroom means linking learners to what they learn in school and their daily lives. Shava (2013) sees it as enhancing practical and relevant learning by allowing blended learning situations that respect and support both indigenous and western knowledge (Ronoh, 2017). As defined by Handayani et al. (2018), views are the built understandings and interpretations that an individual holds about the nature of knowledge in a discipline. In light of this, learners' views in this study pertain to how learners perceive and interpret their experiences in the learning process, which is vital in shaping their learning experiences and outcomes in IK integrated lessons.

Subsequently, being aware of learners' views about IK from their points of views will allow teachers to gain a better understanding of the learners they serve and provide

them with learning opportunities that represent and validate their lived experiences (Ngcoza, 2018). For instance, Knapp (2014) adds that teachers could use realised learners' IK in the process of elaboration to stimulate active participation and learning. As a result, classroom evaluations will transition from being based on the teacher to being learner-centred (Jacobs, 2015). Rahmawati and Ridwan (2017) conducted a study to empower learners' learning and help them connect with their IK by integrating ethno-chemistry into their chemistry classes. Learners were asked to express their views on the endeavour, and they stated that the provided learning opportunities allowed them to indulge in critical self-awareness of their cultural identity and character development within meaningful learning experiences that are relevant to their current curriculum. This agrees with the contention that learning becomes more interesting and relevant if learners can relate what is being taught to their daily life experiences (Hammond et al., 2019).

Fakoyede and Otulaja (2019) integrated IK in the LFSC classroom through the use of beads and beadwork to mediate the learning of organic compounds, notably carbohydrates, lipids, and proteins. The views and expressions of learners when interacting with cultural artefacts during the lesson were explored. They discovered that the endeavour in the classroom brought science closer to the learners' context, thus allowing for greater familiarity with concrete or abstract science concepts. The authors further highlight that learners' cultural, social, and symbolic capitals supported learning and led to enhanced comprehension of the concepts.

Drawing from the results of the aforementioned studies, it is crucial to gain access to learners' views in order to draw on their existing knowledge and worldviews, which can then be used as the foundation for strong teaching points to help learners realise the connection of science to their lives (Pretorius et al., 2014). Furthermore, this exercise of integrating learners' IK in the classrooms is said to enhance the learning of the subject and enable learners to see the relationship between the subject and society (Abah et al., 2015; DBE, 2011). As such, items of IK that can be integrated into the Grade 10 LFSC curriculum include traditional technology and skills, traditional medicines and healers, medical biotechnology, and cloning of plant and animal tissues (DBE, 2011). As well as agricultural and environmental aspects, food

production, indigenous and endemic species, and sustainable use of the environment and natural resources (Ronoh, 2017).

Khupe's (2014) study indicated that integrating IK in science classrooms shows respect for and acknowledgement of the diversity of learners' identities and modes of knowing. Furthermore, Ronoh (2017) argues that exposure to other worldviews encourages learners to value and be open-minded to all forms of knowledge systems. Thus, LFSC learners will experience the content as authentic and relevant, which will then pique their interest in the subject and motivate learning (De Beer & Petersen, 2019). As a result, learners' perceptions of science as difficult and irrelevant will change due to the relatability of the content to the context (De Beer et al., 2014).

However, integrating and using IK in LFSC classrooms is not an easy task because it is unclear which method of instruction may be used, especially since learners and teachers have different IK that is not easily accessible (Diwu & Ogunniyi, 2011; Mothwa, 2011). As such, Jacobs et al. (2016) advised that pedagogies that promote cooperative learning should be used to enhance the integration of IK in LFSC classrooms. Cooperative learning approach is a teaching strategy that encourages the use of teaching methods that promote active learning that is centred on small groups where ideas and views are exchanged and debated (Johnson & Johnson, 2014). According to Johnson and Johnson (2014), face-to-face connection, self- and group reflection, constructive interdependence, individual accountability, and the development of interpersonal and social skills are all present in groups. These characteristics are important for IK because they are mostly conveyed orally and include social engagement and learning. In agreement, Jautse et al. (2016) alluded to the fact that cooperative learning prevails in IK settings.

In addition, Petersen et al. (2019) firmly maintain that the cooperative learning approach, as one of the engaging pedagogies, is an ideal way to aid the integration of IK in science classrooms. Furthermore, Bayati (2015), suggested that such pedagogies encourage learners to reflect on their experiences, think beyond their classrooms, and explore further applications of their learning. Hence, a study on using cooperative learning to enhance learners' understanding of the topic of solar

systems by Mak-Mensah et al. (2018) found that, among other things, through cooperative learning, learners were motivated to verbally share their views in small groups, which played a role in improving their understanding of the solar systems. Lastly, another study on cooperative learning in science by Thurston et al. (2010) found that cooperative learning provided cognitive, affective, and social gains amongst the learners. It is therefore against this background and motivation that this study sought to explore Grade 10 LFSC learners' views on the integration of IK-related topics using a cooperative learning approach.

1.2 Problem statement

The DBE expects LFSC learners to learn about and bring forth their IK during learning of this subject, as highlighted by specific aim 3 in the CAPS document (DBE, 2011). Despite the need for the presence of IK in LFSC classrooms to be publicised, the reality is that the exercise is not fully completed since it’s unclear which teaching method may be suitable (Diwu & Ogunniyi, 2011; Mothwa, 2011). Therefore, this leads to justice not being done to LFSC learners and their IK, as it tends to be overlooked and treated as an add-on (Cronje et al., 2015). Some teachers in Mavuru and Makhunga's (2020) study raised concerns and questioned the source of relevant IK for integration in LFSC classrooms. They are of the view that integrating IK in the classroom creates confusion, and therefore LFSC should only be taught as factual knowledge that is absolute. As a result, it is clear that learners are deprived of the opportunities to express their views by tapping into their IK, as such tend to perceive LFSC in only one world view: western (De Beer, 2019).

In response to the above problem, i adopted a cooperative learning approach. This learning approach consists of different teaching methods that allow learners to learn from each other in groups as they share and discuss their views (Johnson & Johnson, 2014). Jacobs et al. (2019) investigated teachers' abilities to integrate IK in LFSC using cooperative learning approaches, wherein teachers took part in classes that included IK and cooperative learning such as Jigsaw and De Bono’s thinking hats. Among the findings, it was found that these teaching methods make IK more accessible to each individual and have the ability to improve participation and comprehension of the subject matter as a result of group talks (Jacobs, 2015).

Even though the aforementioned study was undertaken outside Sekhukhune District, Moroke Circuit, and used teachers rather than learners, i believed that the technique could be useful in this study because the cooperative learning approach could elicit unique IK and enable knowledge access to different groups. As a result, exploring Grade 10 LFSC learners' views on the integration of IK-related topics within cooperative learning environments was relevant. As noted, both the literature (De Beer, 2019; Reddy, 2019; Seehawer, 2018) and the CAPS document (DBE, 2011) are implicit about embracing IK but not explicit in terms of methods to use (Diwu & Ogunniyi, 2011; Kruger & De Beer, 2019; Mothwa, 2011). Therefore, by exploring learners' views in this study, I will ascertain whether cooperative learning approaches can offer a learning space where learners can express their views by tapping into their IK and reflect on their experiences in a LFSC classroom.

1.3 Purpose of the study and research questions

1.3.1 Purpose of the study

The purpose of this study was to explore Grade 10 LFSC learners' views on the integration of IK-related topics using a cooperative learning approach. This study was guided by the following research questions:

1.3.2 Research questions

Main research question

- What are Grade 10 LFSC learners' views on the integration of IK-related topics?

Secondary research question

- How does the cooperative learning approach influence the integration of IK in the Grade 10 LFSC classroom?
- How relevant is the IK held by learners that can be integrated into LFSC?

1.4 Research methodology

Research methodology is viewed as a structured way of addressing the research problem (Kivunja & Kuyini, 2017). Therefore, this study used a qualitative research

approach. According to Haradhan (2018), this approach enables the researcher to explore and discover issues about a particular phenomenon from an individual's point of view in their natural settings. Deliberations regarding this section are made in Chapter 3 of this study.

1.4.1 Research design

According to Cooper (2011), research design is a set-up to collect, measure, and analyse data. In the context of this study, a single case study, which Gay et al. (2014) define as a way in which researchers focus on a unit of study known as an abounded system, such as individual teachers, a classroom, or a school, was used as a design.

1.4.2 Sampling

According to Okeke and Van Wyk (2015), sampling is the selection of representative individuals (samples) from the larger group (population), which becomes the basis for predicting the outcomes of the study. There are several qualitative sampling techniques that this study could have opted to use. However, this study used purposive sampling as it offers the opportunity for typicality, variety, accessibility, and learning opportunities (Stake, 2005). More deliberations regarding this aspect are discussed in Chapter 3 of this study.

1.4.3 Data collection

According to Kapir (2016), data collection entails the procedure of collecting and measuring information to answer research questions and help evaluate research outcomes. In the context of this study, data was collected through the use of document reviews (learners' scripts), observations, and group interviews.

1.4.4 Data analysis

Data analysis is an important phase in qualitative research since only through analysis can the researcher reach relevant conclusions to answer the research questions (Flick, 2013). Stake (1995) refers to data analysis as a meaning-making process in which the researcher breaks down information and experiences into constituent elements and assigns meaning to them. In the context of this study, in-

vivo coding and categorical aggregation, where themes emerged, were used to analyse data from classroom observations, document reviews, and focus group interviews. More deliberations related to this component are made in Chapter 3 of this study.

1.5 Overview of chapters

Chapter 1 has introduced the study and presented an overall background, problem statement, purpose, and research questions of this study.

Chapter 2 reviews the literature based on or related to learners' views on the integration of IK-related topics in LFSC classrooms using a cooperative learning approach. It also discusses the role of the theory underpinning this study.

Chapter 3 outlines and discusses all the details of the methodological foundations of the study. It provides the research approach, design, sampling, data collection, and analysis. It also entails the quality criteria and ethical considerations of the study.

Chapter 4 presents the collected data, its analysis, and its interpretation. This study presents the data as per each data set from documents, observations, and interviews.

Chapter 5 discusses the findings and refers back to the research questions to address them. The limitations of the study are also highlighted. The chapter is concluded by explaining what this study achieved and listing the recommendations.

1.6 Summary of the chapter

This chapter gave an introduction and background to this study and gave a general overview of the integration of IK in LFSC classrooms. The problem statement, the purpose, and the research questions of this study are also provided. Moreover, an overview of the chapters of the study is highlighted. The next chapter discusses the literature review.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Literature review has a significant role in research as it merges and synthesises ideas from other scholars on the topic of interest (Snyder, 2019). It lets the researcher identify knowledge gaps and model the research to provide a clear understanding of the topic to the readers (Winchester & Salji, 2016). Therefore, this study reviewed literature centred on the integration of IK during the teaching and learning of science in a LFSC classroom. This was done around the following topics: elaboration on western knowledge and IK; integration of IK in science classrooms; the need and benefits of integrating IK in LFSC classrooms; learners' views on the integration of IK in their classrooms; and lastly, the cooperative learning approach to the integration of IK in LFSC classrooms. Moreover, this section presents the role of theory that pinned this study, that is, social constructivism.

2.2 Conceptualising western knowledge and indigenous knowledge

It is stated that humans have developed different views in order to explain and understand the world around them (Mazzocchi, 2018), hence the concepts of Western knowledge and IK. Therefore, it is paramount to clarify these two concepts, as they will be used in every part of this study.

2.2.1 Western knowledge

Western knowledge originated from Western or European nations during the 17th century (Ogungbure, 2013) and has spread to different parts of the world through colonialism (Adas, 2016). Therefore, Gumbo (2017) views it as knowledge that uses laws established through scientific methods to explain phenomena. Yet, the concept of scientific method refers to the production of knowledge through testing and experimentation, which commence with an observation, followed by hypothesis formulation, testing, and drawing conclusions as a result (De Beer & Mentz, 2016). Moreover, this western knowledge is also referred to as science or scientific knowledge (Lederman et al., 2013; Le Grange, 2016); and western science (Shizha, 2010). Therefore, this study used these terms interchangeably.

Accordingly, Bell (2008) stipulates three domains of science to aid in an understanding of what it constitutes. Firstly, he stated that science is a body of knowledge that entails facts, concepts, laws, and theories. Secondly, as a set of methods and processes that are used to produce scientific knowledge featured in the first domain. Lastly, he indicates that science is a way of knowing, of which this domain describes the nature of scientific knowledge and its characteristics. His contentions are in parallel with a prior clarification of western knowledge. As such, Mazzocchi (2006) specified that western knowledge relies on academic and literate transmissions. Hence, it is not surprising that this knowledge is globally known (Chakravartty, 2022) and dominates our science classrooms and textbooks. Additionally, it is argued that it is not the only way of knowing, learning, and understanding the world around us (Haverkort & Reijntjes, 2011); hence, we have IK.

2.2.2 Indigenous knowledge

I noticed that there is no general definition of this knowledge system; hence, there are many terms that are used to refer to it. Nicholas (2018) cites it as traditional knowledge, traditional technology, traditional ecological knowledge, or native science. According to Senanayake (2006), IK is also referred to as local knowledge, folk knowledge, people's knowledge, traditional wisdom, or traditional science. Therefore, this study holds on to IK, as clarified below.

Bruchac (2014) views IK as a way of knowing developed by indigenous occupants of an area through daily interactions, observations, and experimentation with their surroundings (Maapedza & Sellamuttu, 2022; Rankoana, 2017). On the other hand, Senanayake (2006) highlights that IK is collective knowledge belonging only to certain people or cultures and is unique from place to place. This knowledge draws from environment, spirituality, culture, and history and is essential for the livelihood, survival, problem solving, and decision-making of the local people (De Beer & Whitlock, 2019; United Nations Educational Scientific and Cultural Organization [UNESCO], 1998; Zidny & Eilks, 2018).

Grey (2014) underlined that IK includes the expressions, practices, beliefs, skills, understandings, insights, and experiences of indigenous people with their world. So, all these components of IK are orally transmitted from generation to generation

through cultural rituals, storytelling, drawings, and dancing (Mistry & Medonca, 2020; Nyang et al., 2007; Senanayake, 2006). Hence, Masango (2010) indicates that IK is acquired, held, and used by all the members of communities, with no exceptions for learners (Mawere, 2015). For this reason, it is therefore argued that IK should also be used to explain concepts in science classrooms, including LFSC (De Beer, 2019).

In the context of this study, I view IK as learners' existing knowledge, descriptions, understandings, and explanations of things around them, drawn from their communities. I base this on the view that LFSC studies living things and their interactions with one another and their environment. Surely, learners might have an IK that can be used in their classrooms to study and understand our subject, LFSC.

2.3 Integration of IK in science classrooms

Ranasinghe (2015) asserts that education is a basis for human survival as it enables the transmission of wisdom, knowledge, and experiences from generation to generation, preparing individuals for life duties and challenges. Therefore, researchers raised concerns that our science education ranks western knowledge higher than IK (Cronje et al., 2015). And science subjects are constantly taught and learned with little connection to the real world (Bell, 2008; Seehawer, 2018). Hence advocacy for the integration of IK in science classrooms (De Beer, 2019; De Villiers et al., 2016; Khupe, 2014). As such, Mazzocchi (2018) posits that "integration" is a process that involves combining bits of IK with western knowledge. Therefore, Barnhardt (2014) holds that integrating IK in science classrooms means linking learners to what they learn in school and their daily lives. to enhance practical and relevant learning by allowing blended learning situations that respect and support both indigenous and western knowledge (Ronoh, 2017; Shava, 2013).

In addition, Cronje et al. (2015) stipulate that indeed, IK and western knowledge can exist harmoniously in science classrooms. This is shown in Table 2.1, where a brief juxtaposition of the two knowledge systems is presented. Cronje et al. (2015) proposed the framework for NOIK and NOS.

Table 2.1: Tenets of the nature of indigenous knowledge (NOIK) framework in relation to the tenets of the nature of science (NOS) framework

Tenets of NOIK	*Tenets of NOS*
Empirical and metaphysical Nature, according to IK, is genuine, having been partially or largely tested and seen. Experimentation depending on needs. The cosmos is well-organized, metaphysical, and partially predictable.	**Empirical** Nature, according to science, is real, observable, and testable. The universe is organised and predictable.
Resilient yet tentative IK has weathered the test of time, yet as a tradition it is always developing; it is fluid and transforming, related to people's experiences. It is important to remember that the elders' reservoir of methods of knowing is the truth and should not be contested.	**Tentative** Science is not absolute and certain, and it is prone to change. It may be challenged by anybody.
Inferential yet intuitive Facts are validated, and experimental findings are established. Because events have both natural and unnatural causes, metaphysical aspects are significant.	**Inferential** There is a substantial difference between observations of nature and deductions or conclusions drawn from observations in order to explain the reasons. Every incident has a natural cause.
Creative and mythical Observations and experiments are not the sole sources of knowledge. Human imagination, creativity, and mythologies all have a part. Subjective II is cosmologically rooted and intertwined with culture and spirituality. Prior methods of knowing and ideas can impact elders.	**Creativity and imagination** Experiments and observations are not the only sources of scientific information. Human imagination and ingenuity also have a role.
Subjective Indigenous knowledge is founded on cosmology and is intertwined with culture and the spiritual. Prior methods of knowing and ideas can impact elders.	**Subjective** Scientists seek to be impartial and culturally agnostic, yet as humans, they are susceptible to

	theoretical and disciplinary commitments, past knowledge, and preconceptions.
Social, collaborative, and cultural IK is rooted in cultural heritage and a specific historical-political environment. It is the result of actions related to everyday existence in a group of people's natural surroundings. It focuses on the community and sharing rather than the individual. IK is anchored in the community and is environmentally conscious. It is created in a given location by the people that live there. Generalisations are relative to a certain environment and can be disseminated across communities and beyond.	**Social and cultural** Science is a human effort that is influenced by its social and cultural context. Scientists do work alone at times. Science is created in a certain location and so is limited to that location, while generalised scientific rules and ideas have global implications.
Wisdom in action IK is created via actual participation in everyday life and trial-and-error experiences. Ceremonies and repetition are strategies for aiding recall and reinforcing knowledge. In the 'laboratory of survival,' new ideas are severely evaluated.	**Scientific methods** Scientists address issues and test hypotheses in laboratories using a range of ways rather than a single step-by-step universal procedure.
Functional application IK is not only interested in what and why things happen in nature, but also in what should happen. Practical or functional application and abilities are prioritised. IK is more concerned with people's daily lives than with facts, ideas, and laws.	**Theories and laws** To explain what, why, and how things happen in nature, scientists utilise theories (describe why and how) and laws (describe what). Their rules are causal, rational, and logical in nature.
Holistic approach Problems and situations are addressed holistically, treating all of the smaller pieces without regard for the metaphysical realm.	**Reductionist approach** Science analyses complicated things by breaking them down into little bits. The part-to-whole approach is employed.
Source: Cronje et al. (2015, pp. 323-324)	

2.3.1 Three perspectives on the integration of IK in science curriculum

Based on the above listings of the characteristics of the nature of science and IK, scholars such as Cronje et al. (2015), Taylor and Cameron (2016), and Zinyeka et al. (2016) drew three major viewpoints to strengthen the case for the inclusion of IK in the science curriculum. According to them, there are inclusive, exclusive, and overlapping perspectives that present the relationship between NOS and IK (Steenkamp et al., 2019). Therefore, their perspectives are explained below.

- **Explaining the three perspectives for the inclusion of IK in science curriculum:**

➢ **Inclusive perspective**

IK is seen from this angle as being an integral part of science and should be taught as part of the science curriculum (Steenkamp et al., 2019). This perspective draws from tenets that are common to both IK and scientific knowledge and excludes two tenets that are not shared. The two tenets that are not shared are that IK is concerned with practical application, whereas science is founded on theories, and that science is addressed in a reductionist way, while IK is approached in a holistic manner. With this approach, it is argued that the distinctiveness of each knowledge area may be lost as a result of the exclusive tenets (Taylor & Cameron, 2016). Taylor and Cameron (2016) believe that the holistic aspect of IK will be obscured by science, causing the identity of IK to be lost. As a result, some will consider IK unscientific and irrelevant to modern life (Cronje, 2015). Hence, IK is being sidelined and not given the proper respect in science classrooms (Diwu & Ogunniyi, 2012).

➢ **Exclusive perspective**

This viewpoint juxtaposes IK and scientific knowledge, wherein they are considered exclusively as two distinct, separate knowledge areas (Zinyeka et al., 2016). It is based on ontology, specifically looking at the unique tenets, epistemologies, and methodologies of each knowledge domain. Supporters of this perspective occasionally consider IK to be "pseudoscience," especially when considering the holistic and metaphysical nature of IK (De Beer, 2016). Therefore, such viewpoints favour the omission of IK from the science curriculum. However, Taylor and

Cameron (2016) oppose that and argue that IK should be treated as a discrete knowledge domain that deserves proper recognition and promotion.

Additionally, this perspective views science as being limited to studying the material world and cannot provide any insight about the supernatural. Hence, Onwu and Mosimege (2004) contend that verification methods and processes can be compared and brought to a common standard. However, the authors highlight that those methods must be suitable for each knowledge domain; otherwise, one system would be compromised at the expense of another in the process (De Beer, 2019). And as a result, we lose the beauty of what the two systems could provide alongside one another. Therefore, some scholars consider IK to be legitimate knowledge and argue that it is best studied independently from the science curriculum (Diwu & Ogunniyi, 2012). Chimbala-Kalenga (2015) also argues that those who attempt to comprehend IK from a "distance" may misunderstand and misinterpret it because this knowledge requires one to "live it" and have an experiential relationship with it.

An example that shows that IK is best studied independently is the research by De Beer and Van Wyk (2019), who used the poisonous creeper plant Adenia gummifera to indicate the metaphysical nature of IK in the LFSC classroom. They referred to the plant as the “magic” plant because it is believed to inhibit “evil spirits” (De Beer & Van Wyk, 2019). Adenia gummifera is commonly sold at traditional muthi markets, and decoctions of its stem are traditionally used to sprinkle around the house to inhibit “evil spirits” (De Beer & Van Wyk, 2019). The term “evil spirits” was used by IK bearers to describe disease-causing microorganisms like bacteria. They used this term because they had little understanding of microorganisms and did not have access to microscopes to study microorganisms. They have therefore relied on their thorough observations and concluded that Adenia gummifera is a potent antiseptic with powerful antimicrobial properties useful for household hygiene (De Beer & Van Wyk, 2019).

In agreement, modern western homes use bleaches and antiseptic products such as Jik and Domestos to serve the same purpose of preventing the proliferation of disease-causing microorganisms (Van Wyk, 2015). Therefore, De Beer (2019) believes that, by discussing examples like this in the scientific classroom, learners

will discover that there is nothing wrong with the IK itself but that it is more of a nomenclature issue. For instance, IK bearers refer to pathogens as “evil spirits” because of the lack of correct nomenclature. It is evident that this illustration offers a useful platform for learners to interact with the principles of both IK and science. Lastly, De Beer (2019) is of the view that the metaphysical aspect of IK should not be ignored in the science classroom, for fear of leading to pseudoscience. He believes that by engaging with that metaphysical item, learners could develop a more nuanced understanding of the nature of science and be able to tell the difference between science and pseudoscience.

- **Overlapping perspective (intersecting domains)**

This viewpoint honours both the similarities and differences between IK and science. IK and science are viewed as being similar in a way that, for instance, they share the principles that they are both: (a) empirical, observable, testable, and inferential; (b) tentative as they are constantly changing and can be challenged by all; (c) based on natural causes while unnatural causes are considered in IK; (d) are influenced by society and culture; and lastly, they depend on human creativity and imagination, with myths playing a role in IK (Cronje et al., 2015).

The distinctions between each area of knowledge are based on the fact that (a) IK is holistic while western science is reductionist, and (b) IK is more concerned with people's daily experiences than with facts, ideas, and laws. IK examines what, why, and what should occur in nature, with a focus on practical or functional application and abilities. On the other side, science makes use of theories and laws to explain natural events. Laws specify what occurs, while theories describe why and how it occurs (Cronje et al., 2015). In actuality, overlapping perspectives imply that the shared principles of the two knowledge domains would be the main topic of discussion in the classroom (Steenkamp et al., 2019). Others believe that this perspective’s intention is to bridge the gap between science and IK (Zinyeka et al., 2016), as it celebrates both the commonalities and the uniqueness of each knowledge domain. It therefore gives IK a place in the school science curriculum (De Beer, 2019).

This perspective is shown by the practise described by De Beer and Whitlock (2009), in which a teacher might contextualise a problem in terms of IK and then expect the learners to employ scientific methods to analyse the problem. In such a case, the teacher should recall that some elements of IK, especially the metaphysical nature of IK, are outside the purview of science. For instance, De Beer and Whitlock (2009) outlined how the effectiveness of ‘muthi’ plants can be evaluated in the science classroom by adapting the modified Kirby-Bauer method. The procedure will enable learners to ascertain the antibacterial capabilities of therapeutic plants. Similar to this, De Beer and Petersen (2017) describe how an investigation into the traditional Chinese practise of burning incense to ripen fruit could be conducted in a school laboratory. Learners will have to formulate hypotheses and a laboratory procedure to ascertain the impact of ethylene on plants. However, Steenkamp et al. (2019) highlight that this approach may be perceived and critiqued, as it seems like scientific methods are used to validate IK.

I therefore conclude that IK is not a separate strand of the science curriculum. It is rather a curriculum concept that calls for certain curriculum themes to include IK derived from various components surrounding learners' environments and cultures. This conclusion is supported by the emphasis placed on the nature of both knowledge domains and how the two can coexist in science classrooms, considering the three outlined perspectives. Furthermore, Cronje et al. (2015) underline the importance of science teachers understanding the holistic and contextualised character as well as the metaphysical component that dominates IK. They argue that these items should be highlighted before and during the integration of IK in science classrooms (Cronje, 2015; Cronje et al., 2015). Hence, incorporating IK into science classes would result in a shift in perspective, making individuals (both teachers and learners) more open to and tolerant of IK in science. Thus, foster transformative experiences with three characteristics (Pugh et al., 2017).

According to Pugh et al. (2017), the first experience is the motivated use, wherein learners apply learning in ‘free-choice’ contexts. Secondly, there is the expansion of perception, wherein science learners see things, events, or problems through the lens of the content. Finally, the third experience is the experiential value, wherein learners value content for how it improves day-to-day experiences. This is in line with

Vhurumuku (2011), who contends that it also results in scientifically literate citizens who are critical thinkers.

Supporting the aforesaid sentiment expressed by Vhurumuku (2011), teachers in the Mavuru and Ramnarain (2017) study invited learners to voice their cultural perspectives on curbing infertility through surrogacy. The following questions were used to facilitate the learners' discussion: What is surrogacy? What is involved? What are its implications for science and society? Learners expressed concern that the child born from the surrogate mother would be considered a member of two families. Thus, the child would lose his or her identity, which would complicate the issue of which ancestral spirits would govern the child. However, not all learners agreed with this cultural notion. Others argued and maintained that there was a good basis for surrogacy when a mother is unable to give birth in a convectional manner. Such diverse opinions on this issue prompted learners to critically reflect on their previous positions and, in some cases, re-evaluate and change their views. Hence, discussions like this in classes clearly promote critical and analytical thinking skills (Hewson & Ogunniyi, 2011).

2.4 The need and benefits of integrating IK in LFSC

Under the above mentioned section I will review literature that deliberates on the need to integrate IK in LFSC classroom and the benefits of integrating IK in LFSC classroom respectively.

2.4.1 The need to integrate IK in LFSC

IK is an integral component of each learner’s identity; hence, Reddy (2019) highlights that its absence in scientific classrooms has negative implications, such as low performance and learners quitting the science stream. This is supported by literature, which suggests that learners perceive science lessons as uninteresting and equally irrelevant because they fail to connect the curriculum to their daily lives (Reddy, 2019). And learners end up not appreciating the role of science in our everyday lives (Buma, 2018). In the same vein, Zinyeka et al. (2016) also indicate that failure to connect the curriculum to the daily lives of the learners causes them not to choose science subjects in school because of the perceived clash between

their cultural principles and the scientific aspects. It was also seen by Cajete (2015) that many learners experience learning science in school as trans-versing a foreign culture because some of their cultural interactions and behaviours' are at odds with western scientific perspectives. As a result, this may be detrimental to the development of learners' worldview and their self-worth, which could also hinder their ability to learn if it is not stopped (Cajete, 2015).

Supporting the above views, Onwu and Mufundirwa (2020) carried out a study to improve the learning and academic achievements of science learners by using IK and indigenous technologies to teach forces in physical structures. They used a mixed-methods research approach wherein the primary data was quantitative. A quantitative research approach involving pre-, and post-tests was used to investigate the academic achievement of the learners. On the other hand, the qualitative research approach was used to gain learners' and teachers' perspectives on the approaches employed to teach forces. During their study, they grouped learners into two groups: the control group and the experimental group, wherein the control group was taught in a traditional way (talk and chalk). The experimental group was taught with an integration of IK and indigenous technologies. As such, their findings revealed that the experimental group had better academic results and displayed intrinsic motivation for learning than their counterparts. Therefore, these researchers credited the results to the employed approach of using learners IK to teach science concepts, which resulted in

Moreover, during focus group interviews, learners from the experimental group stated that they could not understand what was being taught because they were not engaged in the lesson or provided with examples from their culture or day-to-day experiences. They stated that they were taught from a textbook, so they had to read and memorise it. It is apparent that learners were not inspired by what was presented to them. Hence, reduced motivation and performance were spotted as learners failed to link what was being taught to their lived experiences (Onwu & Mufundirwa, 2020). In support, Mentz and De Beer (2019) unfold that marked teacher-centred classrooms that predominantly focus on preparing learners for tests and examinations enforce memorisation rather than learners' cognition (Reddy et al.,

2018). Thus, Gibbons (2000) calls this Mode 1 knowledge production, which results in learners viewing the content as dislocated from their daily lives.

The solution to the above contentions, according to Pawilen (2021), is that learning could be improved when it is contextualised by relevant and authentic IK. This is also suggested and apparent in the Diwu and Ogunniyi (2012) study. According to these authors, integration of IK in the science classroom would promote the understanding of science topics based on the socio-cultural perspective and context of the learners. He strongly underlined that it would help learners understand how science has always been a part of their lives since the time of their forefathers and how it connects them to their history and culture. That is despite some criticisms that IK is inferior to western knowledge (Mji et al., 2017). However, Jansen (2017) argues that emphasising more on learners lived experiences during science learning would deprive learners of the proper science concepts they would need to engage in the world of science. And that might also promote pseudoscience (Mothwa, 2011).

Anazifa and Hadi (2017) also believe that by using IK in the science classroom, contextual learning can be enhanced, and community values will be further emphasised. To achieve that, for instance, Shizha (2012) hinted at the idea that learners should be given tasks that draw on authentic issues in their local environment. For instance, De Beer and Van Wyk (2011) described how learners could take part in ethnobotanical surveys in scientific classes. Such genuine interactions can therefore serve as learning catalysts and may increase learners' awareness of the resources available in their communities for their science learning. This means that science will be more contextualised for all learners.

It is also argued that inclusion of IK in school curricula would enable indigenous societies, particularly Africans, to find their voice, heal themselves, and reconsider their genuine contributions to the world's cultural and knowledge heritage (Odora Hoppers, 2017; Moichela, 2017). This viewpoint stems from centuries of colonialism that indigenous people have experienced, which resulted in the exclusion of their IK from the school curricula (Steenkamp et al., 2019). as well as IK being condemned as pseudoscientific in favour of western science (De Beer, 2016). Such actions are said to have compromised and severely stunted the development of indigenous

people while allowing only the colonialists to advance their knowledge (Moichela, 2017).

Ramadikela et al. (2020) assert that integrating IK in science classrooms would open up previously closed doors and let all learners receive relevant education regardless of their socio-cultural backgrounds. In the same vein, the World Bank (1998) also endorsed that understanding how people and societies acquire and use knowledge is essential for improving people's lives, especially the lives of the poorest. This implies that IK requires universal recognition and support in order to strengthen the educational experiences of all learners, rural and urban, indigenous, and non-indigenous, and hence our communities. Thus, assisting learners in focusing on their context and what it has to offer (De Beer, 2019), which might help to unlock their creativity and lead to the development of their communities (Mjie et al., 2017; Musitha & Mafukata, 2018).

Supporting the above, the World Bank (1997) points out that IK is the foundational knowledge of every nation, constituting the prior knowledge of all learners (Mawere, 2015). Also, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Conference on Science for the 21st Century and its Declaration in 1999 show that all cultures can contribute scientific knowledge of universal value (UNESCO, 1999). This implies that indigenous societies have their own applied sciences that they have used to deal with the situations that they encounter in their daily lives. But the majority of such sciences are not recorded in writing in reading materials or textbooks (Anazifa & Hadi, 2017; Shehu, 2020), since they are passed down orally from generation to generation (Handayani, 2018). Nevertheless, such cases should not render IK an empty science. Hence, these uttered perspectives make it feasible for IK to be considered and discussed more openly. As a result, IK is now included in academic curricula at primary, secondary, and tertiary institutions around the world (Kaya & Seleti, 2013) to make the curriculum more relevant to learners' lives. Thus, Ng'asike (2019) asserts that integrating IK in the classroom can address issues of relevance in education.

In line with the above, Gay (2000) refers to this achievement as transformative, culturally responsive education since it clearly respects learners' cultures and

experiences. It acknowledges their pre-existing knowledge and expands on it during the learning process, using it as a valuable resource for teaching and learning. Similarly, Cajete (2004) and Pawilen (2021) added that the endeavour empowers learners to articulate their scientific findings and opinions in more creative and critical ways, supported by contexts that are relevant to their culture and communities. Teachers are also given the opportunity to use historical and cultural items from any ethnic group to illustrate scientific concepts (Pawilen, 2021). As a result, academic achievement and cultural identities are not pitted against one another; instead, learners will reinforce and retain their indigenous identities while pursuing their studies.

Ugwu and Diovu (2016) discovered that learners in schools that integrate IK in science teaching are more likely to succeed. According to these authors, IK and practices, combined with excellent teaching and learning, contribute to higher academic attainment. Therefore, this confirms Wilson's (2013) contention that one cannot choose between being indigenous and being educated; one must be both. Hence, DBE (2011) clearly states that it is vital that learners' IK be openly discussed in their classrooms. According to Lamb and Godlewska (2021), such discussions will give learners the chance to learn about indigenous peoples' experiences, historical and current relationships with non-indigenous viewpoints, and contributions to modern society.

Moreover, according to Mandikonza (2019), the integration of IK in classrooms will enable the use of components of learners' IK as a starting point to help learners understand subject concepts described in the curriculum. That is, learning will begin from known to unknown with real-world phenomena embedded in context to develop links between learners’ prior knowledge and classroom experiences (Mavuso et al., 2021). This connection is said to spark learners’ interests and provide practical scenarios of the intended subject knowledge (Zidny et al., 2020). This is crucial for bringing science to where the learners are and enhances the learners' sense of pride and ownership over their education.

Supporting the aforesaid, Mji et al. (2017) strongly emphasised that there is a need to develop spaces in African children's education systems where their IK is

acknowledged, nurtured, and shared in our schools. The authors feel that it will help to confirm and show the broad educational value of cross-generational learning in culturally appropriate situations, as well as the dynamics associated with such learning. They further indicate that it is critical to appreciate and respect all schools of thought (IK and western) in order to establish effective forms or methods of learning. This will then facilitate and validate their humanity.

In line with the above, Gay (2000) argues that such classroom practices are validating because they recognise the authenticity of learners' cultural histories. And build bridges between home and school that connect academic abstractions with experienced socio-cultural realities. They blend multicultural information, resources, skills, and materials into the subject to inform practise and assist learners in recognising and appreciating their own and others' cultural heritages (Gay, 2000). Moreover, Pawilen (2021) asserts that it gives learners the cultural knowledge, scientific knowledge, and life skills they require on a daily basis.

In accordance with the above assertions, Specific Aim 3 in the LFSC Grades 10–12 CAPS document shows how the curriculum strives to enhance learners' knowledge while taking global imperatives into consideration. Hence, Msimanga and Shizha (2014) argue that a positive response to this call will allow learners to maintain their cultural identities while completing their formal education. Given that and the fact that South Africa is a multi-cultural nation made up of numerous ethnic groups, it stands to reason that each ethnic group can be found in a single classroom with their own IK, some of which is shared by multiple cultural groups. Due to this cultural diversity, IK has been frequently misrepresented or inadequately covered in pedagogies, curricula, and texts (Cronje, 2015; Kruger & De Beer, 2019; Lamb & Godlewska, 2021).

Mavuru and Makhunga's (2020) study also found that teachers are not certain of which learners' IK to draw into the lessons, while some don't consider IK authentic; hence, they side-line it in LFSC classrooms. Nonetheless, it is impossible to ignore the DBE mandate that learners should identify and communicate their IK as they learn. Therefore, Mothwa (2011) asserts that the IK possessed by all of the ethnic groups in classrooms is significant and should not be considered as an impediment.

However, rather be praised and used as a resource to enhance the teaching and learning of the subject.

The LFSC CAPS document supports Mothwa's (2011) viewpoint and states that, to the greatest extent possible, integration of IK in the classrooms should reflect many South African cultural groups. Therefore, according to Chimbala-Kalenga (2015), since IK is unique to a specific ethnic group in a specific location, it cannot be challenged anywhere else on the planet but can, as a specialist, join and contribute to some of the world's knowledge and understanding. Thus, its presence in the science classroom will connect all learners to the cultural history of science (DBE, 2011; De Beer, 2019).

Schmidt et al. (2019) posited that the relevancy of statements and examples used during teaching affects learners' impressions of LFSC. As a result, Mawere (2015) argues that drawing from learners' IK during lessons will lead to more appealing, accessible, relevant, and meaningful learning. Such learning situations are said to allow learners to position and recognise themselves in the curriculum (De Beer, 2019). Achieving this will excite the learners, as they will notice that their IK is being recognised. The venture will then counteract the idea of science being difficult and irrelevant (Mashoko, 2014). Therefore, Khupe (2014) backs up these views by stating that it brings learners closer to the content because it is relevant to their lives.

The above views are in accordance with the Fasasi (2017) study, which showed that learners who were exposed to their IK in science classrooms had improved attitudes towards science. The author clarified that the change is caused by their awareness of the link between their cultural beliefs and scientific notions. Again, Fasasi (2017) further indicates that the employment of IK in the classroom appears to have removed or diminished the learners' perception of the strangeness of science concepts. Hence, learners' interests in science developed as a result.

Fasasi's (2017) revelations agree with Mashoko's (2014) sentiment that exposing learners to their IK in classrooms changes their perceptions of science. Interestingly, the study made the importance of science clearer to learners. It made the learning and teaching of the material more relevant to learners’ daily lives, which in turn inspired them to adopt a more positive attitude toward science and science

education. Hence, greater academic performance in science. In a nutshell, the illustration from the Fasasi (2017) study is that integrating IK in science enhances learners' attitudes towards science. Furthermore, the more positive learners' attitudes about a science subject are, the more likely it is that they will perform well academically (Kazeni & Onwu, 2013).

2.4.1.1 Examples of IK that may be integrated in LFSC classrooms

Mothwa (2011) highlights that there are many examples from South Africa's rich cultural diversity and biodiversity that can be used to illustrate the relationship between IK and LFSC. Such examples are suggested as excellent learning opportunities that will encourage learners to actively relate to and adopt this knowledge and integrate it into their daily lives (De Beer & Van Wyk, 2019). As a LFSC teacher, I agree with this author. Therefore, the emphasis below highlights some of these examples. For instance, IK bearers in Limpopo, Giyani, and Mopani districts have a sustainable and environmentally friendly solution for insects. For many years, the inhabitants of Giyani have used the plant Lippia javanica as an insect deterrent (De Beer, 2015). In collaboration with the inhabitants of Giyani, the Council for Scientific and Industrial Research (CSIR) of South Africa has filed a patent for the use of Lippia javanica as an insect repellent. In comparison to the commonly used citronella oil, which has a 40% effectiveness rate in clinical studies as a mosquito repellent, the oils found in Lippia javanica appear to be 95% effective (Van Wyk & Gericke 2018). Therefore, this is one of the examples that can be integrated into LFSC when addressing the effects of chemical pesticides.

Another example is the South African indigenous shrub healing plant, Sutherlandia frutescens (cancer bush). The Khoisan and Zulu healers have long known about the therapeutic qualities of this plant, which is widespread in South Africa. It is believed to radiate energy and well-being, cleanse the blood, act as a tonic, lessen flu symptoms, and have anti-cancer and anti-STI properties. Early people noticed that extracts from this plant were effective at treating cancer patients. According to recent research, this shrub has an amino acid that fights depression, pinitol, which aids in weight gain, and canavanine, which is effective in treating retroviruses (Van Wyk, 2008). Today, it is used to treat AIDS patients, but it does not cure the disease;

rather, it improves their quality of life. This is a fascinating illustration of how modern science is elevating the work of indigenous people.

Additionally, in a particularly dry region of South Africa, the Khoisan used “Hoodia gordoinii” as an edible plant, and its fleshy stem supplied the necessary water. It helped them overcome hunger and dehydration on their hunting journeys. Additionally, the plant is also used as a cure for severe abdominal cramps, indigestion, and hypertension. As a result, the active component of this plant, (Van Wyk & Gericke 2018), has been studied by the CSIR in South Africa and is an efficient appetite suppressor. As a potential anti-obesity drug, it is therefore commercially available and well-known throughout the world.

Moreover, rooibos tea is derived from Aspalatus linearis, a natural herb endemic to the South African Cedarberg Mountains in the Western Cape. This tea plant was widely known to the local Khoisan tribe many centuries ago, who employed it as an herbal cure for a variety of diseases. But, as their population began to decline, the herbal knowledge of rooibos was lost and forgotten. Yet, due to its health-promoting characteristics, it was eventually rediscovered and popularised. Therefore, it is now available on our shelves. Contemporary research has proved that rooibos tea provides the following benefits: it is high in antioxidants such as quercetin, beta-carotene, and vitamin C. Antioxidants safeguard our bodies from damage to cells, which appears to be a cause of aging, cancer, and heart disease. Rooibos can also be used to treat hypertension, sleeplessness, hay fever, asthma, eczema, stomach pains, and colic in infants.

Another illustration is the 2019 South African tree of the year, the Marula fruit tree, Sclerocarya birrea, which is native throughout most of sub-Saharan Africa. The tree is also grown as an experimental crop in Israel. It is a highly valuable, multi-purpose plant that is harvested from January to March for its tasty fruit and seed. Each Marula fruit contains a hard, brown nut with malleable, white kernels at its core. There are numerous domestic uses for every part of the tree, from the leaves to the roots (Murye & Pelser, 2018). Africans have traditionally regarded it as a source of nutrition because of its high vitamin C, fat, protein, calcium, potassium, and

magnesium content. Additionally, it provides a variety of medicinal products for various ailments as well as numerous consumables to the local people.

According to research, marula has considerable amounts of oleic acids and antioxidants, as well as skin-healing and moisturising capabilities. As a result, many companies have begun to incorporate it into their formulas. The juice extracted from the pulp surrounding the seed is used to make traditional brews, jam, wine, and a commercial cream liqueur known as Amarula. White et al. (2019) also hinted at indigenous alcohol fermentation, which can be illustrated from this during the anaerobic fermentation topic in the LFSC lesson. Therefore, the marketing of the mentioned products benefits the community by producing jobs and improving the locals' livelihoods. As a result, we have seen the Limpopo province celebrate this fruit with its annual Marula Festival, which is held in Phalaborwa. Furthermore, the Department of Environmental Affairs and South African National Parks' (SANParks) awareness-raising and reforestation efforts strive to ensure that the tree thrives in a sustainable manner, giving economic value to local communities. This shows the relationship that exists between individuals and the ecology they live in.

2.4.2 The benefits of integrating IK in LFSC

The examples above, and many more, can be used to illustrate the relevancy of IK to our daily lives and the fact that IK has now become a shared asset that benefits all people. This is significant because it shows the history of science and the existence of a link between IK, science, technology, and society (DBE, 2011). As a result, emphasising them in LFSC curriculum themes may pique learners' interest in the subject and motivate learning. In the same vein, Handayani et al. (2018) argue that sharing this knowledge gives learners a good entry point into the scientific world, processes, and procedures. Such a route supports IK claims and may even open up future career opportunities for the learners as it reflects biotechnology, modern pharmacology, and entrepreneurial skills (De Beer, 2019; Le Grange, 2016).

In agreement with De Beer (2019) and Le Grange (2016), the study by Mavuru and Ramnarain (2017) concluded that appreciating learners' IK in the science classroom increases their interest in science, whereas disparaging their cultural beliefs alienates them from science and professions that are related to science. As

observed, De Beer (2019) shed light on ethnobotany, ethnozoology, ethnopharmaceutical, agriculture, and entrepreneurial opportunities linked to IK in science classrooms through his analysis of papers from the Indigenous Plant Use Forum (IPUF) conference held in Limpopo Province. This shows that integrating IK in science classrooms can ignite learners' interests in science-related fields of study and entrepreneurship.

The above emphasis is consistent with the findings of Mothwa's (2011) study, which found that integrating IK into LFSC makes learning more meaningful and that learners become eager to question concepts from both western and indigenous perspectives. Jacobs (2015) agrees with Mothwa (2011) that learners who are exposed to IK in their classroom become more receptive and engaged in the lessons. In a similar vein, Desmarchelier (2020) asserts that the richness of IK challenges and promotes dialogue between indigenous and western epistemologies to discover avenues for knowledge creation in science classrooms. This backs up the view that IK in LFSC classrooms increases learners' interest in the subject and motivates them to learn (De Beer & Petersen, 2016), resulting in higher engagement and comprehension (Knapp, 2014).

According to a study by Erinosho (2013), teaching that integrates local scientific knowledge is advantageous for enhancing learning. The study highlighted that learners developed a solid grasp of the scientific ideas and were enthusiastic about their engagement with local resources. Moreover, learners were better able to understand the relevance and practicality of the subject matter when science was taught in such a manner. Onwu (2020), who found that learners were curious and generally attentive, concurs with this. Learners showed excellent engagement, particularly during discussions and while reflecting on their questions and replies. They loved the concept of relating local practices to the scientific concepts in their class. Furthermore, Erinosho (2013) notes that contextualising school science within indigenous scientific knowledge may result in a more dynamic, adaptable, and engaging learning environment.

Ugwu (2016) carried out the study to determine the influence of the integration of IK and practises into chemistry teaching on learners’ academic achievement. Their

findings suggest that when learners are taught with the incorporation of IK and cultural practices, their performance improves significantly. They emphasise that the performance can be linked to the connection between what learners have been practising in their daily lives and the new topics in the scientific classroom. And it could be because they are delighted that their indigenous practices are useful in modern science. This contention is in line with the emphasis made by Fasasi (2017). Furthermore, this author recommended that learners IK and practices be integrated into science classrooms for more effective teaching and learning. They assert that the endeavour makes it easier for learners to comprehend new concepts and improve their understanding of scientific topics. Thus, improving their knowledge and achievement as well.

Being in the same position as Erinosho (2013), Fasasi (2017), Onwu (2020), and Ugwu (2016), the task of knowledge integration, according to Lazarus (2011), broadens learners' horizons and enriches their knowledge. This can also assist in reflecting on western conceptions of science in order to build more holistic viewpoints (Snively & Williams, 2016). Lastly, I hold that integrating IK in the LFSC classroom shall grant learners the opportunity to study LFSC in ways that consider their prior knowledge, worldviews, and experiences. My position is in accord with Cindi (2021), who echoes the sentiment that dealing with IK in science classrooms entails dealing with many perspectives of reality. This is because each society has its own worldview and set of ideas that define its cultural identity and legitimise its activities. Therefore, the whole relevance of indigenous practices cannot be appreciated by isolating and decontextualising bits of knowledge from the overall sociocultural milieu (Moichela, 2017). That is because nature and society do not exist as separate entities in indigenous worldviews (Kwanya, 2015).

As a result, based on all the presented contentions, I draw the conclusion that integrating IK in science classrooms contextualises learning. It presents learners with relevant and authentic learning circumstances, thus encouraging and enhancing learning. It further supports the growth of their affective domain and critical and analytical thinking abilities. In addition, considering what it would have to offer, it might possibly open up career and entrepreneurial opportunities for learners, which will then promote their personal, social, and economic development.

2.5 Learners’ views on the integration of IK

De Beer (2016) indicated that we tend to forget that learners do not enter the science classroom as blank slates. Therefore, it is significant to recall that they often have important indigenous and personalised knowledge related to the curricular themes that must be explored (Jacobs, 2015). Mandikonza (2019) argued that exploring learners' views is essential for realising the latent potential of their IK, which can complement and contextualise science education (Anazifa & Hadi, 2017). As a result, learners will actively contribute to the body of knowledge and increase their level of engagement as their IK competencies are explored (Knapp, 2014). In a similar vein, Zidny et al. (2020) proposed that this strategy is appropriate for accommodating sociocultural demands in science curricula as well as meeting learners' perceptions of relevance. Learners will then cross-examine differing points of view on science in different contexts based on cultural identity, time, and society. Thus, value and nourish that knowledge across generations (Havenga, 2019).

As an example, to support this emphasis, Van Wyk and Gericke (2018) stated that South Africa is rich in biodiversity, with over 30 000 kinds of plant species used in a variety of ways by diverse cultures. This information is brought up and covered in the LFSC topics of biomes, biodiversity, and classification. Therefore, teachers might use topics like this to incorporate learners' IK and explore their views about the use of various plant species prevalent in their environment. As a result, the prior knowledge and world views of learners will be recognised and linked to science content (Zidny & Eilks, 2020). Therefore, Zidny et al. (2020) indicate that to prevent misunderstandings and potential conflicts when exploring learners' views, it is vital to consider how the IK and Western science have shaped learners' perceptions of scientific phenomena. That means taking into consideration the overlapping perspectives of the two knowledge domains.

In Jacobs' (2015) study, learners were engaged in activities and discussions that drew on their IK. Learners reacted positively to IK; they were more open and able to share their views. Learners further concluded that they see the relevance of IK and would still use it in the future. A similar conclusion was also observed in the Erinosho (2013) and Ugwu (2016) studies. Consequently, learners’ views in Jacobs (2015)

provided teachers with more critical insights into learners' personal beliefs. Such items enabled teachers to use learners' perspectives to build meaningful connections between their IK and LFSC content. These findings are in line with Zindy and Eilks' (2020) research, which revealed that chemistry learners found the integration of IK in their classes to be interesting and relevant. It showed them how interrelated worldviews may be useful in enhancing learning and finding answers to today's issues. This agrees with the Ugwu (2016) study, where learners were delighted that their IK and practises are useful in modern science. Contrary to that, Manyana (2020) revealed that learners did not find any relevance in integrating IK into their physical sciences lessons. Learners argued that the venture only enhanced class discussions and argumentation. These perspectives imply that teachers must give learners a chance to interact with scientific concepts on their socio-cultural grounds and later explore their views of the endeavour.

In the Onwu (2020) study, learners cherished the idea of connecting local traditions to scientific ideas in the classroom. The teacher used the local resources and allowed learners to discuss their IK and work together on the given activities. Learners go on to say that understanding some topics through examples from their cultures increased their interest in their everyday local experiences and how the experience may benefit their science education. Some learners expressed that they believe they will always be able to recall what they learned in such a learning environment. The study concluded that learning environments that allowed for discussions and the interrogation of IK increased learner motivation and engagement with the scientific concepts. Hence, improved learner performance.

In the Mavuru and Ramnarain (2017) study, learners indigenous views related to various science themes were explored. During the teaching of the topic of a balanced diet, learners raised the issue that some foods in African culture are regarded as forbidden. For instance, it is customarily unacceptable for girls to consume dairy products like cheese or eggs. It is thought that consuming them may improve their fertility and lead to pregnancies while they are still young. Yet, learners were unable to offer a convincing justification for the association between eating these items and fertility. The teacher then assisted the learners in determining the nutritional value of these foods. As a result, learners realised that these foods were

essential for growth due to their high protein content. Learners were prompted to reconsider their prior assumptions. Learners then concluded that adults prevented girls from consuming these foods high in protein in order to slow down rapid growth so that young females wouldn't seem "adult-like" and wouldn't start acting sexually at a younger age. Interestingly, here the teacher was able to use learners' socio-cultural beliefs to reconcile the conflict between learners' worldviews and science.

The above example shows how some learners' indigenous beliefs and viewpoints regarding particular issues may not have scientific justification. However, they are nonetheless significant because they encourage critical thinking in classrooms when given the opportunity to explore them. Thus, improved learning takes place in a context that is culturally, cognitively, and linguistically supportive and meaningful (Weiland, 2015). It is also seen by De Beer (2019) that engaging with items that we think have no scientific justifications could help learners develop a more nuanced understanding of science and be able to tell the difference between science and pseudoscience.

2.6 Cooperative learning approach and its relevance in integrating IK in LFSC

According to Johnson and Johnson (2014), cooperative learning is an approach that uses a variety of instructional methods that allow active learning in groups. Learners are divided up into small, face-to-face groups to discuss, converse, and clarify their grasp of the concepts. They work together to construct, uncover, and modify their knowledge as they explain concepts to one another and achieve the learning goals (Gillies, 2016). The hallmark of this learning approach is to make learners the main drivers of their learning (Johnson et al., 2014). Therefore, there are five features that Johnson and Johnson (2014) highlight for the success of this learning approach. That is face-to-face connection, positive interdependence, individual accountability, self- and group reflection, and the development of interpersonal and social skills.

2.6.1 Face-to-face promotive interactions

This refers to learners coming closer together, facing each other, and engaging in verbal interactions wherein they voice their ideas, give feedback, and challenge each other's conclusions and reasoning. Such interaction is said to facilitate greater insight

into the issue being considered, which then promotes effective communication skills and quality decision-making. A study by Cavanagh (2011) indicates that learners acquire immediate results in their understanding, and they also tend to construct new ideas. There is an easy transfer of knowledge from one learner to another and to the whole classroom.

2.6.2 Positive Interdependence

Butera and Buchs (2019) defined positive interdependence as mutual learning between group mates, wherein each learner understands that they cannot succeed unless their group mates do so. Therefore, they work together to achieve the learning goal, with each learner contributing their piece to their own and others' learning.

2.6.3 Individual accountability

Each learner understands that they are responsible for their own learning and for the success of their group. Therefore, they have to say or ask something within the group. This is important because it makes it feasible to know who needs more assistance, support, and encouragement in completing the task (Laal et al., 2013).

2.6.4 Self and group reflection

Johnson and Johnson (2008) highlight that this feature necessitates learners to assess their own and others' roles in order to clarify and improve their effectiveness in contributing to the collaborative efforts to achieve the learning goals. It also offers the teacher a “window” to observe and assess the learners as they work on the task. Such observations will provide important information about how well learners understand the task. Moreover, teachers might also allocate some time at the end of the session for groups to describe whether their peers were helpful or not in completing the task. Listening to learners' reflections allows teachers to make decisions on where to make modifications in the future, if necessary.

2.6.5 Development of interpersonal and social skills

Johnson and Johnson (1991) argue that the constructive feedback that learners receive from their interactions can help them build their interpersonal and social skills. This is because in their groups, learners get to lead, know and trust each other, communicate accurately and unambiguously, accept and support each other, and resolve conflict constructively.

In line with the aforesaid, Evangelou (2023) highlights that the cooperative learning approach is one of the learner-centred approaches to teaching and learning, which posits the learner at the centre of the learning process and draws on their experiences. Learners are offered a platform to express themselves, their prior knowledge, interests, and needs. This author strongly emphasises that adopting such approaches in the classroom gives learners an opportunity and a conducive space to actively act and participate in all phases of the teaching and learning process. Hence, Clinton and Wilson (2019) examined learners' perceptions and attitudes towards cooperative learning. Therefore, learners reported higher levels of perceived value for this learning approach, both in terms of enjoyment and usefulness.

Ogunleye (2013) adds that the approach enables learners to synthesize, analyse, and apply different concepts involved in their lessons through structured activities. The significance of such learning activities is to grant learners an opportunity to support each other's learning (Gillies, 2016). As a result of ensuring the active participation of each learner in the group, Moreover, cooperative learning environments are said to promote experiential learning as well as provide opportunities for developing reflection and critical thinking (Linsenmeyer, 2021; Takele, 2020; Tseng, 2019). Such contexts, according to Evangelou (2023), result in the development of higher cognitive and social skills.

Retnowati et al. (2018) gave an example of how learners' support each other's learning in cooperative learning contexts. These authors indicated that, when learners are faced with a gap in their knowledge, they fill it with the knowledge provided by their group mates. Learners do that by listening to others recall information, relearn information, and receive feedback from others. Correspondingly,

Sakata (2022) asserts that it is cooperation and communication that allow learners to construct "something new" that may not be achieved otherwise.

Warburton and Volet (2012) applaud this approach for fostering more autonomous forms of learning through the active role that learners take in such learning environments and the activities they engage in. These authors consider active participation as a potential driver of learning, resulting in positive and meaningful learning. They are of the view that active participation increases the quality, quantity, and scope of knowledge construction and sharing during group interactions. Moreover, their view is in accord with those of García-Almeida and Cabrera-Nuez (2020).

Doron (2017) also argues that when learners are encouraged to share their knowledge and skills, they tend to participate more effectively and even improve their own and others' knowledge. As such, researchers highlight that supportive and constructive interactions evident in cooperative learning environments increase positive attitudes towards learning (Hudha & Jayanti, 2018). Therefore, this results in enhanced learning and academic achievement (Leoudi, 2018). Moreover, it also improves social relations (Putra, 2015), in addition to high self-esteem and cohesiveness (Leoudi, 2018). Another big gain presented by Gull and Shehzad (2015) is that cooperative learning groups induce cooperative attitudes in the learners, which, in the long run, have the potential to be carried over into other areas of their lives. Because such learning contexts encompass elements of contemporary life that cultivate acceptance and understanding of collegiality (Papageorgiou, 2015),

Supporting the above expressions, learners in Onwu (2020) participated in collaborative activities and discussions about their IK. They displayed exceptional involvement, especially in debates and reflections on their questions and responses. The same involvement was observed in Jacobs' (2015) study. In both studies, the spotlight is on the conversations and interrogation of the IK. The endeavour raised learners’ motivation and engagement with scientific topics, which resulted in science concept comprehension and better learner performance. Learners remarked that understanding some topics through discussions about examples from their cultures

aroused their interest in their everyday local activities and how they could contribute to their science education.

From the above, cooperation as a value within cooperative learning contexts encourages learners to reflect on their experiences, think beyond their classrooms, and explore further applications of their learning (Bayati, 2015). As a result, learners' thinking is said to become audible and visible, wherein they are better able to help and learn from each other by asking questions such as ‘why, how, and could you please explain that?’ (Wang et al., 2008). Such questions will obviously drive individuals to externalise their thinking, and therefore, metacognitive thinking is induced. Pateşan et al. (2016) indicate that such follow-up questions really show that learners find themselves as active participants in the lesson, as they can intervene and share their piece at any time. The above emphasis shows that involving learners in the lesson makes them more active, think critically, and retain information for a longer period of time. Moreover, Kyprianidou (2012) adds that this is an award for the teachers. Because when they hear and see what learners are doing as they go about a task, they will be able to assess their own teaching and figure out how best to help their learners.

Considering all the above sentiments, it is understood why McCombs (2013) considers cooperative teaching and learning approaches to be effective in driving high motivation, meaningful learning, and success for all learners. Equally, Slavin (2011) asserts that learning in groups motivates and encourages all members to learn as they help one another, which is evidenced by learners' ability to explain ideas to their peers. Thus, learning becomes more interesting and relevant (Cornelius-Ukpepi et al., 2016). As such, Wigfield & Cambria (2010) highlight that interest leads to more robust participation, focused attention, and improved cognitive abilities. As such motivates learners to learn, and this linkage affects their performance. Therefore, it is believed that this motivation, supportive learning relationships, and learners' sense of control over the learning process result in enhanced learning (Leoudi, 2018).

2.6.6 Considered teaching methods under cooperative learning approach

It is very important to highlight that there have not been many studies that have used a cooperative learning approach to integrate IK in LFSC with learners as the primary participants. However, Jacobs et al. (2019) conducted a similar study that focused on teachers' ability to integrate IK in LFSC through cooperative learning methodologies. Their findings indicated that Jigsaw and De Bono's thinking methods make IK more accessible and improve participation and comprehension. As such, their findings are in line with those of Jacobs (2015) and Knapp (2014). Therefore, my study drew from such findings and some from other disciplines that have looked at group learning and discussions.

Jacobs (2015) found that learning in groups allows learners to incorporate different viewpoints and lived experiences from various contexts into critical reflective discourse. Agaama (2021) argues that this learning approach teaches learners to think critically, analyse the arguments made to support claims, cooperate, and discuss ideas in groups in an effort to, if at all feasible, come to an agreement and a common understanding. And if used properly in scientific classes, it can help science learners develop the trait of questioning assertions before accepting them on the basis of compelling evidence. Therefore, the teaching methods under the cooperative learning approach considered in this study are the Jigsaw teaching method and De Bono's six thinking hats.

2.6.6.1 Jigsaw teaching method

This study adapted Jigsaw was invented by Elliot Aronson (1978), in which the class is divided into groups and the classroom activity is divided into portions, with each group having their own piece to work on. During its implementation, the teacher selects the content to be explored and divides the class into small groups called jigsaws or home groups that consist of four to six learners. Secondly, learners from each home group are selected to form expert groups. Each expert group is assigned a piece of the main content to work on, which is different from one expert group to another. Here, learners join heads, prepare, and discuss their ideas together, and learn different perspectives on similar content. In this phase, learners are provided with enough time (Dhull & Verma, 2019) and opportunity to learn and understand the

material, gain clarity, and fill their knowledge gaps (Roseth et al., 2019). As such, these learners are considered the masters of the concept they are working on (Syed Anzar Ahmed, 2017).

Lastly, learners return to their home or jigsaw groups, where they become responsible for teaching and explaining the learned material to their peers, with the aim of making all of them competent. Here, learners work together again to combine information and produce a final joint work through integration and evaluation. This helps learners to create a shared understanding and respect for one another as contributors to their learning (Adams, 2013; Sabbah, 2016).

From the above description, it is apparent that the jigsaw learning method maintains an interactive learning context, enhanced learning, and shared understanding. Therefore, in the Aydin and Biyikli (2017) study, it was found that learners were able to participate actively and express their ideas better in jigsaw learning. These authors concluded that the jigsaw method establishes an effective learning environment that promotes learner success and active participation. They further indicate that this can be beneficial for the elimination of misconceptions on any subject. Giving support to that, Sabbah (2016) lists that the strategy authorises learners to take charge of their learning, retain and retrieve knowledge with ease, and oppose learner inattentiveness. In accordance, Hidayah et al. (2017) also found that the jigsaw learning method increases learner activeness in the classroom.

The jigsaw method is also believed to develop learners' affective domains (Karacop & Diken, 2017). Similarly, Nurbianta and Dahlia (2018) reported that this method motivated learners and enhanced their interest in learning. Researchers have shown that learners' interest is critical in the teaching and learning process as it derives curiosity, engagement, commitment, and determination to succeed (Patesan et al., 2016). Therefore, Adams (2013) argues that during Jigsaw learning, learners develop an interest as a result of group cooperation and working with one another. This in turn steers the zeal to learn and promotes better relationships among learners' and teachers' (Bhandari et al., 2017).

Baneng (2020) observed that learners had difficulty understanding the reading material and used the jigsaw method to address the problem. As part of the

intervention, learners had to retell the storey and discuss it with their group members. The author concluded that the approach increased learners' understanding of the reading material as a result of storytelling and group discussions. He added that the jigsaw setting allowed learners to help one another learn and develop their comprehension skills. From this, I draw the conclusion that the jigsaw method will benefit my study as it will enable learners to recall information. So, in my study, learners have to recall, share, and retell their IK related to LFSC themes.

Another study by Ojekwu and Ogunleye (2020) examined the effect of a jigsaw learning strategy on science learners' performance and interest in LFSC. They discovered that the technique enhanced learners' achievements as a result of the active interactions and involvement that occurred within individual, small group, and whole-class learning activities. These authors pinned that on the engaging nature of the jigsaw learning groups. Their findings concur with those of Chukwu and Arakoyo (2019) and Oliveira et al. (2019).

2.6.6.2 De Bono's thinking hats

De Bono's thinking hats is a teaching method developed by Edward De Bono (1985) that consists of six metaphorical hats, each defining a certain way of thinking. There are white hats that contain facts, yellow hats that contain benefits, black hats that contain cautions, green hats that contain suggestions, blue hats that represent the process, and red hats that represent feelings. According to Theologis (2017), six thinking hats allow learners to focus on and deeply broaden their thoughts about the same issue at once (Payette & Barnes, 2017). According to De Beer (2009), this method is great for infusing IK with Western science because it is the best way to explore controversial issues and make decisions.

Kumari (2022) views the six thinking hats as a framework for thinking that leads to a deep understanding of concepts. She emphasises that thinking skills include information processing, reasoning, inquiry skills, remembering skills, organising skills, analysing skills, and generating, integrating, and evaluating skills. All these skills are helpful in effective learning, better understanding, and application of acquired knowledge, problem solving, and decision-making. In addition to improving the achievement level of learners in any area of their lives,

In the same vein, Kivunja (2015) asserts that the six thinking skills are necessary for critical thinking, which is defined as the cognitive process that develops the ability to interpret, analyse, and evaluate information, arguments, or experiences. This then uses a set of reflective attitudes, skills, and abilities to usher in our thoughts, beliefs, and actions. This definition emphasises the need for critical thinking in conveying or proving a point, analysing, and interpreting the significance of given views or ideas, and using what has been learned to address new issues. It can also be employed for the development of creative skills (Oleksii et al., 2017).

Likewise, Gupta and Bhattachary (2015) say six thinking skills posit learners should focus on ‘knowing how'' as well as ‘knowing what’ when interrogating elements of knowledge. These authors argue that the hats facilitate a way of thinking skills in the classroom, which they have categorised into four. That is information processing, reasoning, inquiry, creativity, and evaluation skills. They indicated that information-processing skills allow learners to locate and collect relevant information; to sort, classify, sequence, compare, contrast, and analyse parts or whole relationships. Secondly, reasoning skills allow them to give reasons for opinions and actions, draw inferences, and make deductions. And to use precise language to explain what they think and make judgments and decisions informed by reasons or evidence.

On the other hand, inquiry skills enable learners to ask questions, pose and define problems, and plan what to do and how to do it. And further predict outcomes, anticipate consequences, test conclusions, and improve ideas. While creative thinking skills allow them to generate and extend ideas, suggest hypotheses, apply imagination, and look for alternative innovative outcomes, and lastly, evaluation skills enable learners to evaluate information and judge the value of what they read, hear, and do. And to develop criteria for judging the value of their own and others’ work or ideas, and to have confidence in the judgments. It is clear that this teaching method is designed to help with the deliberate search for and appreciation of different perspectives (Bayati, 2015).

Supporting the above contentions, Kumari (2014) revealed through her study that the six thinking hats are helpful in the development of parallel thinking, lateral thinking, general creativity, and argumentativeness among learners. In agreement, Dasar

(2019) reported that this method has the potential to assist learners in thinking critically through step-by-step development. It shows that learners can acquire practical knowledge by using reasoning and logic in an innovative way for a deep understanding of the concept.

Animasahun (2007) stated that the six thinking hats technique facilitates knowledge transfer, improves communication, and decreases disruptive behaviors in the classroom environment. As it requires learners to focus on one item at a time and think about it from different perspectives, Also, Kaya (2013) is of the view that this technique gives effective results in the specification of problem-solving and increases learners' success, curiosity, and interest in class. And as a result, it develops better communication among learners.

According to Hani et al. (2017), it is critical to create a relaxed and engaging learning environment where learners are free to speak up and express their opinions. Therefore, these authors investigated the effect of six thinking hats and critical thinking on speaking achievement. They employed this learning method with the hope that it would allow learners to broaden their thinking. According to their findings, learners did well in terms of vocabulary, fluency, and comprehension. They concluded that the results are related to the use of the thinking hats, which mandated learners to think, learn, and understand the content they would be presenting before they spoke. In other words, they tend to get ready to add new phrases that are pertinent to the information they will be presenting to the class. Adams (2015) added that the comprehension level occurs when learners are able to show understanding of the meaning of the information that they encounter by paraphrasing it in their own words and explaining the ideas to others.

Similarly, Shi and Han (2019) explored how cooperative group learning helps to improve learner autonomy. According to their findings, cooperative groups enhance learners' attitude, interest, and motivation towards learning. It further improves their language competencies (Swamy et al., 2019). These authors found that learners use the language they know to communicate, brainstorm the given topic, look at the issue from different angles, and discuss and debate various perspectives during De Bono's six thinking hats activity. Hence, in the process, they develop language

competency, which is crucial in the preservation and transmission of knowledge (Khupe, 2017). Additionally, Hani et al. (2017) emphasised that learners tend to be more fluent in speaking because the strategy encourages them to be more comfortable speaking and sharing their ideas and thoughts.

Nie and Aziz (2019) investigated how learners perceived the use of De Bono's red, yellow, and green thinking hats technique to improve reading and answering comprehension questions in English classes. The results showed that all participants viewed the technique as interesting and useful. It supported their language learning, offered peer support and feedback, and boosted their confidence. These findings are in consonance with those in the Alghamdy (2019) study. According to these authors, thinking hats help learners to articulate and generate their thoughts in a more critical, driven, and constructive manner. Hence, the technique enabled learners in their study to respond to comprehension-based questions by paraphrasing their responses in their own words. And to apply knowledge in new contexts and assist them in integrating knowledge into their current cognitive schemas (Nie & Aziz, 2019).

In line with Nie and Aziz (2019), and Payette and Barnes (2017) maintain that each learner takes a stance and perceive the issue as a group, taking into account all perspectives "in parallel". Thus, help them comprehend the specific circumstance. Therefore, each learner in the group act as solution provider for every issue they encounter in accordance with the scenario provided (Grenier & Yeaton, 2019). This is because the tactic calls for more cognitive processing as they put on their thinking hats in the classroom, than just remembering facts (Nie & Aziz, 2019). They further emphasise that the technique will help learners understand that every action they will be taking in any situation; whether in a classroom or in real life, requires them to implement critical thinking skills.

2.7 The role of theory in the study

The theory underpinning this study is social constructivism theory by Lev Vygotsky (1978), which holds that knowledge is actively constructed during social interactions. This theory served as a lens to interpret data that was analysed in this study. It is therefore important to highlight that social constructivism is a branch of the umbrella

theory, constructivism, advocated by three psychologists, Jean Piaget, Lev Vygotsky, and John Dewey (Brau, 2020). Constructivism stresses that knowledge is actively constructed as opposed to passively received and is built by linking existing knowledge with new ones (Golder, 2018). As such, Vygotsky (1987) argues that knowledge construction is embedded in social and cultural contexts, wherein individuals are active agents in the construction of their own knowledge through interactions with others. The interactions involved include conversations, negotiation of ideas, and collaborative activities in action for knowledge formation (Allred, 2020).

Moreover, Kapur (2018) added that the social construction of knowledge occurs in a variety of ways and at multiple locations. Learners gain the information and experience needed to live successful and productive lives when they engage with people and their material and immaterial surroundings. McLeod (2018) indicates that social constructivist theory posits the teacher as the creator of learning environments that stimulate active interactions among learners. Hence, this study adopted cooperative learning approaches as a way to establish learning context based on active engagements and interactions in groups, wherein learners can communicate their IK. Therefore, components of this theory considered in this study are culture, language, and the zone of proximal development (ZPD).

2.7.1 Culture

Culture encompasses all of a society's shared information, beliefs, attitudes, behaviours, and values (Idang, 2015). As such, Vygotsky (1962) indicates that learning cannot be isolated from its social and cultural context. Therefore, cultural tools such as language, traditions, and beliefs form an important base for learning within contexts. He indicates that learners use these tools for their learning, which are different from one group to another in a society. On that note, Cherry (2022) supports the idea that learning is a social process of acquiring the culture of those we interact with and using that to help us understand the world.

This study required learners to share their IK views with one another in relation to LFSC content. Thus, allow each learner to use their cultural tools to construct new knowledge in the LFSC classroom. Consideration of culture offered learners the flexibility to draw from their own beliefs and traditions and use their own language to

communicate and support their views as they collaborated with one another. It also allows learners to be more engaged and receptive to the information from others.

2.7.2 Language

Language is a set of written or spoken symbols that serve as the foundation for thinking, reasoning, and comprehension developed from social interactions (Vygotsky, 1962). Moreover, language facilitates cultural transmission and communication during social interactions, as well as building and sustaining relationships (Vygotsky, 1987). It is seen as the ability through which we gain the ability to comprehend and communicate through speech. Therefore, Vygotsky (1987) listed three forms of language, which are social speech, private speech, and inner speech, used to organise thoughts and regulate behaviour during social interactions. He clarified that social speech is used for communication purposes. While private speech is personal and facilitates an individual's intellectual functioning, It is also viewed as the transition point between social and inner speech, where language and thought tie together to form verbal thinking. Moreover, inner speech is composed of thoughts that are connected with the words to be said. Private speech is the expression of inner speech. Hence, McLeod (2018) highlights that the internalisation of language is vital as it drives cognitive development. Language is therefore an accelerator for thinking, communication, and understanding during social interactions.

The aim of this study was to explore learners' views on the integration of IK-related topics in LFSC, which learners had to tell their IK on certain items. Therefore, language enabled learners to scrutinise the learning material to understand what was represented and required of them. As such, the use of language that learners understand qualifies them to arrange their thoughts, communicate, and give their views, both spoken and written. In this study, learners used both the language of teaching and learning (English) and their home language (Sepedi) to facilitate learning, communication, and understanding amongst them. Thus, it allowed me to draw conclusions from the learners’ points of views, as reflected in the meanings they attached to certain items.

2.7.3 Zone of proximal development

Vygotsky (1978) asserts that learning can only occur within the ZPD. This is the developmental level that distinguishes what the learner can and cannot do independently and with the help of knowledgeable others, such as peers and adults who have a greater comprehension of a concept. Actual and potential development are the two stages of the ZPD. Actual development refers to what a learner can do on their own, whereas potential development refers to the level to which a learner can go under guidance or in collaboration with others. He further suggests that it is through mediation and assistance by more knowledgeable others (MKO) during social interactions that can facilitate the development of learners from one level to another. Therefore, interactions that occurred during this study enabled learners to convey what they know (IK) and do not know concerning LFSC concepts while simultaneously gaining some knowledge from others in the learning context.

Central to ZPD are mediation, MKO, and scaffolding. Denhere et al. (2013) support that teaching in the ZPD, where learning is mediated and scaffolded by the MKO, makes learning easier and more meaningful. Beal and Arroyo (2002) indicate that learning is said to be in the ZPD if learners can show efficient and effective learning.

- **More knowledgeable other**

The more knowledgeable other refers to those who have better knowledge, understanding, and skills than the learner regarding the task, process, or concept (Cherry, 2023; McLeod, 2018). Others can also be tools and interactions that can channel learners to the ZPD (Abtahi et al., 2017). As clarified by Vygotsky (1978), learners' social interactions with MKO and their environment influence their ways of thinking and interpreting situations. It is the communication that occurs in these settings that helps the learner construct their knowledge and understanding.

In this study, the teacher, learners, the textbooks, learners' families or communities, and the environment served as the MKO's. The teacher developed groups for interactions, presented the lessons, and gave background information and resources. She served as the facilitator, guiding and providing instructions on what was required of the learners for effective social interactions. She also clarified some items for

learners. Learners were able to share their IK views with their peers and the teacher, thus assisting and facilitating knowledge construction. Moreover, the textbooks had information about some items that learners were not familiar with; hence, they were required to draw IK from that. Families or communities instil knowledge in the learners, which serves as their reference point during classroom interactions and knowledge construction. Lastly, learners were expected to help their peers comprehend an item by showing and pointing it out as it was apparent in the school environment. This was expected to allow learners to link what is done in class with the context in which they would find themselves and construct knowledge and they share their IK views.

- **Mediation**

This refers to parts played by other people or tools within and outside the classroom to help the learners move from one level to the next layer of knowledge and understanding. This stems from the view that effective learning emanates from the nature of social interactions between people with different levels of skills and knowledge (Vygotsky, 1978). Therefore, there is human mediation and symbolic mediation. Kozulin (2002) highlights that human mediation describes the involvement of MKO to enhance the learning experience. While symbolic mediation deals with how tools such as language and learning context influence learning, It is clear that these mediators create supportive conditions in which the learners can participate by sharing their views and expand their skills and knowledge to the next level (Denhere et al., 2017).

In this study, human mediators are the teacher, learners, and their families or communities. There were activities that learners were engaged in that required them to talk and write. The teacher was expected to formed learning groups, which became communities of learning wherein learners were able to get together and share their knowledge and views. The teacher was also expected to be engaged in the classroom, which enabled her to assist learners in the learning process. Families or communities transfer their IK into learners, which they carry to their classrooms and serve as prior knowledge, which is used to construct the new knowledge. Therefore, learners, as part of the learning groups, were expected to provide their IK,

their views, and their ideas to help the whole classroom learn from one another and build new knowledge.

The textbooks, interactions, and the environment served as symbolic mediators. The textbooks had information about some items that learners were not familiar with; hence, they managed to draw IK from that. Lastly, learners were expected to help their peers comprehend an item by showing and pointing it out as it was apparent in the school environment. This was expected to allow learners to link what is done in class with the context in which they find themselves and construct knowledge. The interactions between the teacher, learners, and their environment was expected to allow learners to construct and share their knowledge with one another, both verbally and in writing using both languages, English and Sepedi, to facilitate communication and understanding.

- **Scaffolding**

Vygotsky (1978) emphasised this as the support provided by others (people and tools) to facilitate learners' development. He adds that scaffolding facilitates learners' ability to build on their prior knowledge and internalise new information. It enables learners to accomplish tasks that they could otherwise not complete without assistance (Bransford et al., 2000). Scaffolding is seen as a way to engage the learner and motivate them to learn (Van Der Stuyf, 2002).

Lajoie (2005) list three stages in scaffolding which is, contingency, fading and responsibility. Contingency involves using suitable strategies to aid learners learning. Such strategies should provide an insights if learners understand the task or not, and thus invite for modifications and assistance if necessary. While fading refers to the withdrawal of supports as learners get to understand the material and shows confidence. Lastly, responsibility occurs as the supports fades, which makes the learner more responsible and in charge of their own learning. Thus, allow for independent development. It is clear that the scaffolds are short- term and withdrawn as learners shows abilities to carry the task on their own increases.

In this study, this item allowed the teacher to use a cooperative learning approach to aid in the exploration of learners' views on the integration of IK in their learning of

LFSC. The teacher was expected to group learners, to present the lesson, and integrate IK into these lessons. She was then expected to give learners instructions and activities to provide their IK, ideas, views, and perspectives. She was expected to step back and let the learners write the activities on their own. However, she was also expected to make herself available to help those who needed it.

2.8 Summary of the chapter

This chapter presents literature related to the research topic. It has outlined what other researchers have found about the integration of IK in science classrooms by showing the link between IK, science, and learning. But it has not provided much insight into learners' views on the integration of IK in LFSC classrooms, especially when using a cooperative learning approach. This shows that there is a gap in the literature on the efficacy of a cooperative learning approach in the integration of IK. Moreover, the role of the theory underpinning this study, which is Vygotsky's social constructivist theory, has also been described. Therefore, the next chapter discusses the research methodology employed for this study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter (2) addressed the review of literature relevant to this study. This chapter explains the research approach and design used to explore Grade 10 LFSC learners' views on the integration of IK-related topics using a cooperative learning approach. It also outlines the context in which the study was done, selection of participants, data collection tools, the data collection process, and its analysis. Moreover, it speaks to the measures of trustworthiness and concludes with ethical measures.

3.2 Research approach

This study used a qualitative research approach. According to Haradhan (2018), qualitative approach enables the researcher to explore and discover issues about a particular phenomenon from an individual's point of view in their natural settings. Furthermore, Denzin and Lincoln (2000) highlight that qualitative researchers use words combined into meanings to present the collected data and offer insights for a better understanding of the phenomena as well as the generation of new concepts and theories. As such, the approach was found suitable for this study since its main aim was to explore Grade 10 LFSC learners' views about their IK linked to specific LFSC concepts. Therefore, the Grade 10 LFSC classroom was the natural setting through which the phenomenon, which is learners' views about their IK, was explored. Moreover, Myers (2009) showed that qualitative research uses different data sources like observations, interviews, questionnaires, and documents. Hence, this study used documents, interviews, and participant observations to collect data from the learners' point of view.

3.2.1 Research design

Cooper (2011) clarified research design as a set-up to collect, measure, and analyse data. This study used a case study research design. The main focus of this study was to explore Grade 10 LFSC learners' views on IK-related topics within cooperative learning contexts. Hence, a qualitative single case study was found suitable since its major purpose is to explore the phenomena within their natural

setting (Rashid et al., 2019). According to Stake (1995), qualitative single case study examines the particularity and complexity of a single case, coming to grasp its activity within significant conditions. Stake's approach to a case study is underpinned by a strong desire to understand experiences in context and find meaning, which places the researcher in a position to engage with the case and participate in the study (Harrison et al., 2017). Hence, this study adopted Stake's view of the case study since the interest was in exploring Grade 10 LFSC learners' views about their IK linked to specific LFSC concepts within a cooperative learning environment.

The design adapted an exploratory case study, which is meant to explore issues to understand foundational notions. This was drawn on the sight that being able to explore learners' views on their IK might reveal the efficacy of a cooperative learning approach in facilitating the integration of IK-related topics in LFSC classrooms. The case in this study was Grade 10 LFSC learners. On that view, Stake (1995) stressed that a case is unique, poses dominance with paramount importance, and should pose a problem to solve. Moreover, the boundaries of the study featured Grade 10 LFSC learners' views on IK-related topics at a secondary school in the Moroke circuit. Creswell and Poth (2018) posit that the boundaries enable the researcher to analyse varied participants' perceptions, gather multiple sorts of evidence, and pay close attention to the context in which all components of the study were embedded. Therefore, to build a rich and detailed picture of the case, the researcher used a variety of data collection tools, which are deliberated upon in data collection section.

3.2.2 Research setting

The research setting speak of the context in which research is carried out (Majid, 2018). The school selected for this study is located in the rural area of Limpopo Province, Sekhukhune East District in Moroke Circuit, situated along the R37 road in Fetakgomo-Tubbatse municipality. The area is declared the nodal point in terms of poverty index and is made up of vast villages that are scattered. It is dominated by Sepedi-speaking occupants of Ga-Sekhukhune. The area is arid and mountainous, with vegetation and animals that are adapted to dry environments. Learners enrolled in this school come from several villages under various traditional leaders that are

either in close proximity to the school or surround it, as well as the circuit. In this region, people still live in accordance with their traditional customs and beliefs.

3.2.3 Sampling

Sampling is the selection of representative individuals (samples) from the larger group (population), which becomes the basis for predicting the outcomes of the study (Okeke & Van Wyk, 2015). The population for this study was 233 Grade 10 learners at a secondary school in the Moroke circuit. Out of this 233 group, some learners are enrolled in the commercial stream, while others are taking the general stream, the science stream, or a mix of science and commercial subjects. This study used purposive sampling as it offers the opportunity for typicality, variety, accessibility, and learning opportunities (Stake, 2005). Therefore, all 69 Grade 10 science stream learners were purposefully selected to participate in this study. That was because they were all doing LFSC. Secondly, learners were easily accessible because I was their grade and subject teacher, hence the easy collection of data. Lastly, I thought the insights from the study would allow learners to learn from the study as well as afford the teacher the opportunity to shape the future practices of integrating IK in their classroom. However, out of the 69 learners who were eligible to participate in this study, only eight (8) learners were willing to participate.

3.2.4 Data collection

Data collection entails the procedure of collecting and measuring information to answer research questions and help evaluate research outcomes (Kapir, 2016). Insights (2020) indicates that there are data collection tools used to obtain, measure, and analyse data. Therefore, this study collected data on two sessions, each with activities for learners to engage in. Thus, document reviews (learners' scripts), observations, and interviews were used to collect data in all the sessions. The rationale for the aforementioned choices of collecting data is elaborated below.

3.2.4.1 Document reviews

Bowen (2009) remarked that the researcher should collect and interpret documents to give expression and meaning to the topic of interest. Creswell (2014) alludes to the fact that it channels the researcher to be on par with the language and words of

the participants, who have considered their written work. Therefore, in all the two sessions of this study, learners wrote activities (Appendix F) in groups, wherein their scripts were collected. Learners' scripts served as the documents to be analysed to draw out their responses in an attempt to response to the secondary research question one that sought to determine the influence of cooperative learning approach on the integration of IK in the Grade 10 LFSC classroom. Furthermore, the data collected from documents review intended to respond to secondary research question two, which sought to determine the relevance of IK held by learners that can be integrated into LFSC. In order to examine the responses related to each activity's component, I developed a document analysis tool (presented in Chapter 4), which helped achieve this goal.

The activities were developed by the researcher, and validation was done to establish their content validity. Slaney (2017) clarified content validity as the degree to which the instrument covers the relevant topics and aspects of the research problem and goals. This can be accomplished by, for instance, reviewing relevant literature and consulting experts in the field (Taherdoost, 2016). Therefore, in this study, the Grade 10 LFSC work schedule (DBE, 2011), the CAPS-approved Focus Life Sciences learners textbook (Clitheroe et al., 2011), and the People's Plants book (Van Wyk & Gericke, 2018) were looked into in order to extract relevant items to include in the activities. Additionally, the activities were sent to the study supervisor for further validation and approval.

3.2.4.2 Observations

Walshe et al. (2012) described observations as a way of collecting data using senses, looking, and paying attention to different behaviours at the research site in a systematic and significant way. This study adopted the participant observations; which gives me a chance to look at and engage in some of the activities at the research site they observe (Creswell, 2014). Therefore, I was a participant observer in all the sessions of this study, engaged in the lesson and moved around the classroom. In addition to the video recorder that was used, The teacher generated an observation tool (presented in chapter 4), to record learners' actual behaviour as they work and discuss together to complete the task in their respective groups. The

pattern of learners' behaviour during the learning experience; as well as interactions between learners, the teacher (researcher) and their environment were also recorded. Their speech, gestures and facial expressions were all considered. The reflexive journal was also used to note down some points during whole class discussions. The classroom observations intended to respond to the secondary research question one, which sought to determine the influence of cooperative learning approach on the integration of IK in the Grade 10 LFSC classroom, as well as secondary research question two which sought to determine the relevance of IK held by learners that can be integrated into LFSC.

3.2.4.3 Interviews

Interviews are a way of collecting data through question and answer between the researcher and participants, which gives the researcher an entry into what an individual thinks, allows the measurement of what they know, and draws on their beliefs and attitudes (Kumar, 2011). Therefore, this study adopted focus group interview, which allowed me to obtain information from a group of people who cooperate and from a specific person in the group (Creswell, 2014). In this study, interview was based on the overall learning (research) experience.

I posed a question to the group, stepped back, and allowed natural conversation to emerge from the group. Learners were taking turns answering the questions. The researcher continuously directed the conversation back to the topic by asking clarity-seeking questions. I encouraged all participants to express themselves by carefully picking out those who seemed to shy away and asking for their opinions. For an accurate record of conversation, questions, and answers, interviews were audiotaped. I also used a reflexive journal to jot down some points, especially the reactions of the listeners (learners who were not talking). The abovementioned data collection instrument was used to answer the main research question which sought to determine Grade 10 LFSC learners' views on the integration of IK-related topics, as well as the secondary research question one that sought to determine the influence of cooperative learning approach on the integration of IK in the Grade 10 LFSC classroom.

3.2.5 Qualitative data analysis

Stake (1995) alludes to data analysis as a meaning-making process wherein the researcher separates information and experiences into constituent parts and gives them significance. According to Flick (2013) data analysis is a foundational phase in qualitative study because any kind of data that is used, it is by analysis that researchers are able to make trustworthy judgement towards answering research questions. Furthermore, Creswell and Plano Clark (2018) suggest that qualitative data analysis is usually inductive in nature as such allows for data to be organised into themes by recognising overall patterns and associations among the themes. Hence, qualitative data analysis is an organisation and description of linguistic or visual data to generate accounts about implied and obvious proportions and structures of making sense of the material and what is represented in it (Flick, 2013).

In addition, Stake (1995) posits that case study researchers should choose between categorical aggregation and direct interpretation when analysing data. Creswell (2007) highlights that in categorical aggregation, the researcher searches for multiple instances or patterns in the data to derive meaningful conclusions. Whereas, in direct interpretation, the researcher looks for a single instance and derives significance from it. Therefore, in the context of this study I generally used categorical aggregation, inductive approach, and coding to analyse the textual material from the three data sets.

In an attempt to analyse the data drawn from the reviewed documents, the learners' responses were presented, and deliberations based on their similarities, and differences were made at the end of each question from the activities. This helped me to make conclusion of the learners' responses with regard to the research question that the instrument intended to answer.

Secondly, in an attempt analyse the classroom observations where I was the participant observer, I used In-vivo coding, which allowed me to stress on the actual spoken words by the participating learners during classroom observations (Manning, 2017). This is because In-vivo coding does not force the researcher to generate codes to data, hence the learners' responses during classroom discourse where written as they are during high and low moments related to the research question.

Lastly, In an attempt to analyse the focus group interviews conducted on the eight Life Sciences learners who participated in the classroom observations, I used verbatim transcription, which is defined as the transcribing of every word, includes the stammers, the gaps and the filler words as uttered by the interviewee (Saldana, 2009). After transcribing the teachers' responses, I then used In-vivo coding to help me make deliberations with regards to the research question.

3.3 Quality criteria

This study employed a qualitative research technique that emphasised trustworthiness by examining reliability, validity, transferability, and conformability (Lincoln & Guba, 1985; Pieterse, 2014). As a result, the instruments used to collect data were included in the application to the university ethical committee, which was followed by the supervisor's quality certification of the data obtained. All of this was done to safeguard the rights of the participants and assure the validity of the study. As a result, it was critical that the following criteria not be compromised in order to establish the research's quality: confirmability, transferability, credibility, and dependability are maintained throughout the study (Gay et al., 2014).

3.3.1 Credibility

Credibility refers to the believability of the research findings based on evidence, clear logic, and valid data (Polit & Beck, 2012). Furthermore, Credibility relates to the data's honesty and the researcher's depiction of that data in textual form (Polit & Beck, 2018). As a result, in order to assure consistency and correctness of the findings in the data obtained, the following actions were carried out to ensure the credibility and accuracy of the findings in this study:

- **Triangulation**

Noble and Heale (2019) defined triangulation as a tool for assuring the credibility and validity of a study. Frambach et al. (2013) employed four forms of triangulation: methodological triangulation, investigator triangulation, theory triangulation, and data triangulation. Data triangulation was employed in this study, which incorporated different data sources such as observations, semi-structured interviews, and document reviews (Frambach et al., 2013).

- **Prolonged engagement**

Prolonged involvement was used to acquire rich and trustworthy data (Kortjens & Moser, 2018). Furthermore, Creswell and Creswell (2017) said that the more time spent with participants, the more accurate the feedback. Three data collecting tools were utilised in the framework of this study: participatory observation, semi-structured interviews, and document review, which allowed for sustained participation.

3.3.2 Dependability

Dependability is defined by Frambach et al. (2013, p.552) as "the extent to which the results are consistent if the study is replicated or the extent to which the findings are consistent concerning the context in which they were generated." Creswell (2005) defines dependability as the consistency that determines a researcher's ability to collect data in the same way from numerous settings. In the context of this research, the following factors were assessed (Frambach et al., 2013):

- **Data saturation**

According to Mwita (2022), a researcher must assess if qualitative data has been acquired properly throughout the collection procedure. Data saturation, as defined by Frambach et al. (2013), is the process by which a researcher gathers data until no new themes emerge. In the context of this study, data saturation was ensured by using more than one data-collection instruments such as classroom observations and document review on several occasions. This contributed to the fact that no new data themes were created.

- **Iterative data collection**

According to Kekeya (2016), iterative means returning to the data or going back and forth on the data on a frequent basis. Iterative data collection, on the other hand, is defined by Frambach et al. (2013) as the continuous assessment of data throughout data collection to advise the researcher on how data may be obtained further. In the framework of this study, data was collected using two data collection devices, where data was now and again interrogated to deduce meaning.

3.3.3 Confirmability

This is the extent to which study findings may be confirmed and are free of researcher bias. To obtain the necessary confirmation, Stake (1995) suggests the use of protocols to accomplish the research. In this study, the supervisor confirmed and gave the go-ahead for each step. Also, I had a reflexive journal to record and confirm methodological decisions used to achieve all collected data, analysis, and conclusions.

3.3.4 Transferability

Transferability refers to the study's findings that may be applied in various contexts (Houghton et al., 2013). Transferability refers to the extent to which research results may be translated or applied in various situations (Frambach et al., 2013; Younas et al., 2023). This component attempts to determine whether the study findings are compatible with the my experiences and, as a result, look transferable to the reader (Terharne & Riggs, 2015). To address the component of transferability, the research employed the feature of a detailed description, which is discussed more below.

- **Thick description**

The detailed descriptions of the qualitative findings are critical to improve the transferability of the findings of the qualitative study. They enable researchers to evaluate their applicability in diverse contexts (Younas et al., 2023). According to Merriam and Tisdell (2016), a detailed description is essential for increasing the transferability and analytical generality of qualitative research findings since it allows researchers to test their applicability in other situations. A thick description, as described by Younas et al. (2023), is the act of offering a full explanation of the participants' views, goals, situations, reasons, meaning, and understandings. A dense description was handled in the context of this study by using in-vivo coding to assess the learners' replies during group interviews and document reviews.

3.4 Ethical considerations

Creswell (2003) emphasised that it is of significance that the researcher respects the research site and its participants' rights before, during, and after the study has been conducted. Therefore, this study adhered to the ethics elaborated below.

3.4.1 Permission

Before collecting the data, I applied for and obtained an ethical clearance certificate from the Turfloop Research Ethics Committee (TREC) at the University of Limpopo (UL). The approval of research ethics was sent to the Limpopo Department of Basic Education (LDoE) to request permission to carry out the research at the selected school. The approval of the permission letter from LDoE was sent to the circuit manager (Moroke) and the school principal (see appendices), asking for permission to perform the study. Therefore, permission was granted from all the stakeholders, which gave me authority to inform the learners about the study.

3.4.2 Policies

Since the study involved learners who are under the age of 18, some items were considered under the following policies to safeguard their rights and interests as the main research participants.

- **Children's rights**

Bell (2008) highlights the importance of respecting the safety and wellbeing of the learners and their rights to participate in any research. Therefore, this study was based on the learners as the main participants; therefore, their rights were strongly considered and respected. The following items were considered: consent and voluntary participation, protection from harm, and the provision of feedback on study findings.

- **Consent and Voluntary participation**

After receiving the approvals to conduct the study, learners were verbally informed about the study and ensured that they were given informed consent. Informed consent means all the parties involved in the study are thoroughly informed about the goals of the study in order to make educated decisions. Firstly, i verbally informed learners about the intended study in their classroom and announced the date. Learners were told to engage in the study voluntarily and freely, without any force or pressure. Hence, they can disengage at any point if they no longer feel comfortable. Secondly, interested learners were given assent forms and were also

given consent forms for their parents, guardians, or caretakers to sign (see appendices).

- **Protection from harm**

There was no potential harm that may have been imposed on the children in any way through their participation in this study. Learners were assured that the activities would not be used for any school-based assessment. Therefore, i ensured that no one suffered any physical, mental, emotional, or social harm as a result of their participation by forever being there, observing, and moving around the classroom during the process. Thus, there was no harm observed. Moreover, learners were also encouraged to report any incident that threatened them during the occurrence of this study, but no reports were received.

- **Feedback on the research findings**

I will make certain that the findings are communicated to the children who took part in the study.

3.4.3 Protection of Personal Information Act (POPIA)

This refers to the processing and sharing of personal information, as well as the protection of other important rights and interests, such as privacy (Thaldar & Townsend, 2021). Therefore, this study considered anonymity and confidentiality, security of data, and loss of privacy.

- **Anonymity and confidentiality**

Confidentiality means the participants' identities are known to the researcher but not to anyone else. Anonymity means that the participants' identities will never be revealed (Fleming & Zegwaard, 2018). Therefore, the learners in this study were known to me, but they used pseudonyms on their scripts instead of their real names. But they were required to mention their names during interviews to facilitate transcription. However, during data presentation, analysis, and before sharing the findings, i removed any identifying characteristics to ensure confidentiality and anonymity. Furthermore, when presenting photographs taken during observations,

learners' faces and their school emblem on their uniform are concealed. Participants are assured that their names will never be used for any purpose, nor will information be shared that reveals their identity in any way to protect them against unwanted exposure.

- **Security**

All the personal information and collected data are stored safely and securely on a computer and password-protected. Learners' scripts and observation tools were scanned and electronically saved per session. Videos for observations are also saved electronically per session. Moreover, the video data for interviews is also electronically saved according to each group name. This is to ensure that no one has access to it, to maintain confidentiality and integrity, and to avoid information leakage. These data records will be deleted or destroyed after two years.

- **Risk of loss of privacy**

Due to the nature of this study, learners might have lost their privacy during group activities and interviews, which required them to share their experiences and IK. In order to mitigate privacy loss, this study did not reveal any of the participants' names. Thus, anonymity and confidentiality are strengthened.

3.4.4 Safety of data

The researcher is obliged to keep research records for two years. Audio and video data are stored on a computer, are password-protected, and will not be shared with anyone else. All information from document reviews (learners' scripts) was scanned, electronically saved with a password, and will be kept on a computer for two years.

3.4.5 Issues of bias

To address the issue of bias from learners' side, i 1) encouraged learners to be themselves as there is no right or wrong answer as they share their lived experiences; 2) emphasised that each learner's point of view should be noted down in their respective groups and assured them of confidentiality and anonymity; 3) encouraged learners to provide as much information as possible about the issue at

hand; 4) moved among the groups and employed a more engaging tone to keep the discussions conversational and keep participants active to avoid learners being passive and providing the same views.

3.5 Summary of the chapter

This chapter explains the research methodology and design used to explore Grade 10 LFSC learners' views on the integration of IK-related topics using a cooperative learning approach. The research was conducted in one LFSC classroom at only one secondary school in Moroke Circuit, Limpopo Province. I was guided by the case study research design to collect qualitative data. Observations, interviews, and documents (learners' scripts) were used to collect the data. Moreover, the data was analysed using categorical aggregation and an inductive approach. Also, the tenets of the theory underpinning this study provided a lens through which observations were analysed. The trustworthiness of this study was achieved through credibility, dependability, confirmability, and transferability. Ultimately, i adhered to all the ethical issues as required by the registered university (UL), the provincial department of education (LDoE), the circuit (Moroke), and the school. Henceforth, the next chapter discusses the data analysis and interpretations of the findings of the study.

CHAPTER FOUR: PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

4.1 Introduction

This chapter focuses on presenting the data, its analysis, and its interpretation using the three tenets of the theory underpinning the study (culture, language, and Zone of proximal development). The interpretation of the analysed data is made after the presentation and analysis of each session. The presentation of how the data was prepared for analysis, presentation of the data as per each data collection tool and highlights the findings. The study used document reviews (learners' research scripts), observations (participant observations), and focus group interview to explore Grade 10 LFSC learners' views on the integration of IK-related topics using a cooperative learning approach.

4.1.1 Description of participants

Eight (8) learners participated in this study; they were six (6) girls and two (2) boys. Learners were divided into two (2) groups, each group having four (4) learners: three (3) girls and one (1) boy. In this study, learners were given pseudonyms in order to protect their identities and to strengthen the anonymity and confidentiality of the participants. Therefore, the groups and learners were given names as follows: Group (G) one as G1 and Group (G) two as G2; and learners (L) were named L001 to L008. All these learners belong to the same classroom and are doing the same subjects, which are: Sepedi Home Language, English First Additional Language, Mathematics, Life Orientations, Agricultural Sciences, Life Sciences, and Physical Sciences. Table 4.1 below presents the biographical details of the participants.

Table 4.1: Biographical details of the participants

Participant	**Group**	**Gender**	**Age**
L001	G1	F	16
L002	G1	F	15
L003	G1	F	15

L004	G1	M	15
L005	G2	F	15
L006	G2	F	15
L007	G2	F	15
L008	G2	M	15

4.1.2 Preparation of data

This study had two sessions (days 1 and 2), and data was collected using document reviews (learners' research scripts), observations (participant observations), and focus group interview. That is to say first session (day 1) learners were observed and provided and activity and second session (day 2) learners were observed, provided and activity and focus group interview took place after the last session. As such, Abdallah et al., (2017) highlight data preparation as the process of manipulating data, transforming it from its existing representation, and organising it into a form that is ideal for analysis. Herein, there is a presentation of how data organised and prepared for an analysis.

4.1.2.1 Document reviews

In the first session, learners were given two activities to write. The first activity **(Activity A)** was written individually to serve as a stimulant for collaboration and class discussion and will not be used to answer any of the research questions. The second activity **(Activity B)** was written in groups. In the second session, only one activity was given **(Activity C)** and written in groups as well. Learners' scripts were then collected for analysis.

4.1.2.2 Observations

In all the sessions, I was a participant observer. I presented the lesson using two different methods: jigsaw in the first session and De Bono's Thinking Hats in the second session, and later gave learners activities to do. I moved around the class and from group to group. Learners were observed throughout the sessions, video

recorded, and some observations were recorded on the observation schedule. A reflexive journal was also used to note down some points, especially during the whole classroom discussion. The videos were later watched, comparing what was recorded and captured on the observation schedule to avoid missing some items.

4.1.2.3 Interviews

During interview sessions, i used a video recorder to capture conversations and reactions. The video data was saved in different folders labelled according to each group name, to be transcribed into a Word document. After the transcription of the data, i listened to the recording again while reading the transcriptions to check for any mistakes or omissions and made corrections and additions where necessary.

4.2 Data presentation and analysis

This section presents and summarises the results of the collected data and provides insight that will drive decisions to answer the research questions. Therefore, the data from each instrument is presented and analysed separately per session.

4.2.1 Presentation and analysis of data for the first session

4.2.1.1 Presentation and analysis of document data (learners' scripts)

Initially, learners were not seated in groups; therefore, I gave each learner a work sheet for Activity A to write individually within 10 minutes without helping one another. The activity was only meant to serve as a stimulant for collaboration and class discussion and will not be used to answer any of the research questions. This activity was motivated by Van Wyk and Gericke's (2018) notion that there are various plant species in learners' communities that are used for different purposes, some of which may be used in LFSC classrooms to link the content with context. Therefore, this activity featured seven plants that are commonly used as food sources and were linked to the topic of organic compounds. Learners were required to determine the name(s), main nutrient(s), and other uses of the plant. As such, by looking at the sampled learners' scripts (Figure 1), one can notice that learners were able to identify the plant, list its nutrient(s) and uses, but could not provide scientific names. Since this activity will not be used to answer any research question(s).

Secondly, after the discussion of the items in Activity A, I adapted the Jigsaw teaching method and grouped the learners into two groups, entailing four learners per group. The presentation of the lesson to the whole class, based on the seven terrestrial biomes of South Africa. As a researcher/teacher I defined a biome as any region made up of various ecosystems with distinct climatic conditions, soil types, vegetation, and animal species. Therefore, the lesson objective was to help learners understand South African biomes, their locations, and how the local climate and soil conditions affect the kinds of plants and animals that are found there. Furthermore, understanding biomes makes it possible for one to talk about environments, how plants and animals adapt in different areas, and how they can benefit people living there. As such, I integrated IK into this lesson by highlighting the indigenous uses of various plants and animals found in different biomes, such as the Marula tree, which is mainly found in the Savanna biome and is mostly abundant in the learners' area.

Moreover, learners were given an activity (Activity B) to work on in groups—jigsaw groups. When using the Jigsaw method, the class is divided into groups (home groups and expert groups), and the classroom activity is divided into portions, with each expert group having their own piece to work on. And later, expert groups separate, go back to their home groups, and share all that they have learned in their expert groups with their peers in their home groups.

As such, in the given activity, learners were expected to identify the name of the plant or animal, the biome(s) where it is found, and the traditional use of that plant or animal. This activity integrated IK as it required the traditional uses of plants and animals to check if learners knew what plants and animals offered. The activity had two talking points: one was based on animals (three animals) and the other on plants (three plants). Initially, learners were in their home groups, as indicated in Table 4 above, noting that there were only two main groups. The two home (main) groups were further divided into four expert groups, each consisting of two learners. The expert groups were named A to D, given a specific topic to study, and provided with materials to read. Two expert groups (A and B) studied plants, and the other two (C and D) studied animals. Moreover, Table 4.2 shows the arrangements of the learners and topic allocation as they were engaged in the jigsaw activity. The codes G1 and G2 under group members represent the home group to which the learner

belongs. I ensured that each expert group is composed of one learner from each home group to avoid having two learners from the same home group studying the same topic together.

Table 4.2: Learner arrangements and topic allocation

Expert group	**Group members**	**Topic**
A	G1L001 and G2L008	Plant
B	G1L003 and G2L006	Plant
C	G1L002 and G2L007	Animal
D	G1L004 and G2L005	Animal

In each expert group (see figure 1), learners studied the assigned topic together, exchanged ideas, and discussed issues while writing them down on their note-taking sheets. The time allocated for this activity in the expert group was 20 minutes. Later on, learners returned to their home groups to share information about what they had learned from their expert groups with their peers.

Figure 1: Learners working together in Jigsaw expert groups

Subsequently, i handed out a question-and-answer sheet with all three plants and three animals studied in expert groups for learners to write down their answers in their home groups. The time allocated for the home group activity was 20 minutes. There was only one learner who served as a scribe per home group. Later on, we engaged in a classroom discussion as they presented their answers about each plant and an animal. I then collected the learners' scripts after the session.

Due to the nature of jigsaw learning, it is important to note that most learners' answers might be the same. Therefore, for easy data presentation and analysis purposes, I consolidated learners' responses into one, in table 4.3 below wherein deliberations are also made for each item. This was also necessary because all these responses were shared and discussed with the whole class. Therefore, for analysis of the activity presented in table 4.3, I have developed document analysis tool shown in table 4.4 below.

Table 4.3: Data presentation and interpretation of learners' responses on the Jigsaw activity

Diagram	**Name of the plant/ animal**	**Biome(s) where is found**	**Traditional uses**
	Learners' responses		
	*Elephant (Loxodonta aricana)*	*Savanna, grassland, and thicket*	- *Inhaling the smoke of burned dungs heals headaches, toothaches, nose bleeds and unblock sinuses* - *Smoke also keeps mosquitos away.*
Deliberations: Here, learners managed to identify the animal, by providing the common			

English name and a scientific name. They also listed the biomes in which it may be found, as well as its traditional uses. Learners made most reference to the traditional use of only one item, which is dung, and did not mention other parts and their uses. As such this reflects the learners' knowledge and understanding of the animal and plant. This is drawn from their ability to provide the scientific, common English and vernacular name of both the plant and animal.			
	*Sekgopha* *(Aloe ferox)*	*Savanna, succulent karoo and grassland*	- *Mothers use it to stop their babies from breastfeeding by rubbing their nipples with the gel that comes from the cut-off leaf. Then that bitter taste of the gel will make the baby to fear the breast.* - *We collect the dried plant for making fire.* - *Apply it to wounds and bleeding gums* - *Mixed with Vaseline and apply it on the body to prevent sunburn, and on the hair to prevent natural hair damage in winter*

			- *Apply them to dipudi (ringworm) to stop them from itching and spreading* - *Boil and drink the water to relieve constipation* - *Use its leaves to make a rope* - *Making the medicine called Lewensessens*
Deliberation: Learners were able to identify the plant, giving it a vernacular name and a scientific name. They allocated the plant to three different biomes, listed its traditional uses, and highlighted how it is used. Their responses show that they are well versed in this plant. It is interesting that their knowledge of how mothers stop their children from breastfeeding is also apparent in the Senol, Ercan, and Karatekin (2023) study. Moreover, learners have mentioned the value of this plant gel for healing and as a cosmetic. Their views are in parallel with those who applaud the anti-inflammatory and hydrating properties of this gel (O'Brien, Van Wyk, & Van Heerden, 2011). Learners also mentioned the modern use of aloe ferox, which was not required.			

	*Mošwaana, (Acacia karroo) or sweet thorn*	*Savanna and Grassland*	- *Drink water of the boiled or soaked bark for fever* - *Smoke of the bark treat headache and eye problems* - *Gum from the wounds of the barks are used to treat sore throats, soothe coughs and relief tooth pains* - *The thorns (not dried) can be chewed to treat stomach- ache* - *Dried thorns can be used as pins when sweing traditional mats (legogwa)* - *The leaves, bark and the thorns are soaked or boiled to treat cattles, goats and sheeps from poisoning and sicknesses by allowing them to drink the water* - *We cut them down*

			for firewood, building and as fence (ka mashemong and in newstand)
Deliberation: Learners were able to identify the plant; gave it a vernacular, English and a scientific name. They allocated the plant to only two biomes and listed its traditional uses. They have highlighted its medicinal uses for both humans and animals, and on traditional technology. Their views agree with those of Dingaan and Du Preez (2017) who alluded that *Acacia Karoo* has many socio-economic benefits for most of the South Africans.			
	*Springbok, (Antidorcas marsciplalis)*	*Savanna, forest, grassland, and desert*	- *Provide us with meat* - *Use the skin, bones, blood, and the food inside its stomach to treat ulcer and babies tummy problems* - *The skin is used to make clothes, bags, mats, headband, arm bracelet and to decorate furniture* - *The horns bring luck to those who wear them* - *The horns can be used to decorate rooms by mounting them on*

			the walls
Deliberation: Learners were able to identify the animal; they gave it an English and a scientific name. They allocated the animal to four biomes and listed its traditional uses. They have referred to it as a food source and highlighted its medicinal uses, traditional technology, arts, and crafts. These traditional uses of the springbok are also mentioned by Roche (2005). Therefore, I agree with these learners on the clothing and decorative items made from this animal, which also provide a source of income to those who make and sell such items.			
	*Noko, Porcupine, (Hystrix africaeaustralis)*	*Savanna, desert, grassland and forest*	- *Its spine prevents nose bleeds* - *Dried and crushed intestines are used to treat stomach- ache* - *Traditional healers use them to enhance their strengths and protection against enemies* - *The spine can be placed at any room at home to chase evil spirits and protect the family from witchcrafts* - *Their quills are used as ornaments and talismans*

Deliberation: Learners managed to identify the animal; they gave it a vernacular, English, and scientific name. They allocated it to four biomes and listed its traditional uses. Amongst other uses, learners linked this animal to protection against enemies, evil spirits, and witchcraft, which shows the metaphysical purposes. This disclosure was also reported by Neiman, Leslie, and Wilkinson (2019). Interestingly, Cronje et al. (2015) point out that aspects like these should not be overlooked in science classrooms; instead, a holistic approach to IK should be adopted in such instances.

	*Cancer bush, (Sutherlandia frutescens)*	*Fynbos biome*	- *Treat cancer, fever and loss of appetite*

Deliberation: Learners were able to identify the plant; they gave it a common English name and a scientific name. They allocated it to only one biome and listed its traditional use, the medicinal use. From their listing of the uses of this plant, it shows that learners are not familiar with this plant. Nonetheless, these are among the other traditional medicinal benefits of this plant listed by the Cancer Association of South Africa (CANSA) (2021), drawn from various scientific studies that have evaluated this plant. So, there is still more to this plant that learners did not mention.

The table above presented learners responses of the written activity, and deliberations were made with reference to what and how the learners have responded to the specific item of the activity. Therefore, table 4.4 below was developed in order to aid with the analysis of the learners responses presented above (in table 4.4).

Table 4.4: Document analysis tool: Jigsaw learning activity

ITEMS	YES	NO	OTHER COMMENTS
Were learners able to identify and provide the names for:			
All the given plants	**X**		Provided common English names, vernacular and scientific names
All the given animals	**X**		Provided common English names, vernacular and scientific names
The biome(s) in which the plants/ animal may be found	**X**		
Were learners able to provide the traditional uses of:			
All the given plants	**X**		They have included the modern use of the *Aloe ferox*
All the given animals	**X**		

The table above was developed in order to aid with the analysis of the learners responses presented in table 4.3 above. From its contents, it is evident that learners were able to identify and provide names and the biomes from which the given plants and animals may be found. Learners were also able to provide the traditional uses of both the plants and the animals.

Overall comments

From the above learners responses (in table 4.3) and the document analysis tool (table 4.3), one can see that learners were able to identify all the given animals and plants. They managed to give them names, inclusive of common English names, scientific names, and vernacular names. Learners could also pick out the South African biomes in which each plant and animal could be found and put together their traditional uses. However, they have also included the modern use of aloe ferox, which was not needed. This shows that they have misinterpreted the question, as it required only traditional uses. Therefore, from this misinterpretation, the drawbacks of the Jigsaw learning method can be drawn. It revealed that if there is any false information from one group of learners, the whole class will carry the misunderstood concept unless the teacher can pick that out and correct the mistake. But the good thing about this learning method is that it allows learners to have common knowledge and understanding of the concepts as a result of group and class discussions.

4.2.1.2 Presentation of data from observations

Observations were made by me (participant observer) when learners were working on the jigsaw activity (Activity B) and giving answers during classroom discussions. Learners were video recorded, and some observations were noted on the observation schedule and the reflexive journal (during the whole classroom discussion). These observations were done in order to explore the efficacy of the jigsaw learning method in facilitating the integration of IK in the LFSC classroom. Information from the video and the reflexive journal was transferred to the observation schedule during data preparation. Therefore, seven areas of interest were taken into consideration during the process. That is, held indigenous knowledge and sharing of it; knowledge construction and negotiation; learner communication and interaction; learner attitude and motivation; learner involvement—being passive or active; time spent on various activities; and lastly, decision-making (see observation schedule below).

Table 4.5: Observations recorded on the first session

Schedule of class

Date: 19 June 2023	**Time: 10 am**
Items	**Comments**
1. Held indigenous knowledge and sharing of it	- Learners do have IK related to the given plants and animals and are able to share it within their groups and to the class. - But they seem not to have any IK related to an elephant and cancer bush plant. They copy directly from the support material. I could not hear anyone giving any additional information related to this two items.
2. Knowledge construction and negotiation	- Learners use their own prior knowledge (held IK), ideas from their peers (in their groups and the class), their environment (learner L004 points the Acacia karoo plant through the window, and the support material given to them to construct and negotiate the knowledge. - They are all engaged, giving information, and asking questions.
3. Learner communication and interaction	- Learners do work well together as a team/ group - They use both Sepedi and English to present their ideas. - They give each other a chance to talk and take turns to present their ideas; one learner speaking at a time - They listen to one another and show respect - They are able to ask questions and give each other a feedback
4. Learner attitudes and motivation	- Learners display a positive attitudes towards the learning experience since they work actively and collaboratively with one another, none seem to be disengaged. - Learners seem to be motivated enough to learn more from their peers since they are able to

	cheerfully share their ideas and politely ask questions.
5. Learner involvement: being passive or active	- All learners were actively involved and engaged. They are talking to one another, reading the material together, and writing their points down. - Learner L004 points an *Acacia karoo plant* through the window for others to see it.
6. Time spent on various activities	- Time is used effectively for all the activities. But they have spent more time discussing the Porcupine, Springbok, *Aloe ferox* and *Acacia karoo*; than on the elephant and the cancer bush plant.
7. Decision making	- Learners presents their ideas to the group, the idea is discussed, and they make conclusions together. They write their conclusions down as a group. Conclusions are not made by an individual.

The table above presented the records of what has transpired during classroom observations when learners were engaged in a Jigsaw learning activity. Therefore, below is the stretching of what is recorded on the observation schedule above on: (1) held indigenous knowledge and sharing of it, (2) knowledge construction and negotiation, (3) learner communication and interaction, (4) learner attitude and motivation, (5) learner involvement—being passive or active, (6) time spent on various activities; and lastly, (7) decision-making.

(i) Held indigenous knowledge and sharing of it

The majority of the learners do have IK related to some of the given plants and animals, and they were able to talk about and share that knowledge. This was evident when they were working on the Aloe ferox and Acacia karoo plant, wherein learner (L004) even pointed the Acacia karoo plant through the window (see Figure 2) so that others could see it. They were also able to talk a lot about pork and springbok. But that was not the case with the cancer bush plant and an elephant, as learners

appeared to be reading and copying directly from the materials given to them. From this act, I could see that they do not have IK related to these two items.

Figure 2: Acacia Karoo plant found within the school

(ii) Knowledge construction and negotiation

Learners could construct and negotiate knowledge as they were able to express and share what they know and add to what they receive from their peers and environment, as well as what they read from the materials given to them. They were working together, doing one thing at the same time; none seemed to be disengaged. They could construct and negotiate knowledge through active interactions with each other and the material given to them. They were talking and even asking for clarity from their peers and the teacher until they reached a common understanding and wrote down their conclusions. They even asked me the vernacular name of the cancer bush plant because none of them knew or had seen the plant. It is clear that they wanted support and to link what they do and see in class with what they experience at home or in their environment.

(iii) Learner communication and interaction

The learners were freely and actively talking to each other and the teacher. They used both English and Sepedi to converse and to present answers in class, in their

respective groups, and on their answer sheets. Their communication was good; I could see and hear them giving each other a space to give and receive information without making any interruptions while one was still talking. They showed respect for each other's ideas and waited for one to finish talking before they could ask them any questions or clarify anything. This was also evident during the whole classroom discussion, where some learners raised their hands to ask for clarity once we were done elaborating on the item. Moreover, good listening skills and cooperation were highly illustrated by the learners.

(iv) Learner attitude and motivation

Learners had a positive attitude towards this learning experience because they were active, engaged, and free and relaxed during discussions. They could cheerfully share their IK and showed the desire to know more by politely asking questions and getting clarity from their peers and the teacher. They appreciated and valued each other's views, and as a result, it motivated them to say and learn more from one another, their environment, and the provided study material. None of them seemed to be disengaged.

(v) Learner involvement- being passive or active

All the learners were actively involved and engaged. They could talk and share their IK and even go through the study material with their peers, looking for more information. They offered each other support; this was evident when one learner pointed an Acacia Karoo plant over the window for the rest of the class to see.

(vi) Time spent on various activities

Learners were able to use the time allocated for each section wisely. But they have spent more time discussing items that they knew more about (Porcupine, Acacia Karoo, Springbok, and the Aloe Ferox) than the ones they knew less about (Elephant and the Cancer bush plant), as they had a lot to say about them and clarified one another.

(vii) Decision making

Decisions were made by the whole group and not by an individual learner. They gave each other a chance to express themselves, ask questions, and derive a conclusion together from the available information. They wrote their conclusions down for the class presentation.

b. Analysis of data from observations

I used the tenets of the theory (social constructivism) underpinning the study as the lens to analyse the above-presented data from the observations. The following tenets of the theory are being used: culture, language, and the ZPD.

(i) Culture

Culture refers to all the information, beliefs, attitudes, behaviours, and values shared by society (Idang, 2015). Therefore, the following items from the observations were considered under culture: IK by learners, knowledge construction and negotiation, learner communication and interaction, and learner attitudes and motivation. As such, consideration of culture enabled learners to be more comfortable sharing what they know, their IK, and their practises from various backgrounds about the given plants and animals. They used both Sepedi (their home language) and English (the language of teaching and learning) to facilitate the construction, communication, and transmission of what they knew, both in dialogue and in writing. Moreover, learners' use of the written and spoken language that they can all understand brought about good collaboration, communication, interactions, and understanding amongst them.

On the other hand, learners showed that they did not have any IK about cancer bush and an elephant, as they are not readily apparent and reachable in their area. This might imply that these two items are not of use or importance in the culture of these learners. But interestingly, learners were able to read through the provided material that was written in English in order to find and single out relevant information about cancer bush and an elephant, rather than leaving them out. This was possible because they could understand and respond to the written language. From this act, learners showed a very positive attitude towards the learning experience; they were keen and motivated enough to look for information from the provided support

material so that they could get to know the IK of these two items, which they were not familiar with from their respective cultures.

(ii) Language

Language refers to written or spoken symbols that serve as the foundation for thinking, reasoning, and comprehension (Vygotsky, 1962). It is a medium through which culture and communication are transmitted through social interactions. Therefore, the following items from observations were marked under language: knowledge construction and negotiation, learner communication and interaction, learner involvement, and decision-making. As observed, learners were working in groups to converse and make sense of what was given to them. Therefore, the use of written and spoken language that all learners understood allowed the construction, negotiation, and sharing of knowledge from one learner to another or the group with ease. Both Sepedi (their home language) and English (the language of teaching and learning) were used to facilitate the construction, communication, and transmission of knowledge in dialogue and in writing amongst the groups. This brought about good collaboration, communication, interactions, and understanding amongst the learners.

Learners were free to use the language they were comfortable with to share their expertise or ask questions. And as a result, it further invited and enabled all of them to be more active and engaged in the learning experience. Moreover, learners' ability to interact with one another, their environment, and the given support material without any language barrier allowed them to make group judgments or decisions for each given item after thoughtful elaborations from the members of the group.

(iii) The ZPD

ZPD differentiates between what the learner can do on their own and what they can do under guidance or when they are in collaboration with others who are more knowledgeable (Vygotsky, 1978). To move learners to the ZPD, there has to be a MKO, mediation, and scaffolding (Denhere et al., 2013). Therefore, the following items from observations were considered under ZPD: held IK and sharing of it; knowledge construction and negotiation; learner communication and interaction;

learner attitudes and motivation; learner involvement; time spent on various activities; and decision making. Firstly, the teacher (researcher) served as the facilitator and guided learners throughout the learning experience by forming groups, teaching, and giving group activities such that learners could express and share their IK. The teacher also gave learners instructions as well as time allocated for each activity. Learners were able to follow instructions and use the time allocated for each section wisely. The instructions served as a roadmap to enable learners to complete the task at hand and focus on one item at a time. I therefore observed that learners have spent more time on items that they knew the most than the ones they knew less about.

Secondly, the formation of learning groups allowed for collaboration and interactions amongst the learners so that they could communicate their IK with one another. The groups served as a platform through which all learners could contribute their knowledge and learn from each other by linking what they know and what they receive from their peers, study material, and the environment. This setting allowed for the ultimate construction and negotiation of knowledge, as it made it easier for learners to elaborate on given items and clarify one another. They were openly, actively engaged, and involved in the group discussions, which allowed them to make informed decisions as a group and note down their ideas.

Thirdly, both the teacher and some learners served as MKO's, mediators, and scaffolds to assist their group and classmates to learn and understand the given items. Learners played a role in being more knowledgeable than others because they were able to share their detailed IK with their classmates and answer any questions that emanated, as well as give clarity where it was needed. This was also evident when learner L004 pointed the Acacia Karoo plant through the window to allow all learners to be conversant. On the other hand, the learners were asking for assistance from the teacher with the vernacular name for cancer bush. Therefore, such acts implied the positive attitude of learners towards the learning experience as well as being highly motivated to learn. In a nutshell, learners were able to share their knowledge and learn from each other, the teacher, and their surroundings by linking what they knew with what they received from their support mates during

group collaborations. And lastly, it is unfortunate that what learners can do on their own cannot be judged since they are not engaged in any individual work.

Overall comments on the first session

From the above-presented data and its analysis, it is evident that the employed Jigsaw learning method afforded learners an opportunity to get together and share their IK, as well as gain new knowledge about the selected plants and animals found in different biomes. With the role of the teacher as the facilitator and guide of the learning process, the jigsaw groups allowed for active learner engagements that authorised the sharing of different perspectives. Learners were free to converse and draw information from different directions, considering their prior knowledge, fellow classmates, the teacher, and their environment. As such, learners supported one another, synthesised the available information, and made cohesive ideas and conclusions together as demanded by the learning activity. thus, leading to common understanding and learning. But the danger with this learning method is that any misunderstood concept from one group of learners can be passed on to the rest of the class if not detected and corrected.

4.2.2 Presentation and analysis of data for the second session

4.2.2.1 Presentation of data from documents

In the second session, learners were in groups, and the lesson was presented to the whole class based on the diseases that affect the skeleton, their causes, and their treatments: arthritis, rickets, and osteoporosis. The objective of the lesson was to allow learners to be aware of the diseases that may affect their skeleton and the various treatments that are available. And mostly to understand that various diseases can be treated traditionally and in a Western way. Therefore, I integrated IK when dealing with the causes and treatment of arthritis. Firstly, I clarified arthritis as the condition in which cartilage and synovial fluid sacs between the joints begin to break down, causing pain and inflammation in the joints, especially on the hips, knees, and ankle bones. I indicated that there are various factors that can lead to arthritis, such as age, obesity, genetics, and injuries involving joints. Furthermore, I

highlighted that there are also traditional beliefs that cold weather and bathing in cold water cause arthritis; this is also highlighted in learners' textbooks.

As such, I presented that arthritis can be treated in both Western and traditional ways. Either by using Western medicines such as Devil's Claw (Harpagophytum procumbens) capsules, aspirin, or cortisone drugs, which reduce pain and joint inflammation, Or traditionally, by using the tubers or roots of the devil's claw plant (Harpagophytum procumbens), the bark of pepper (molaka in Sepedi) (Warburgia salutaris), and powdered elephant's foot (Kgato in Sepedi) (Dioscorea sylvatica). These plants are boiled in water and drained, and the person will drink the water or bathe the painful joints. I then emphasised that the devil's claw plant, which is featured in both traditional and western medicine, contains a chemical (iridoid glycosides) that has been proven to reduce inflammation that causes pain in joints and tendons. The plant is also said to be used traditionally to treat rheumatism, fever, sore muscles, reduce cholesterol, and ointment sores, boils, and ulcers. It cleanses the lymph system and removes toxins from the blood.

As such, learners were given an activity (Activity C) to work on in groups using De Bono's thinking hats. The aim of the activity was to allow learners to brainstorm and state their views and experiences with regard to the use of traditional and Western medicines, whether the two are conflicting or can coexist. Learners in their groups discussed the issue, with each learner arguing from his or her point of view, as determined by the colour of the hat. The time allocated for each hat was 5 minutes. This method invites all learners to view an issue from different perspectives and is said to develop critical thinking skills. Furthermore, as learners were busy discussing, some learners were interviewed based on their experiences with the use of indigenous and Western medicines. Later, we engaged in a whole classroom discussion as we concluded the lesson, and learners' scripts were collected thereafter. Moreover, Table 4.6 shows the group arrangements of the learners as they were engaged in the activity. Also, figure 3 illustrates learners as they were working in groups. On the left-hand side is group 1 (G1), and group 2 (G2) is on the right-hand side.

Table 4.6: Learner arrangements during De Bono's thinking hats activity

	Group 1 (G1)	**Group 2 (G2)**
Participants	L001	L005
	L002	L006
	L003	L007
	L004	L008

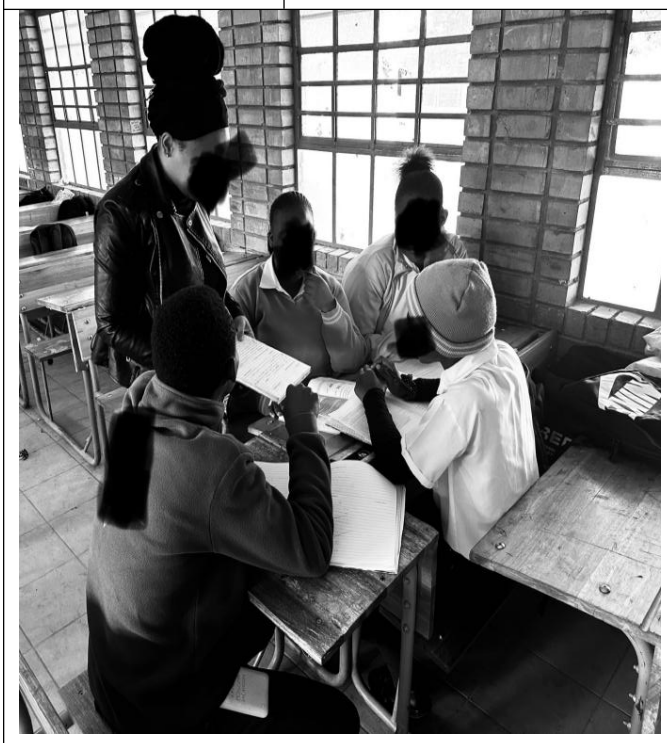


Figure 3: Learners in groups working on the De Bono's thinking hats activity

The above table and the figure presents the arrangements of learners during De Bono's thinking hats activity. Therefore, for data presentation, interpretation and analysis purposes, learners' responses are presented in Table 4.7 wherein deliberations are also made for each hat. The activity was therefore analysed with the aid of a document analysis tool (Table 4.8) that I have developed.

Table 4.7: Learners' responses on the De Bono's thinking hats activity

Type of De Bono's thinking hats	**Learners views**	
	Group 1 (G1)	**Group 2 (G2)**
White hat **(facts)**	*Most people in South Africa prefer to use traditional medicines than western medicines because they believe that traditional medicine is more efficient, accessible, and affordable. Unlike western medicines which you have to use more money to travel to clinic, hospitals, and pharmacy to get the medication. And sometimes when you get there, they would say they are out of medication.*	*There are many traditional healers in each community in South Africa. That is why many black people trust traditional healers and go to them when they are sick, even after coming from the clinic and doctors they would still go and consult to the traditional healers to give them traditional medicines.* *- Back then there were no or there were few clinics and hospitals, and people relied more on traditional medicines, and they were healed. There are also older people in the villages who know more about plants and animals that can be used to cure different diseases that we suffer from. They would go and get that plant or animal and tell you what to do then you will be fine. In this way we save costs of buying*

		western medicines.
Deliberation: This hat called learners to discover the facts about traditional and western medicines, but their views are more sided toward traditional medicines. Both groups hold that the use of traditional medicines dominates our South African communities. Therefore, their views and reasoning are in agreement with those of Ndlovu (2016), Neiman et al. (2019), and Sobiecki (2014). Group two highlights that people pair traditional and western medicines. On that note, Mbongwa (2018) asserts that people have always relied on traditional medicines for years, and so they believe some conditions need both western and traditional treatments (Mahwasane, Middleton, & Boaduo, 2013).		
Red hat **(feelings, no reasons are given)**	*- In support of traditional medicines because they are cheap and easy to get, and they can be used now and then.* *- In support of western medicines because they are more effective. They can cure the disease in the time they have prescribed on the bottle of the medicine and because i do not believe in Sangomas that is why i prefer western medicines. I feel that traditional medicines are not safe to use.*	*- I love traditional medicines than western medicines as I never went wrong with them. They cause faster healing.* *- I doubt if traditional medicines are safe to use since we don't know what they can do in your system. Unlike western ones which are proven to cure a specific disease.* *- In support of both because some diseases can be cured by traditional medicines and others by western medicines. And some by both, it depend on which one you like and works for you.*

Deliberation: Learners were supposed to express their emotions, feelings, or intuition about traditional and western medicines with no justifications. Therefore, by looking at their views, some have used the word “in support of” to show approval of either traditional or western medicines. While some have made their feelings very clear, all the groups have attached reasoning to their feelings.		
Yellow hat **(benefits, logical reasons are given)**	*- Indigenous medicines are cheap and easier to get than the prescribed western medicines. But both of them are helpful and can work, it depends on which one you like and can afford.*	*- Both indigenous medicines and traditional medicines work. It depends on which one you love, and it is your right to choose the one you favour.* *- Real traditional healers are registered just like nurses and doctors. And the medication that traditional healers give us is safe because before they can give you, they check you first (using dikgagara/ dipheko), to find out what could be the problem with you. Then after that they will give you medication that is best for your problem, and it will work. This is the same to what nurses and doctors do.*
Deliberation: Learners view both traditional and western medicines as being good for those who choose to use them. They focus on the issues of human rights, personal preference, and costs.		

Black hat **(cautions, logical reasons are given)**	*- Most of the traditional medicines are not scientifically tested and others say they are bad (bad taste), unlike western medicines which are tested, approved, and used worldwide.* *- Some fake traditional healers, and anyone can just make fake remedies for people, as we don't know what they have used in their mixtures. This can worsen the diseases, make the person weak, and end up dying. Traditional medicines seems like they do everything in the body, they cleanse the body.* *But with western medicines, everything is written on their packages. They indicate what was used, who is suitable to use, how, and side effects. That is why we get them after the doctors and nurses have told you what is wrong with you. The medication that they give you will be suitable to the disease that you suffer from.*	*- Traditional medicines are not scientifically tested and proved to be safe. Some people experience diarhoea and some skin rash after drinking them.* *- May lead to extinction of some plants. Because anyone can just pick the plants from the surrounding area as they are not protected and there are no laws to control the process. That is why we see people on the roads and taxi ranks selling different ready- made traditional medicines and dried herbs. We don't trust them anymore and nothing is being done about them.* *- Some people even take advantage of teenage girls and sell them this traditional medicines to do abortions illegally. The girls end up being weak and sick for a very long time, and some die because of that.*
Deliberation: This required learners to expose the weaknesses associated with both traditional and western medicines. Therefore, both groups argue that most		

traditional medicines, unlike western ones, are not scientifically tested, and some threaten human life. De Beer and Whitlock (2009) are also of the view that some traditional healing practises are unsound.		
Green hat **(solutions to black hat problems, creativity)**	*- Indigenous medicines should be tested and proven to be safe to consume* *- People should only consult to the registered traditional healers and stop taking the medicines from anyone else, especially the ready- made ones*	*- They can investigate and test different plants in laboratories to check if they are suitable to cure a particular disease and check other benefits of that plant, as well as risks. But this does not mean we should undermine the traditional medicines.* *- There should be laws to protect the plants and people from those who picks the plants claiming to know more about what it can do, just to get money from those who love traditional medicines.* *- Encourage people to only consult to registered traditional healers and not just from anyone else.*
Deliberation: Learners have provided solutions to the problems listed under the black hat. They suggest that traditional medicines should be tested, and that people should be vigilant against fake healers.		

Blue hat **(overview, thinking holistically, planning for an action)**	*- Since many South Africans prefer and use traditional medicines, especially in rural areas because they are cheap since they have plants and animals that they need to use near them. And even the older people are still there to show us this medicines and how they are used. We think traditional medicines and western medicines can co-exist; they shall become one. Traditional healers and our elders should work together with the researchers and doctors by showing them the plants and animals that can cure diseases that are trending and affect most people. And then researchers and doctors should use that information to produce western medicines to accommodate and cure those who don't believe in traditional healers and traditional medicines.*	*- Traditional healers are recognised in South Africa because they register them. This shows that their knowledge and work is not bad. It has been used many years ago before we had western medicines.* *Therefore, researchers, doctors and traditional healers should work together. They can advise each other on what kind of medicine can certainly plant or animal offers. And they can even combine western and traditional practices to make medications for the benefits of all people.*
Deliberation: Learners conclude that traditional and western medicines can co-exist. They suggest that elders, traditional healers, doctors, scientists, and researchers should cooperate and enrich each other for the benefit of all people. Such an approach is said to be empowering, and it creates respect for the veracity		

of traditional medicines globally (De Beer & Van Wyk, 2021).

The table above presented learners responses of the written activity, and deliberations were made with reference to what and how the learners have provided their views as expected by each hat. Therefore, table 4.8 below was developed in order to aid with the analysis of the learners responses presented above (in table 4.7).

Table 4.8: Document analysis tool: De Bono's thinking hats learning activity

Items	**YES**	**NO**	**Other comments**
Do learners have any experience with either traditional medicines or western medicines?	**x**		
Are learners able to reflect on their experiences?	**x**		
Were learners able to provide their perspectives as required by each hat:			
White hat	**X**		
Red hat	**X**		Learners gave reasons to justify or explain their feelings which was not necessary.
Yellow hat	**x**		
Black hat	**x**		

Green hat	**x**		
Blue hat	**x**		

The table above was developed in order to aid with the analysis of the learners' responses presented in table 4.7 above. From its contents, it is evident that learners understood the requirements of each hat, hence they were able to articulate their views with regard to the use of western and traditional medicines.

Overall comments

From the learners' perspectives (in table 4.7) and the analysis tool (table 4.8), one can see that learners are aware of and have knowledge about both traditional and western medicines. They managed to detail, express, and document their views as required by each hat, and their views are in line with the topic at hand. Even though the red hat did not require any reasoning, it is patent that both groups gave justifications or explanations for their feelings. This helps one to acknowledge and understand their individual stance with regard to either traditional or western medicines for different ailments. At the end, groups managed to view the topic from different angles, put their perspectives together, and come up with new perceptions and suggestions. From this learning method, I have noticed that it gives learners a chance to reflect on their own experiences, compare them with those of their peers, and relate them to the discussion. This enables learners to think about their previous knowledge and their new knowledge about the issue under discussion and make informed decisions. For the best outcomes, it is crucial to ensure that all learners understand the requirements of each hat.

4.2.2.2 Presentation of data from observations

Observations were made by me (participant observer) when learners were working on the group discussion activity using De Bono's thinking-hats learning method (Activity C), as well as during classroom discussion when learners were interacting with the teacher as they gave their views. Learners were video recorded, and some observations were noted on the observation schedule and the reflexive journal

(during the whole classroom discussion). These observations were done in order to explore the efficacy of De Bono's teaching and learning methods in facilitating the integration of IK in the LFSC classroom. Therefore, seven areas of interest were taken into consideration during the process. That is, knowledge exhibition, knowledge construction and negotiation, learner communication and interaction, learner attitude and motivation, learner involvement (being passive or active), time spent on various activities, and lastly, decision-making. These points were also distributed amongst the three tenets of the theory underpinning this study: culture, language, and the ZPD. See the observation schedule below.

Table 4.9: Observation schedule: De Bono's thinking hats activity

Schedule of class	
Date: 22 June 2023	**Time: 10 am**
ITEMS	**Comment**
1. Knowledge exhibition	- Learners do have knowledge about both the traditional medicines and the western medicines. - I can hear them explaining their experiences to their group mates. They ask each other questions, and feedback is provided. - For instance, G1L002 explains to the group of what she has used to treat period pains. - From their conversations, they highlight that they get this knowledge of traditional medicines from the elders at home.
2.Knowledge construction and negotiation	- The colour of the hat directs interactions amongst the learners. - All learners are actively involved and they reflects on their lived experiences and what they observe around them, to construct and negotiate the knowledge within their groups. - Learners share with their group mates of what they have used to treat various ailments.

	- Drawing from their conversations, some learners were in favour of traditional medicines while some were in favour of the western medicines
3.Learner communication and interaction	- Good communication skills are evident here; learners give each other a chance to express themselves, they show respect and listen to their peers when they talk. - They are able to ask one another questions and provides feedback. - They use both Sepedi and English to express themselves.
4.Learner attitudes and motivation	- Learners shows a positive attitude towards the learning experience as they seem to be free, relaxed and joyous during the discussions. - They seem motivated to know more, hence they are able to ask questions and clarity especially after one learner shares their lived experiences with traditional medicines. - They use each other's experiences presented to the group to draw their conclusions as required by each hat.
5.Learner involvement: being passive or active	- All learners are actively involved and engaged. They are able to explain the requirements of each hat to their group members. This allows them to switch from one hat to another and arrange their thinking as per each hat requirements. None of the learners seem to be disengaged.
6.Time spent on each hat	- Time allocated for each hat is used effectively. They work on one hat at a time
7.Decision making	- Learners focus on one hat at a time,

	converse, and note their conclusions down as a group. Decisions are made by the whole group after exploring all their opinions, and after that they move to the next hat.

The table above presented the records of what has transpired during classroom observations when learners were engaged in a De Bono's thinking hats learning activity. Therefore, below I stress out what is recorded on the observation schedule above on: (1) knowledge exhibition, (2) knowledge construction and negotiation, (3) learner communication and interaction, (4) learner attitude and motivation, (5) learner involvement—being passive or active, (6) time spent on various activities; and lastly, (7) decision-making.

(i) Knowledge exhibition

Learners were aware of and had knowledge about both indigenous and western medicines. This helped them to converse and work through each topic for group discussion and individual thinking. They were not given any study material for reference, but they were only reflecting on their experiences and how they relate to the discussion at hand. This was evident when they were sharing their experiences within their groups, taking turns. For example, I heard one learner explaining what she used for period pains, and I was fascinated by that conversation and decided to capture and record it. Such an exhibition of knowledge allowed learners to organise their thinking, discuss their opinions, and come to conclusions.

For example, learner G1L002 expalined to the group how she used traditional knowledge to treat period pains. She said " I *use "monotlwana kgwale" (leg/ feet of a Patridged bird), I boil it and drink the water in the morning and evening. Dry it in the sun and will boil it again next time".* This invited all the learners to share their expereiences, of which learner G1L001 shared a different view to highlight that traditional knowledge did not work out for her hence she is in favour of the western knowledge. She said *"I used this other plant called Marepetlana for tonsils, I was told to crush the plant, boil and drink its tea, and then I would be healed in two days. But*

it never healed me. I then went to buy calpol, tonzolyt pills and strepsils and I became better and healed in 3 days. That is why even today I would still go for western medicine". It is interesting to note that every learner participated fully in the conversation and shared various remedies for different ailments.

Another learner (G2L007) on the other group highlighted some procedures of how they traditionally cure certain diseases at home. He said "*maam sale ka tšwa mauwe (measels), then frogo bare ke ye go opelela ka gare ga pitša, kere "mauwe uwe boela pitšeng". Then the following day ka tsoga ke fodile. Then le bana ba gešu ba ba dira sowe ge ba tšwile mauwe. And Ye nngwe ke gore ke be phela ke eba le problem ya lelengwana (*epigottis*) ke sa kgone le go metša anything. Then they took me to this other granny in another village where she cut out piece of lelengwana lela, a fetša a tšhela motšoko (*snuff*) mola a go cut. It was painful but since then I never experienced the problem again".*

As a way of engaging the whole group, I asked the group if they knew about what learner G2L007 is saying; and their answer was yes. Then learner G2L008 added that "*E swana le ge re fahlile ke maswi a monoto (Euphorbia tirucalli), ba go iša go mosadi wa go amuša then ago gamela maswi ka mo mahlong; wa fola same time".*

The above responses exhibit informed views from the learners because they are able to clearly articulate their lived experiences with either traditional or western medicines. Learners also used their home language (Sepedi) to aid in the presentation of the processes and procedures involved. It is also evident that the elders play an important role as IK holders in our communities, ensuring the generational transfer of knowledge. Such an exhibition of knowledge allowed learners to organise their thinking, discuss their opinions, and come to conclusions.

(ii) Knowledge construction and negotiation

Learners were constructing and negotiating knowledge through active interactions with each other, expressing and sharing their perspectives as required by each hat. They were working together, focusing on one thing at a time; none seemed to be disengaged. They were talking, giving each other a chance to link what they knew with the topic under discussion, until they reached a common understanding and

wrote their conclusions down. For instance, expressed a similar view of being in favour of that traditional medicines because they are accessible, economical, and offer quick treatment. The response from learner G2L007 and his group (as elaborated above) highlights that the use of traditional medicines is prevalent in their community. Their view reflects that their knowledge of traditional medicines is passed from elders in their communities to the young. Contrary to that, only one learner (G1L001) reflected the view that she prefers western medicines as they seem to be more effective for her than traditional ones. This shows that indeed learners were not just agreeing to what others in the group, were saying, but had to stand their grounds. This shows that they were actively involved during knowledge construction and negotiation.

(iii) Learner communication and interaction

The learners were freely and actively talking to each other and the teacher. They used both English and Sepedi to converse and to present answers in class, in their respective groups, and on their answer sheets. Their communication was good; I could see and hear them giving each other a space to give and receive information without making any interruptions while one was still talking. They showed respect for each other's ideas and waited for one to finish talking before they could ask them any questions or clarify anything. This was also evident during the whole classroom discussion, where some learners raised their hands to ask for clarity once we were done elaborating on each hat. Moreover, good listening skills were highly illustrated.

(iv) Learner attitude and motivation

Learners had a positive attitude towards this learning experience because they were active, engaged, and free and relaxed during discussions. They could cheerfully share their knowledge and showed the desire to know more by politely asking questions and providing clarity. They appreciated and valued each other's perspectives, and as a result, it motivated them to say and learn more from one another. None of them seemed to be disengaged. From their discussions, they indicated that the recommended remedies (either traditional or western) are all health-giving and able to mend the abnormal state of being. Learner G1L001 feedback to say sometimes the traditional method might not work to treat some

diseases of might force an individual to consider the western method suggests that there are alternatives to consider if one method cannot be beneficial. This shows a change in perspectives in the learners, and thus giving both the traditional and western medicines a room.

(v) Learner involvement- being passive or active

All the learners were actively involved and engaged. They could talk and share their perspectives as per the demands of each hat. I can say they were mindfully involved and focused.

(vi) Time spent on each hat

Learners were able to use the time allocated for each hat wisely since they have managed to articulate their perspectives required by each hat.

(vii) Decision making

Learners had to focus on one hat at a time, give perspectives, conclude, and move on to the next hat. Therefore, decisions were made by the whole group and not by an individual learner. They gave each other a chance to express themselves, ask questions, and derive a conclusion together from the available information. They wrote their conclusions down.

b. Analysis of data from observations

I used the tenets of the theory (social constructivism) underpinning the study as the lens to analyse the above-presented data from the observations. The following tenets of the theory are being used: culture, language, and the ZPD.

(i) Culture

Culture refers to all the information, beliefs, attitudes, behaviours, and values shared by society (Idang, 2015). Therefore, the following items from the observations were considered under culture: knowledge exhibition, knowledge construction and negotiation, learner communication and interaction, and learner attitudes and motivation. As such, each of De Bono's thinking hats required learners to organise

and share their views and feelings about both indigenous and western medicines. Hence, consideration of culture enabled learners to reflect on their lived experiences and practices and share their knowledge and views on the issue at hand. From learners' views, one could assess an individual as a member of society based on their beliefs and values, as well as their attitudes towards either traditional or western medicines. Learners used both Sepedi (their home language) and English (the language of teaching and learning) to facilitate the construction and expression of their perspectives, both in dialogue and in writing.

Moreover, learners reflecting on their experiences brought about good collaboration, communication, interactions, and understanding amongst them. which invited active engagements and freedom to share their experiences and elaborate on the requirements of each hat to one another. From this act, learners illustrated a very positive attitude towards the learning experience, as they were cheerful to share their views and respected each other's views. It therefore motivated their need to know more by politely asking for clarity and elaborations from their peers.

(ii) Language

Language refers to written or spoken symbols that serve as the foundation for thinking, reasoning, and comprehension (Vygotsky, 1962). It is a medium through which culture and communication are transmitted through social interactions. Therefore, the following items from observations were considered under language: knowledge construction and negotiation, learner communication and interaction, learner involvement, and decision-making. As observed, learners were working in groups to converse and share their views with regard to traditional and western medicines, in parallel with De Bono's thinking hats. Therefore, the use of written and spoken language that all learners understood allowed the construction, negotiation, and sharing of knowledge from one learner to another or to the group with ease. Both Sepedi (their home language) and English (the language of teaching and learning) were used to facilitate the construction, communication, and transmission of knowledge in dialogue and in writing amongst the groups.

Lack of a language barrier brought about good collaboration, communication, interactions, and understanding amongst learners. It freed learners to use the

language they are comfortable with to share their experiences or to ask questions. As a result, it provided an excellent space for all of them to be more active and engaged in the learning experience. Moreover, learners' ability to interact with one another without any language barrier allowed them to draw judgments or decisions for each thinking that after thoughtful elaborations from the members of the group.

(iii) The ZPD

ZPD differentiates between what the learner can do on their own and what they can do under guidance or in collaboration with others who are more knowledgeable (Vygotsky, 1962). To move learners to the ZPD, there has to be an MKO, mediation, and scaffolding (Denhere et al., 2013). Therefore, the following items from observations were considered under ZPD: knowledge exhibition, knowledge construction and negotiation, learner communication and interaction, learner attitudes and motivation, learner involvement, time spent on various activities, and decision-making. Firstly, the teacher (researcher) served as the facilitator and guided learners throughout the learning experience by forming learning groups, teaching, and giving activities such that learners could express and share their experiences with traditional and western medicines. The teacher also gave learners instructions as well as time allocated for each hat. Learners were able to follow instructions and use the time allocated for each section wisely. The instructions served as a roadmap to enable learners to complete the task at hand and focus on one thought at a time.

Secondly, the formation of learning groups allowed for collaboration and interactions amongst the learners so that they could exhibit their knowledge to one another. The groups served as a platform through which all learners could contribute their knowledge and learn from each other by linking what they knew and what they received from their peers. This setting allowed for the ultimate construction and negotiation of knowledge, as it made it easier for learners to organise and elaborate on their thinking as per each hat. Learners were more open, actively engaged, and involved in the group discussions, which allowed them to make informed decisions as a group and note down their ideas.

Thirdly, both the teacher and some learners served as MKO's, mediators, and scaffolds during this learning process. Learners played a role in being MKO's

because they were able to share their detailed experiences about traditional and western medicines with their classmates and answer any questions that emanated, as well as give clarity where it was needed. This gave learners who were never exposed to some of the explained practises the ground to draw and organise their thinking as they analysed the given information. Therefore, such acts implied the positive attitude of learners towards the learning experience as well as being highly motivated to learn. In a nutshell, learners were able to exhibit their knowledge about traditional and western medicines and learn from each other, the teacher, and their surroundings. They were able to link what they knew with what they received from their support mates during group collaborations, synthesise their thinking, and share their perspectives as per Hat. Lastly, what learners can do on their own cannot be judged since they are not engaged in any individual work.

4.2.2.3 Presentation of data from interviews (focus groups)

The interview session was based on the overall learning experience (from session 1 and 2).I posed a question to the group and allowed all learners to give their opinions, taking turns while being video recorded. The interview questions, learners' comments, and codes are presented below. Deliberations are made thereafter each question.

(i) Interview session

Q1: What are your experiences with learning Life Sciences this way?

Table 4.10: The participating learners' responses

Learners responses	***Codes***
G1L001 "*It is good and motivating. I really enjoyed the lesson. I love the fact that we don't sideline each other's views, but we encourage each other to talk, and we write everything down then discuss it as a group. If one of us doesn't know or don't understand, we explain to them until they understand"*	$G^{1}L^{001}$ALLOWS FOR THE EXPRESSION OF INDIVIDUAL'S VIEWS.
G1L002 "*It is good because I was never engaged in a lesson like this before, where we are given a chance to*	$G^{1}L^{002}$ENCOURAGES EXPRESSIONS OF VIEWS. VISIBLE

talk about our indigenous knowledge. It allowed me to see the connection between Life sciences and the little knowledge that I have from home. And I now understand why we have different places in South Africa that are not the same in terms of climates and the type of plants and animals"	CONNECTION BETWEEN IK AND LIFE SCIENCES CONTEN.
G1L003 "*Good, we should do it more"*	G^1L^{003}FEELS GOOD.
G1L004 "*Good and interesting"*	G^1L^{004}INTERESTING.
G2L005 "*Good, it allows us to talk about what we see and do at home and connect them with what we do in class. This can be helping some learners who fail to understand some topics in Life Sciences. Like now I understand why we have different plants and animals in different areas"*	G^2L^{005}ALLOWS FOR CONTEXTUALISATION OF THE CONTENT TAUGHT.
G2L006 "*It is helpful because we learn from each other as we work together in groups. I really enjoyed the lesson*"	G^2L^{008}ALLOWS COLLABORATION.
G2L007 "*Good, I have realised that plants that we have in our communities are important as some can be used to heal some of the diseases that we deal with in Life Sciences. And in Life sciences we deal with both plants and animals found in different areas. Surely people in those areas use them for different reasons. So, talking about such uses is really interesting as we learn more from each other and we will know more about what people use the plants or animals for, in their areas. I also learnt that some of the western medicines that we use today are made from our indigenous plants"*	G^2L^{007}LEARNED THE VALUE OF PLANTS IN COMMUNITY, COLLABORATION AND EXPRESSION OF VIEWS.
G2L008 "*The lessons were good and interesting, especially the last activity of De Bono's hats. It allowed each one of us to think out of the box like looking at advantages and disadvantages of something before*	G^2L^{008} GOOD, ALLOW LEARNERS TO THINK OUT OF THE BOX. APPRECITION OF OTHER PEOPLE'S VIEWS.

making up your mind. And I have realised that we don't see things the same way, we have different knowledge and views. And taking about them is very interesting, you come to learn new things that you knew nothing about, or you had a little knowledge about"	

Learners' responses reflect that they have enjoyed the two lessons carried out in cooperative learning environments. They clearly stated that working in groups motivated them to learn from one another with ease, as they were able to talk, ask questions, and clarify one another, and their views were not taken for granted. Their responses also declare that their involvement in these lessons gave them an opportunity to realise the connection between IK, LFSC, their environment, and society. The setting also stimulated their interest, allowed learners to tap into and talk about their IK, and linked it to the LFSC content presented to them as they organised their thinking and learning. Hence, learners suggest that this kind of learning environment should be the norm in order to accommodate those who find it difficult to understand certain LFSC content.

Q2: Are you comfortable sharing your views in this kind of learning

Table 4.11: Participating learners' responses

Learners responses	***Codes***
G1L001 "*Yes"*	$G^{1}L^{001}$IN AGREEMENT
G1L002 "*Yes"*	$G^{1}L^{002}$IN AGREEMENT
G1L003 "*Yes, comfortable, free and enjoying this"*	$G^{1}L^{003}$IN AGREEMENT
G1L004 "*Yes"*	$G^{1}L^{004}$IN AGREEMENT
G2L005 "*Yes"*	$G^{2}L^{005}$IN AGREEMENT

G2L006 "*Yes*"	G^2L^{008}IN AGREEMENT
G2L007 "*Yes"*	G^2L^{007}IN AGREEMENT
G2L008 "*Yes, it also helps because the group members can help you understand something better. It is easy to ask questions and for clarity, you also get feedback same time"*	G^2L^{008}IN AGREEMENT, ALLOWS FOR IMPROVEMENT OF UNDERSTANDING.

Learners showed that they were at ease sharing their ideas throughout the two sessions. It is clear from the responses from learners G1L003 and G2L008 that comfort was possible because the setting freed the learners to easily converse and exchange ideas with their group mates and provided immediate feedback. Thus, they enjoyed the lesson.

Q3: What can be improved about this learning environment and why?

Table 4.12: Participating learners' responses

Learners responses	***Codes***
G1L001 "*Nothing"*	G^1L^{001}SENSE OF SATISFACTION
G1L002 'Did not answer the question'	G^1L^{002}SILECNCE
G1L003 'Did not answer the question'	G^1L^{003}SILENCE
G1L004 "*Nothing, I just feel like indigenous knowledge could be included in Life Sciences textbooks and during day- to day lessons because "dia nyalelana" (*they relate*). It is interesting and it made me to enjoy the lesson. So maam you can imagine if it was done daily"*	G^1L^{004}ACKNOWLEDGEMENT OF RELATIONSHIP BETWEEN LIFE SCIENCES AND IK.
G2L005 "*Get more learners to participate so that we can be many. In that way we will get more*	G^2L^{005}FEELS MORE CAN BE LEARNED IF MORE

ideas and information from different learners. We would learn more from each other"	LEARNERS ARE INCLUDED
G2L006 "*We should be given more time to do research at home because we don't know some indigenous uses of some plants and animals*"	G^2L^{008}NEED FOR MORE TIME TO LEARN ABOUT OTHER IK.
G2L007 'Did not answer the question'	G^2L^{007}SILENCE
G2L008 "*Time allocation for each activity should be more because you find that you still have more to say but because of time you leave out some information"*	G^2L^{008}MORE TIME NEEDED TO COMPLETE SOME ACTIVITIES

Three (3) out of eight (8) learners did not respond to the question. But two (2) learners in the five (5) who gave their views highlight that nothing can be improved on the cooperative learning situation that they were engaged in. Instead, learner G2L004 added that we could improve the teaching and learning of the subject by including and integrating IK in both their LFSC study materials and day-to-day lessons because they are allied. This shows that the learner can now link and see the relationship between the two knowledge domains. She further indicated that this kind of learning environment made her enjoy the lesson, and it seems like she wants more because of her response, "*So, mam, you can imagine if it were done daily*." On the other hand, learner G2L005 pointed out that more learners should be included, which is true as a large sample would imply more ideas from diverse learners. So, this learner still shows an interest in hearing and learning more from others who were not part of this learning session. While learners G2L006 and G2L008 highlighted that the time frame for the activities was not enough, which implies that they did not explore ideas to their satisfaction, this item should be improved.

Q4: Are you learning anything from the group?

Table 4.13: Participating learners' responses

Learners responses	***Codes***
G1L001 "*Yes, the medicinal uses of the springbok. I really did not know that it can cure tummy problems in babies"*	$G^{1}L^{001}$LEARNED ABOUT THE HEALING PROPERTIES OF SPRINGBOK
G1L002 "*Yes"*	$G^{1}L^{002}$IN AGREEMENT
G1L003 "*Yes, especially the period pains remedy from "monotlwana noko". I am really struggling with period pains to the point that I have to be absent from school every month. I have been using the pills and surely when I get home i will tell my mom about this new information"*	$G^{1}L^{003}$SENSE OF APPRECIATION FOR LEARNING ABOUT MEDICINE FOR PERIOD PAINS.
G1L004 "*Yes, that the mošwaana (Acacia Karoo) can cure goats when they are sick. I will surely use this information at home since we have goats"*	$G^{1}L^{004}$SENSE OF APPRECIATION FOR HEALING ABILITIES OF INDIGENOUS PLANTS.
G2L005 "*Yes mam, I love this. They made me realise that not everything is science and technology based, even in the past people used to survive with what their environment gave them. And they are still doing that even today. And some of the items today are made from our indigenous plants and animals but we don't even entertain that thought. We have sidelined the indigenous knowledge, and we are now focused on science and technology, but bringing this indigenous knowledge up into the lessons is very helpful and reviving. I wish this can be done every day in all the subjects because is interesting"*	$G^{2}L^{005}$SENSE OF APPRECIATION OF WHAT IK AND INDIGENOUS PLANTS ARE ABLE TO DO.
G2L006 "*Yes, learning that the thorns of Acacia Karroo can cure sore throats really amazed me. I thought thorns*	$G^{2}L^{008}$SENSE OF APPRECIATION FOR THE USEFULNESS OF INDIGENOUS

are useless"	PLANTS.
G2L007 "*Yes, I loved the porcupine part. I thought it is just an animal"*	G^2L^{007}SESNE OF APPRECITION FOR HEALING ABILITIES OF CERTAIN PARTS OF ANIMALS.
G2L008 "*Yah, gona le taba tše ntšhi mo mam"*	G^2L^{008}APPRECIATION OF LESSONS LEARNED DURING THE SESSION.

The responses reflect that learners have gained and appreciated the knowledge of their group members, and they came to realise the value that different plants and animals have offered people in their context. It is also clear that learners are excited about this learning experience, and they will use or even share what they have learned from their groups with others at home or even at school. Learner G2L008 also asserts that there is indeed a lot to learn from one another. Moreover, learner G2L005 considered teaching and learning all their school subjects in this fashion.

Q5: How have they (the group) been helpful?

Table 4.14: Participating learners' responses

Learners responses	***Codes***
G1L001 "*Allow us to be free and open to share what we know, and we can even ask questions. We have exchanged a very important and helpful information that I can go and share with other people"*	G^1L^{001}ENCOURAGES COLLABORATION, ALLOW FOR EXPRESSION OF VIEWS.
G1L002 "*Oska nyatša di method tšeo batho ba bangwe ba di šomišago go fodiša malwetši because you can learn from them and benefit out of them"*	G^1L^{002}APPRECIATION OF NEW APPROACHES.
G1L003 "*It helped me to build friendship, because we are classmates, but we never hang around or even talk with each other. So now when we work in groups we have a chance of talking to each other, as we move from one*	G^1L^{003} ENCOURAGES COLLABORATION, ALLOW FOR EXPRESSION OF

group to another. Surely we will continue being like this"	VIEWS.
G1L004 "*We shared different ideas. Ye o tseba se nna ke sa setsebego, lenna ke tseba se a sa se tsebego. Then a thoma a nruta se a se tsebago, lenna ka mo ruta se ke se tsebago. Then re felletša re tseba dilo ka moka"*	G^1L^{004} ENCOURAGES COLLABORATION, ALLOW FOR EXPRESSION OF VIEWS.
G2L005 "*I have learnt new things from the group, things that I did not know about and never heard from anyone. But now I know, and I will use some of them at home, especially that monotlwana kgwale for period pains. The information is interesting and helpful"*	G^2L^{005} ENCOURAGES COLLABORATION, ALLOWS FOR EXPRESSION OF VIEWS.
G2L006 "*I have learnt to be patient and to accept other people's views even if they are different from mine. And to also check issues before you accept or reject them because you can get something useful out of them*" **As a follow up, I asked the learner to elaborate on how she learnt to be patient and she said:** "*I was the one who was writing down the answers for the group. So, some learners were very slow to give their views. But we were patient with them, gave them time to think and at the end they said something. And we noted that down*"	G^2L^{008} ENCOURAGES COLLABORATION AND PATIENCE. ALLOWS FOR EXPRESSION OF VIEWS.
G2L007 "*They have shared important and helpful information that I can even use now and, in the future, because most of this things surrounds us- we know them, and we see them. And I will also share the knowledge with other people so that they can also know the benefits of some plants and animals that surrounds us.* *Working in groups also help with communication and respect as we have to talk now and then, we all have to*	G^2L^{007}ENCOURAGES COLLABORATION, ALLOW FOR EXPRESSION OF VIEWS.

contribute our ideas to the group. That force you to talk, even if you are shy you will end up saying something as we discuss. Because it is not like in normal class where everyone will be listening to you, and you end up not saying anything because of fear of being laughed or judged somehow. So here we listen and respect each other" **Follow up question: You mentioned respect, right? How does respect come about in the group?** "*Because as we share ideas, we don't side line other people's views or even laugh at them. We respect their views. And if we don't understand what they are saying we ask them to explain to us. And again, if one is saying something, we keep quiet and listen to them, then we can only talk when they are done*"	
G2L008 "*They helped me realise that one plant or animal can have so many benefits. I have learnt new things that I did not know anything about, and I have added some information on some that I knew"*	G^2L^{008} SENSE OF APPRECIATION FOR THE USEFULNESS OF INDIGENOUS PLANTS AND ANIMALS

From the responses, one can notice that learners have acquired new knowledge from this learning experience and have managed to build on their knowledge and several personal and social skills through working in groups. The stated and reflected social skills include cooperation, good communication, active listening, respect, patience, a sense of humour, and acceptance. Also, learners managed to take on leadership roles as well as build friendships with one another. Lastly, they are grateful for the knowledge they received from their groupmates; they are prepared to use and share the knowledge with the next person.

Overall comments on the second session

From the above-presented data and its analysis, it is observed that the employed teaching and learning method, De Bono's thinking hats, afforded learners an

opportunity to collaborate, reflect on, and share their IK, as well as gain new knowledge from one another. With the role of the teacher as the facilitator and guide of the learning process, the formed groups allowed for active learner engagements that authorised the expression of different perspectives as directed by the colour of the hat. Learners were free to converse and draw information from different directions, considering their prior knowledge, fellow classmates, and their environment. They used the language that they could all understand to facilitate their learning. As such, learners critically synthesised the available information, made cohesive ideas, and reached informed conclusions together as demanded by the learning activity. Thus, it led to common understanding and learning.

On the other hand, the interview responses exhibit that learners value different knowledge domains and are able to disseminate them. It is evident that their engagement in this learning space allowed them to freely express themselves and link the LFSC content with their prior knowledge, including IK, and their context. The two employed teaching and learning methods that stimulated learners' interest in learning and led them to enjoy the lessons, which further motivated them to be open-minded and learn from one another in their respective groups and from their classmates as they brainstormed. This is supported by their assertions and recommendations they made during interviews: that a similar approach should be employed in the day-to-day teaching and learning of all their school subjects and study materials. Moreover, there are personal and social skills that were instilled and enforced in learners during cooperative learning environments.

4.3 An overall summary of the overall data analysis

The main aim of this study was to explore Grade 10 LFSC learners' views on the integration of IK-related topics using a cooperative learning approach. Therefore, the study used document reviews (learners research scripts), observations (participant observations), and focus group interviews to collect data, which occurred in two separate sessions. The first session employed the jigsaw learning method to integrate IK when teaching and learning the South African biomes. The second session was based on De Bono's thinking hats to explore learners' perspectives on the use of traditional and western medicines to treat different diseases. As such, the

findings from the presented data reveal that the two adapted learning methods grant learners an opportunity to freely express and state their views regarding the issue under discussion. All the presented data sets per session corroborate with one another and indicate that learners have informed knowledge that they are able to clearly articulate to one another. Therefore, thorough discussions on the findings will be done in the next chapter.

4.4 Summary of the chapter

This chapter presented and analysed the data from the documents (learners' scripts), observations (participant observations), and interviews (focus group) of eight (8) learners that participated in this study. The findings from the overall data reveal that the employed cooperative learning methods allow for the exploration of learners' perspectives and the integration of IK in LFSC classrooms. Therefore, the next chapter will discuss the findings, provide a conclusion, and enlist recommendations for practise and future research. It will also highlight the limitations of the study.

CHAPTER FIVE: DISCUSSIONS OF FINDINGS, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses the findings, provides conclusions, and provides recommendations for practise and future research. It will also review the limitations of the study. The conclusions are based on the study research questions, the problem statement, and the purpose of the study.

5.2 An overview of the study

I reiterate that the main aim of this study was to explore Grade 10 LFSC learners' views on the integration of IK-related topics using a cooperative learning approach. This was prompted by the need for the presence and emphasis on learners' IK during the teaching and learning of LFSC (DBE, 2011). which is not optimally fulfilled because it is unclear which teaching methods can be used. Therefore, this causes IK to be overlooked in the classrooms and results in injustice to LFSC learners, who are forced to perceive the subject mainly in a western way (De Beer, 2019). Hence, i found it suitable to try out a cooperative learning approach to integrate IK in LFSC teaching and learning of the two aforementioned topics (in Chapter 4). This assumed that the approach can draw out the unique IK that each learner holds and enable knowledge access and transmission to different learners in the learning context (Jacobs et al., 2019). To achieve that, i decided to look into learners' views by allowing them to bring forth, discuss, and incorporate their IK experiences related to LFSC content into the lesson. Thus, their expressions would highlight the IK they hold as well as the efficacy of the cooperative learning approach in facilitating the integration of IK in LFSC classrooms.

5.3 Discussions of findings

This section reports and discusses the findings established in Chapter 3 so as to answer the research questions. This avenue is given significance in assisting me to derive conclusions from the study (Taherdoost, 2022). As such, to lay out a detailed and logical flow for this section, findings for the main research question are presented first, followed by the first sub-question, and lastly, the second sub-

question. Findings are discussed through themes that emerged from the data. Some themes are further broken into sub-themes as they exhibit similar ideas to the main theme. According to Vaismoradi et al. (2016), the focal point of each sub-theme is also a distinct aspect of the research question. Moreover, given a room for triangulation (Stake, 1995), the presentations inculcate responses from all data sets and quotations from learners' replies to enhance the credibility and validity (Noble & Heale, 2019) of this study.

5.3.1 What are Grade 10 LFSC learners' views on the integration of IK- related topics?

This study found that intergrating IK in LFSC lessons allow learners to express themselves and see the connection between the subject content and their IK, as well as their context. Learners are of the view that the endevaour (1) enhanced their comprehension and learning of LFSC and (2) allowed them to conceptualise IK and its overall significance.

Learners revealed that they appreciate the presence and interogation of IK in their lessons of which enabled the construction of new knowledge and understanding. Which was possible because they were able to collaborate, draw from their own and others IK and what they experienced in their context, as well as the learning material they have interacted with. The responses from G1L002 and G2L005 on Q1 of the interviews strengthen this point. I quote learners responses to the question: What are your experiences with learning life sciences this way? From this question, learners had to express their views of being engaged in the lesson that integrated IK. Therefore, G1L002 said "… *It allowed me to see the connection between Life sciences and the little knowledge that I have from home",* while G2L005 said "… *it allows us to talk about what we see and do at home and connect them with what we do in class".* This learner declared a similar view and affirms with those in Jacobs (2015) study that integration of IK enabled them to connect their lived experiences with LFSC concepts.

This finding is also consistent with Keane (2017) and Mothwa (2011) findings, which reported that there are a variety of IK in science classrooms, of which it is confusing which one to use. Based on my findings, I agree with them, but argue that all of the

IK that is present in our classrooms, from the teacher to the learners and learning materials, ought to be evoked and discussed during teaching and learning. This is further corroborated by the theory underpinning this study, social constructivism, which acknowledges and values learners' uniqueness and advocates for this distinctiveness to be an integral part of the learning process. Therefore, to accomplish that, I suggest that teachers identify topics and concepts that are compatible with the integration of IK and prepare the learning opportunities for their learners. They should also step back from being the main source of knowledge in the classroom and give learners a centre stage to talk about their own IK and the one that emanates from the classroom context as they interpret and process the learning opportunities.

- **Including IK in the lesson enhances comprehension and learning**

This study revealed that including and discussing IK in LFSC lessons enhances comprehension and learning. Mawere (2015) mentioned that all people, including learners, acquire, hold, and use their IK in the different contexts they find themselves in. As such, learners in this study used their IK as prior knowledge through which they constructed new knowledge, learning, and understanding of LFSC topics. Integrating IK in the lesson also invited collaborations and discussions, which allowed learners to build knowledge from what they received from others in the learning context. For instance, G1L002 disclosed that "*It is good because I was never engaged in a lesson like this before, where we are given a chance to talk about our indigenous knowledge….I now understand why we have different places in South Africa that are not the same with climates and the type of plants and animals"*. From these assertions, it is clear that learning that is supported by IK becomes relevant to learners, and as a result, learners are more likely to easily grasp concepts and the content presented to them. Hence, learners were able to articulate their knowledge, engage in discussions, and apply and relate what they were learning to real-life situations. Moreover, they were able to analyse information, synthesise new ideas, and form and justify their conclusions. These acts showed that learning was occurring and enhanced by IK.

It can also be supported by reviewing some of the learners' perspectives, which emphasise how including IK in LFSC lessons encourages learners to learn and challenge preconceived notions, piques their curiosity, and boosts their participation. As a result, it promotes meaningful learning. From the interviews, G1L004 highlighted that "…*I just feel like indigenous knowledge could be included in Life Sciences textbooks and during day- to day lessons because "dia nyalelana" (*they relate*). It is interesting and it made me to enjoy the lesson. So maam you can imagine if it was done daily."* On the other hand, G2L008 also indicates that "*The lessons were good and interesting, especially the last activity of De Bonos hats. It allowed each one of us to think out of the box like looking at advantages and disadvantages of something before making up your mind. And I have realised that we don't see things the same way, we have different knowledge and views. And taking about them is very interesting, you come to learn new things that you knew nothing about or you had a little knowledge about them."* These voices make it obvious that integrating IK into the lesson increases learners' interest, receptivity, and engagement. Similar impressions are reported in the literature (De Beer & Petersen, 2016; Jacobs, 2015; Knapp, 2014; Onwu, 2020).

- **Conceptualisation of IK and its overall significance in school subjects**

This study revealed that integrating IK in LFSC classrooms evokes learners' conceptualisation of the IK they hold, and that that surface across cultures and contexts. They think of its significance both inside and outside their classrooms. Therefore, they believe that it would be of great benefit if it were included in every subject they study in school. G2L005 stated that being engaged in IK integrated lessons made her realise its relevance. She said "*They made me realise that not everything is science and technology based (today's world), even in the past people used to survive with what their environment gave them. And they are still doing that even today. And some of the items today are made from our indigenous plants and animals but we don't even entertain that thought. We have side lined the indigenous knowledge and we are now focused on science and technology, but bringing this indigenous knowledge up into the lessons is very helpful and reviving. I wish this can be done every day in all the subjects because is interesting."*

Similar findings are documented by Ugwu (2016), and Zindy and Eilks (2020), who found that learners perceived the integration of IK in their classes to be interesting and relevant. They showed that it has the potential to improve their education and help solve contemporary problems. I therefore concur with these findings and hold that IK should be integrated into all school subjects so that learners can realise the relationship between their education and society. Drawing from my personal experience as a learner and a teacher, IK is occasionally brought into the lesson in order to emphasise certain concepts, especially if it can be realised that learners fail to comprehend them. After that, learners will have a better comprehension of the concept and begin to challenge or expand upon it. I therefore suggest that teachers keep on drawing from learners IK and integrate it fully into their classrooms since CAPS has given them room to do so.

5.3.2 How does cooperative learning approach influence the integration of IK in Grade 10 LFSC classroom?

The focus of this research question was on the efficacy of the cooperative learning approach on the integration of IK in the Grade 10 LFSC classroom. Bearing in mind that the jigsaw and De Bono's thinking hats were the two methods under the cooperative learning approach adapted in this study to integrate IK in LFSC lessons, Therefore, to address this research question, data from the observations, documents reviews and interviews supported the development of the three themes: (a) that the cooperative learning approach is efficacious in integrating IK in LFSC lessons; (b) other benefits of using cooperative learning in the classroom; and (c) challenges of using cooperative learning to integrate IK in LFSC classrooms.

- **Cooperative learning approach is efficacious in integrating IK in LFSC lessons**

This study discovered that the cooperative learning approach competently brought out the IK that is present in the LFSC classroom. It was noted in Section 2.6 of Chapter 2 that cooperative learning is a learner-centred approach that enables group learning, where learners collaborate to build, uncover, and modify their knowledge as they clarify concepts with one another (Johnson & Johnson, 2014). It is against this background that this approach helped the teacher to plan and conduct the lessons

that contained IK and then provided learners with tasks that required them to relate, talk about, and exhibit their IK in light of what they were exposed to. Hence, the study found that learners could get together and share their IK in cooperative learning contexts. This finding validates what Evangelou (2023) pointed out: that a cooperative learning approach gives learners a platform to actively express themselves and their prior knowledge, interests, and needs in the learning context. Therefore, such acts were also seen in this study during observations, and they enabled IK to emerge from various sources, including the teacher, learners, and the learning materials. As a result, everyone was able to share their knowledge verbally and in writing, ask questions, and receive clarification, leading to a more knowledgeable classroom. These conversing platforms enhanced the integration of IK in the classroom and prevented knowledge transfer transpiring only in one direction, which is from the teacher to the learner.

Teachers in the Jacobs et al. (2019) study also emphasised this finding, stating that they would integrate IK using the cooperative learning approach since it makes IK accessible. Some learners' responses to the interview strengthen the point that indeed, IK becomes more accessible in cooperative learning contexts. For instance, G2L008 said "*Yah, gona le taba tše ntšhi mo maam* (yes, there is a lot of information here)". The other ones also indicated that learning in groups allowed them to learn new things that they were not aware of. G1L004 said "*We shared different ideas. Ye o tseba se nna ke sa setsebego, lenna ke tseba se a sa se tsebego. Then a thoma a nruta se a se tsebago, lenna ka mo ruta se ke se tsebago. Then re felletša re tseba dilo ka moka* (These ones knows what I don't know, and I know what they don't know. Then they started teaching me what they knew, and I taught them what I knew. Then we all end up knowing things)." While G2L005 said *"I have learnt new things from the group, things that I did not know about and never heard from anyone. But now I know and I will use some of them at home."* These perspectives justify that the cooperative learning approach is indeed efficacious in integrating IK in LFSC classrooms.

The observations made in this study also showed the influence of the cooperative learning approach on the integration of IK, lending credence to the aforementioned contentions. They revealed that the learning methods employed under this approach

enhanced social interactions, which facilitated the construction and transmission of knowledge in the classroom. Since IK is ingrained in culture, embodied in practises, and orally transmitted (Shava & Manyike, 2018), it is known that most of it is not easily recorded and accessible in classrooms (Shehu, 2020). However, this study showed that having productive classroom discussions in cooperative learning contexts allowed IK to emerge from each individual and become approachable. The discussions improved the engagement, enthusiasm, and drive of the learners in this study. As a result, learners developed good attitudes towards the learning process and showed no reluctance to share their IK. Additionally, languages (English and Sepedi) that were spoken and understood during group and whole-class interactions enhanced classroom communication, facilitated integration of IK, and allowed for the development of new insights. Based on these findings, i draw the conclusion that a cooperative learning approach enables the integration of IK in LFSC lessons.

- **Other benefits of using cooperative learning approach in the classroom**

This study found that, because of the learning communities (groups) that were formed in the classroom, a cooperative learning approach does not only enhance the integration of IK in LFSC classrooms but also the development of social and interpersonal skills. The following skills were identified through observations and interviews conducted for this study: cooperation, understanding, leadership, communication, relationship-building, sharing, active listening, support and encouragement, acceptance, appreciating differences, accountability, responsibility, assertiveness, decision-making, teamwork, patience, positivity, and negotiation were among the skills that were evident in the classroom. Moreover, De Bono's thinking hats catalysed the development of critical thinking skills. All of these skills are needed in today's world, and they are what our educational system strives to instil in our learners since they are essential for effective communication and collaboration in any functional society, community, culture, and organisation.

This study showed that De Bono's thinking hats give learners a space and a voice in the classroom, showing that they are critical, confident, and independent agents as a result of the extensive verbal exchanges they engage in with their peers. Such context is critical for learners to engage in real-world issues and wrestle with

concepts in order to deepen and extend their thinking. Noticeable learners' thinking skills included decision-making, critical thinking, and creative thinking. Furthermore, learners showcased positive attitudes and thoughts that contributed to a positive learning environment, which enhanced obtaining and integrating knowledge, extending and refining knowledge, and making meaningful use of the knowledge. This showed that learners are not simply empty vessels waiting to be filled.

Conversely, this study revealed that the Jigsaw learning method promoted positive interdependence and individual accountability. In this study, learners were able to take on various responsibilities as information bearers, while others valued the peer support that was equally necessary for their learning. Hence, they acted as MKO's, mediators, and scaffolds to enhance one another's learning and understanding. Furthermore, by kindling their interest in the learning activities, learners have shown their ability to be highly autonomous and motivated; hence, they developed high knowledge and skills as a result of these learning methods. Therefore, if these two methods can be realised by teachers, all of the aforementioned benefits will manifest in our classrooms and in life outside of the classroom, including adult life. Thus, DBE (2011) aspirations that learners should not be taught simply academic material while neglecting other vital life skills will come true. As a result, we must consider the methods we now employ in the classroom to communicate content. Furthermore, since learners are our future leaders, we must consider the types of learners we tend to produce as well as the people they will become. I therefore support the use of this strategy to encourage the development of academic, affective, and social skills.

- **Challenges of using cooperative learning to integrate IK in LFSC classrooms**

This study recognised that deploying Jigsaw and De Bono's thinking methods to integrate IK in LFSC classes has a number of impediments that should be considered. I observed that these methods require more time and effort to prepare for and complete the learning task. This is due to the fact that cooperative learning involves more than just having learners work in groups; rather, focus should be placed on group functioning. Therefore, when designing the lessons, the teacher should keep in mind the five features that are critical for the success of this approach.

As outlined by Johnson and Johnson (2014), there should be face-to-face connection, positive interdependence, individual accountability, self- and group reflection, and the development of interpersonal and social skills. Furthermore, since this approach makes learners the main drivers of their learning, it follows that even learners require more time to interact with the learning material to construct and negotiate knowledge within their groups. During the interviews, G2L008 indicated that "*time allocation for each activity should be more because you find that you still have more to say but because of time you leave out some information".* In support of this learner assertion, during observations, it was noted that learners spent more time on topics they were more familiar with.

In addition, learners face difficulties when they lack prior information on the topic of interest. That was observed during the Jigsaw learning exercise, wherein learners end up approaching the teacher for assistance. This implies that it is imperative that teachers do thorough research on the items they will present before delivering the lessons. Furthermore, this issue was also mentioned by the learners during interviews wherein G2L006 said "*We should be given more time to do research at home because we don't know some indigenous uses of some plants and animals".* This also signifies that learners should be allowed time to conduct research at home and return to the classroom to present their findings. This might also improve the pool of information in the classroom.

This study showed that though the cooperative learning approach promotes common understanding and learning, there is still a risk that, if not identified and addressed, a misinterpreted idea from one group could spread to the entire class. As a result, engaging in whole-classroom discourse is critical since it will disclose misinterpreted items for the teacher to correct and for learners to rethink their conceptions.

5.3.3 How relevant is the IK held by learners that can be integrated in LFSC?

- Mandikonza (2019) asserts that in order to fully use learners' IK to improve and contextualise science learning, it is imperative to examine their points of view and unlock the potential of their IK (Anazifa & Hadi, 2017). Hence, learners in this study have expressed their IK in writing and verbally, which have been analysed in order to be aware of the IK they hold. Thus, the

information gathered from observations and document analysis provides an answer to this research question. Learners' possess distinct IK related to LFSC topics, the link between LFSC content and learners' IK, as well as learners' IK that can be integrated into LFSC lessons, are the three themes that emerged.

- **Learners' possess distinct IK related to LFSC topics**

This study found that Grade 10 LFSC learners possess distinct IK connected to LFSC topics. Learners articulated, verbally and in writing, their IK for every topic they encountered in this study. This showed that learners do, in fact, come to class with important knowledge (IK) that they can link to the LFSC topics and share during the learning process. The descriptions that learners have revealed in their scripts and during group discussions manifest this point. As such, this discovery agrees with the argument that LFSC learners carry with them special IK that should be used for the teaching and learning of LFSC topics (De Beer, 2019; Reddy, 2019). Moreover, learners were able to uncover IK that they were unfamiliar with from their cultures and contexts. This revelation is what the LFSC CAPS document (DBE, 2011) emphasises in its argument that for learners to realise the relevancy of IK in science, they should be exposed to IK from other cultures and contexts in addition to their own. It is evident that this venture gave learners the chance to learn about others' experiences, histories, current relationships, and contributions to modern society (Lamb & Godlewska, 2021).

- **The link between LFSC content and learners' IK**

This study revealed that there is a link between LFSC content and Grade 10 learners' IK. From the document analysis and learners discussions during observations, it is noted that learners could articulate and connect their IK to the LFSC topics considered in this study. LFSC studies living things and their interactions with one another and their surroundings, whereas IK is the knowledge acquired through interactions and understandings of the close surroundings. This illustrates that the LFSC subject matter reflects the experiences that learners have on a daily basis with themselves, their surroundings, and their daily lives. Hence,

drawing from learners' surroundings and their IK made it easier for them to understand the LFSC topics presented to them. In other words, learning was contextualised. Additionally, their usage of vernacular names lends credence to this. Interestingly, this study acknowledged that this connection shows that IK may be used as prior knowledge to base the learning, enhance the curriculum, and clarify ideas during LFSC lessons. Similar remarks were made by Mandikonza (2019), Mavuso et al. (2021), and Zidny et al. (2020). As such, in order to improve teaching and learning as well as learners' comprehension, I suggest that teachers should choose topics from the LFSC themes and integrate learners' IK. Learners will ultimately come to realise the relevance of LFSC to their lives and its connection to their IK, which might foster transformative experiences highlighted by Pugh et al. (2017).

- **Learners' IK that can be integrated into LFSC lessons**

The LFSC CAPS document specifically highlights the integration of traditional technology and skills, traditional medicines and healers, medical biotechnology, and cloning of plant and animal tissues in Grade 10 lessons (CAPS, 2011). Ronoh (2017) added items like agricultural and environmental aspects, food production, indigenous and endemic species, sustainable use of the environment, and natural resources. Therefore, based on the IK that learners have shared, this study found that the following are relevant to be integrated in LFSC classrooms: indigenous health and medicines, veterinary medicines, nutrition, natural resources, traditional technology, and skills. These results are consistent with those highlighted by DBE (2011) and Ronoh (2017).

Handayani et al. (2018) argue that integrating IK within curricular themes would give learners a good entry point into the scientific world, processes, and procedures. which may spark learners' interests and open up future career opportunities for them (De Beer, 2019; Le Grange, 2016). To support this, De Beer (2019) sheds light on the ethnobotany, ethnozoology, ethnopharmaceutical, agricultural, and entrepreneurial opportunities associated with IK in science classrooms. Furthermore, I add that it will not be surprising to see some of the learners enrol in IK-related

courses, such as the Bachelor in Indigenous Knowledge Systems at the University of Venda (UNIVEN).

Given the emphasis made in Section 2.3 of Chapter 2 on the nature of science and the nature of IK, as well as the three perspectives provided for the integration of IK in scientific classrooms, I anticipate that the above-mentioned items should be integrated into the Grade 10 LFSC lessons. It may result in a shift in perspective, making both the teacher and learners more receptive to and tolerant of IK in science. De Beer (2019) stresses that it may build a nuanced understanding of the nature of science and IK, in addition to comprehending the relationship between science and society (DBE, 2011). As a result, learners will be scientifically literate.

5.4 Implications

This study set out to explore how well a cooperative learning approach can facilitate the integration of IK-related topics into the LFSC classroom. This was accomplished by considering the learners' viewpoints and letting them share, discuss, and incorporate their IK experiences related to the LFSC content. As a result, it is clear from the findings that the cooperative learning approach works well for integrating IK in LFSC lessons. This approach makes it easy for the learners to express themselves due to its engaging nature and the voice it gives them. Thus, this approach brought out the IK that is there in the classroom and allowed all the participants to use it to construct new knowledge and learn from one another. The findings also imply that it is critical to integrate learners' IK into the lessons as it contextualises learning, which helps learners understand how what they are learning relates to their everyday lives. resulting in more meaningful and enhanced learning. Furthermore, along with critical thinking abilities, the approach also promotes the development of social and interpersonal skills. As a result, based on these findings, I strongly believe that this is the method that teachers should use to integrate IK into LFSC lessons and to help learners develop other crucial life skills.

5.6 Significance of the study

Much focus has long been on challenges on integrating IK, with less being said and implemented about any fruitful teaching and learning methods that can unfold such

challenges. Therefore, this study has benefited the literature, educators, researcher and the learners. It offered practical significance by providing an understanding of what cooperative learning approach can and cannot do in the classroom, especially when integrating IK. This study gave learners the opportunity to exchange and discuss their IK with each other. Which allowed them to realise, recognise and appreciate ones IK as it emerged from the learning experience. Learners were able to earn important knowledge from their peers, and grasp the connection between LFSC and their IK. Additionally, this study gave me as an LFSC teacher new experiences and knowledge that can shape her future pedagogical practices. Therefore, other educators can also try this approach to integrate IK in their lessons. Moreover, the endeavour added to the limited literature on the field of cooperative learning approach on the integration of IK in LFSC classrooms with learners as the main research participants, especially within South African contexts.

5.7 Limitations of the study

Theofanidis and Fountouki (2019) clarified delimitations as the boundaries set by the researcher to narrow their studies and make them manageable to achieve the research goal. On that note, IK was only integrated into two LFSC topics. Secondly, this study focused only on one secondary school in Limpopo, Moroke Circuit, in Sekhukhune East district. Only one class of Grade 10 Life Sciences learners (69 learners) was considered because i is the grade and subject teacher. Thus, it facilitated easy access for the learners and the collection of data. On the other hand, they noted limitations as potential flaws in the study that are beyond my control (Theofanidis & Fountouki, 2019). The findings of this study were subject to at least two limitations. Firstly, the study was carried out in one circuit, one school, one grade and class, and two topics in LFSC. Therefore, the findings cannot be generalised to all other classes, schools, and subject topics in the same or different circuits. Secondly, the small number of participants has prevented the collection of rich data. In the future, similar investigations should be carried out using larger samples and more topics in LFSC at various class levels. Moreover, the involvement of different circuits and more learners and teachers will be necessary.

5.8 Conclusion

This study employed Jigsaw and De Bono's thinking methods under the cooperative learning approach to integrate IK into LFSC topics and examine their efficacy for the endeavour. This was accomplished by considering learners' views attached to documents and revealed during interviews, which were also supported by the observations made throughout the study. Therefore, findings showed that the cooperative learning approach is efficacious in integrating IK in LFSC classrooms, as it freed all the participants to actively engage in the discussions where they could share their IK, ask for clarity, and construct new knowledge. On the other hand, learners' views were crucial to analysing various IK experiences that they hold and how they feel about being engaged in cooperative learning contexts that draw from their IK. Not only were there instances where learners described their thought processes, reported their high positive affect, and identified important points in the lesson, But the diversity of learners' articulations added detail to the findings and raised awareness of what might be learned from learners' IK in the LFSC classroom. As such, this study concludes that a cooperative learning approach, specifically Jigsaw and De Bono's thinking hats, should be considered for effective integration of IK in LFSC classrooms.

5.9 Recommendations

I recommend that more research be done on the integration of IK in Grade 10 LFSC classrooms using Jigsaw and De Bono's thinking hats with the same topics considered in this study. Other studies should also be carried out in Grades 11 and 12, with learners as the main participants and involving all similar and different topics. This will add to the limited literature on the use of cooperative learning approaches to integrate IK in LFSC classrooms. Recommendations to LFSC teachers are that they should create learning contexts that allow learners to talk about their IK. Such acts allow learners to realise the connection between the subject and their lived experiences. Thus, it leads to enhanced and meaningful learning. Therefore, they should deploy a cooperative learning approach in their classrooms.

REFERENCE

Abah, J., Mashebe, P., & Denuga, D. (2015). Prospect of integrating African indigenous knowledge systems into the teaching of science in Africa. *American Journal of Educational Research, 3*(6), 668-673.

Abdallah, Z. S., Monash, L. Du & Webb, G. I. (2017). 'Data preparation'.

Abtahi, Y., Graven, M., & Lerman, S. (2017). Conceptualising the more knowledgeable other within a multi-directional ZPD. *Educational Studies in Mathematics,* 96(3), 275–287. http://www.jstor.org/stable/45185375

Adams, F. H. (2013). Using Jigsaw Technique as an Effective Way of Promoting Co-Operative Learning Among Primary Six Pupils in Fijai. *International Journal of Education and Practice*, *1*(6), 64–74. https://doi.org/10.18488/journal.61/2013.1.6/61.6.64.74

Adams, N. E. (2015). Bloom's taxonomy of cognitive learning objectives. *Journal of the Medical Library Association : JMLA*, *103*(3), 152–153. https://doi.org/10.3163/1536-5050.103.3.010

Adas, M.(2016). Colonialism and science, in: Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures. *Springer Netherlands.*

Ahanonye, U. A. (2021). *Teachers' indigenous knowledge and the possibilities of integrating it with Life Sciences teaching and learning* (Doctoral thesis, University Witwatersrand). Johannesburg, South Africa.

Alghamdi, H. H. (2018). Exploring Second Language Vocabulary Learning in ESL Classes. *English Language Teaching*, *12*(1), 78. https://doi.org/10.5539/elt.v12n1p78

Allred, K. (2020). *From Classroom to Real-World: Preparing Students for the Newsroom.* Theses and Dissertations, 356.

Anazifa, D., & Hadi, R. F. (2017). The integration of Javanese indigenous knowledge in Biology learning resources development. Journal of Physics: Conf. Series, 812, 1-5. Balfour, R. J. (2019). Foreword. In: De Beer, J. (Ed)., The decolonization of the

curriculum project: The affordances of indigenous knowledge for self-directed learning. Stellenbosch: AOSIS.

Animasahun, R. A. (2007). Measured effect of emotional intelligence education in the remediation of aggressive behaviours among the members othe NURTW in Ibadan Metropolis. *IFE PsychologIA*, *15*(1). https://doi.org/10.4314/ifep.v15i1.23733

Aronson, E. (1978). *The jigsaw classroom.* Sage Publications.

Aydin, A., & Biyikli, F. (2017). The Effect of Jigsaw Technique on the Students' Laboratory Material Recognition and Usage Skills in General Physics Laboratory-I Course. *Universal Journal of Educational Research*, *5*(7), 1073–1082. https://doi.org/10.13189/ujer.2017.050701

Baneng, M. (2020). Cooperative Learning Approach Applying Jigsaw Strategy to Enhance Students' Comprehension Skill. *Journal of Physics: Conference Series*, *1471*(1), 012027. https://doi.org/10.1088/1742-6596/1471/1/012027

Barnhardt, R. (2014). *Creating a place for indigenous knowledge in education. The Alaska native knowledge*. New York: Psychology Press.

Baxter, P., & Jack, S. (2015). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *The Qualitative Report*. https://doi.org/10.46743/2160-3715/2008.1573

Bayati, E. (2015). *Brainstorming, Concept Mapping and the Six Thinking Hats as teaching techniques in education*. Heraklion: Regional Directorate of Primary & Secondary Education of Crete, 8th Region of Heraklion Regional Unit of Primary Education.

Bayati, I. (2015). Students with special education needs: spontaneous perceptions toward nature compared to those of students without special education needs. Science and Technology Issues in Education, 8(1-2), 67–90.

Beal, C. R., & Arroyo, I. (2002). *The AnimalWatch project: Creating an intelligent computer mathematics tutor*. Children in the digital age. Greenwood.

Bell, R. L. (2008). *Teaching the nature of science: Three critical questions.*

Bhandari, B., Mehta, B., Mavai, M., Singh, Y.R., & Singhal, A. (2017). Jigsaw Method: An Innovative Way of Cooperative Learning. Indian Journal of Physiology and Pharmacology, 61(3), 315-321.

Brau, B. (2020). *Constructivism: The students' guide to learning design and research*. *EdTech Books*.

Bruchac, M. (2014). *Indigenous Knowledge and Traditional Knowledge.* In Smith, C. (Ed.), Encyclopedia of Global Archaeology, 3814-3824. New York: Springer.

Buma, A. M. (2018). Reflections of Science Teachers in a Professional Development Intervention to Improve their Ability to Teach for the Affective Domain. *African Journal of Research in Mathematics, Science and Technology Education*, *22*(1), 103–113. https://doi.org/10.1080/18117295.2018.1440906

Butera, F., & Buchs, C. (2019). *Social Interdependence and the Promotion of Cooperative Learning.* Social Psychology in Action, 111-127.

Cajete, G. (2004). Philosophy of native science. *Am. Indian Thought 45–57.*

Cajete, G. A. (2015). Indigenous education and the development of indigenous community leaders. *Leadership*, *12*(3), 364–376. https://doi.org/10.1177/1742715015610412

Cavanagh, M. (2011). Students' experiences of active engagement through cooperative learning activities in lectures. *Active Learning in Higher Education*, 12(1), 23-33.

Cancer Association of South Africa. (2021). *Fact sheet and position statement on Sutherlandia frutescens.*

Chakravartty, A. (2021). Risk, Reward, and Scientific Ontology: Reply to Bryant, Psillos, and Slater. *Dialogue*, *60*(1), 43–63. https://doi.org/10.1017/s0012217320000311

Cherry, K. (2022). *What is Sociocultural Theory?* VeryWell Mind. Retrieved from https://www.verywellmind.com/what-is-sociocultural-theory-2795088

Chimbala-Kalenga, R. (2015). *Adjusting western research techniques to accommodate research in the indigenous realm.Indilinga.* African Journal of Indigenous Knowledge Systems, 14(1), 1–11.

Chukwu, J. C., & Arokoyu, A. A. (2019). Effects of Jigsaw-Puzzle Instructional Strategy on Secondary School Students' Performance on Growth as a Concept in Biology in Abia State. *Advances in Research*, 1–6. https://doi.org/10.9734/air/2019/v20i130148

Cindi, L. (2021). *Incorporating African indigenous knowledge systems into the Basic Education curriculum: Experiences from two schools in the Gauteng and KwaZulu-Natal provinces, South Africa* (Masters dissertation). University of Free State, South Africa.

Clinton, V., & Wilson, N. (2019). More than chalkboards: classroom spaces and collaborative learning attitudes. *Learning Environments Research*, *22*(3), 325–344. https://doi.org/10.1007/s10984-019-09287-w

Clitheroe, F., Doidge, M., Marsden, S., Mbambisa, N., Rampou, S., Sinleton, N., Stander, M., & Van Aarde, I. (2011). *Focus Life Sciences learners book: Grade 10.* Maskew Miller Longman (Pty) Ltd: South Africa.

Converse, M. (2012). Philosophy of phenomenology: how understanding aids research. *Nurse Researcher*, *20*(1), 28–32. https://doi.org/10.7748/nr2012.09.20.1.28.c9305

Cooper, D.R. (2011). *Education and Science*. Florida University: United States of America.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods (2nd ed.)*. Thousand Oaks: Sage Publications.

Creswell, J. W. (2007). Five qualitative approaches to inquiry. In J. W Creswell (Eds), *Qualitative inquiry and research design: Choosing among five Approaches*. Thousand Oaks: Sage Publications.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approach (4th ed.*). Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative Inquiry and Research Design Choosing among Five Approaches (4th ed.)*. Thousand Oaks, Sage Publications.

Cronje, A., de Beer, J., & Ankiewicz, P. (2015). The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge. *African Journal of Research in Mathematics, Science and Technology Education*, *19*(3), 319–332. https://doi.org/10.1080/10288457.2015.1108567

Dasar, P. (2019). *Six Thinking Hats Method for Developing Critical Thinking Skills.* Journal of Educational Science and Technology, 5(1), 82-91.

De Beer, J. (2016). *Re-imagining science education in South Africa: the affordances of indigenous knowledge for self-directed learning in the school curriculum.* Journal for New Generation Sciences, *14*(3):34-46.

De Beer, J. (2019). The affordances of project-based learning and classroom action research in the teaching and learning of natural sciences. *Perspectives in Education*, *37*(2), 67–79. https://doi.org/10.18820/2519593x/pie.v37i2.5

De Beer, J. & Petersen, N. (2016). *Decolonisation of the science curriculum: A Different Perspective (#Cookbook-labs-must-fall)*. Unisa Press.

De Beer, J., & Petersen, N. (Eds.). (2017). A Laboratory Investigation on the Role of Ethylene in Seed Germination from an Indigenous Knowledge Perspective. *The American Biology Teacher*, *79*(1), 55–61. https://doi.org/10.1525/abt.2017.79.1.55

De Beer, J., & van Wyk, B. E. (2011). Doing an Ethnobotanical Survey in the Life Sciences Classroom. *The American Biology Teacher*, *73*(2), 90–97. https://doi.org/10.1525/abt.2011.73.2.7

De Beer, J., & Van Wyk, B- E. (2019). *Arguing for the inclusion of indigenous in the STEM curriculum: Possibilities and challenges*.

De Beer, J., & Van Wyk, B-E. (2021). *Indigenous Knowledge Systems and Western Science: The Conundrum of Validation.* Indilinga African Journal of Indigenous Knowledge Systems, 20(2), 170-193.

De Bono, E. (1985). *Six thinking hats*. Boston: Little, Brown, and Company.

Denhere, C., Chinyoka, K., & Mambeu, J. (2013). Vygotsky's Zone of Proximal Development Theory: What are its Implications for Mathematical Teaching? *Greener Journal of Social Sciences*, *3*(7), 371–377. https://doi.org/10.15580/gjss.2013.7.052213632

Denzin, N. K., & Lincoln, Y. S. (2000). *Introduction: The discipline and practice of qualitative research*. In N. K. Denzin, & Y. S. Lincoln (Eds.), Handbook of Qualitative Research (2nd ed., pp. 1-34). Thousand Oaks, CA: Sage Publications.

Department of Education. (2011). *Curriculum and assessment policy statement*. Pretoria, South Africa: Government Printers.

Desmarchelier, R. (2020). *Indigenous knowledges and science education: Complexities, considerations and praxis.* United Kingdom: SAGE Publications Ltd.

Dingaan, M., & Preez, P. J. du. (2018). *Vachellia (Acacia) karroo Communities in South Africa: An Overview*. InTech.

Diwu, C. T., & Ogunniyi, M. B. (2012). Dialogical argumentation instruction as a catalytic agent for the integration of school science with Indigenous Knowledge Systems. *African Journal of Research in Mathematics, Science and Technology Education*, *16*(3), 333–347. https://doi.org/10.1080/10288457.2012.10740749

Doron, E. (2017). Fostering creativity in school aged children through perspective taking and visual media based short term intervention program. *Thinking Skills and Creativity*, *23*, 150–160. https://doi.org/10.1016/j.tsc.2016.12.003

Dhull, P., & Verma, G. (2019). *Jigsaw teaching technique for teaching science.* International Journal of Research and Analytical Reviews, 6(2), 809- 815.

Erinosho, S. (2013). Integrating Indigenous Science with School Science for Enhanced Learning: A Nigerian Example. *International Journal for Cross-Disciplinary Subjects in Education*, *4*(2), 1137–1143. https://doi.org/10.20533/ijcdse.2042.6364.2013.0160

Evangelou, F. (2023). Teaching techniques for developing the learner–centred approach in the classroom. *European Journal of Education Studies*, *10*(2). https://doi.org/10.46827/ejes.v10i2.4667

Fakoyede, S. J., & Otulaja, F. S. (2019). Beads and beadwork as cultural artifacts used in mediating learners' agentic constructs in science classrooms: a case for place-based learning. *Cultural Studies of Science Education*, *15*(1), 193–210. https://doi.org/10.1007/s11422-019-09911-4

Fasasi, R. A. (2017). Effects of ethnoscience instruction, school location, and parental educational status on learners' attitude towards science. *International Journal of Science Education*, *39*(5), 548–564. https://doi.org/10.1080/09500693.2017.1296599

Fleming, J., & Zegwaard, K. E. (2018). *Methodologies, methods, and ethical considerations for conducting research in work integrated learning.* University of Waikato: New Zealand.

García-Almeida, D. J., & Cabrera-Nuez, M. T. (2018). The influence of knowledge recipients' proactivity on knowledge construction in cooperative learning experiences. *Active Learning in Higher Education*, *21*(1), 79–92. https://doi.org/10.1177/1469787418754569

Grey, G. (2000). Culturally responsive teaching: theory, research, and practice. *Choice Reviews Online*, *38*(03), 38–1683. https://doi.org/10.5860/choice.38-1683

Gillies, R. (2016). Cooperative Learning: Review of Research and Practice. *Australian Journal of Teacher Education*, *41*(3), 39–54. https://doi.org/10.14221/ajte.2016v41n3.3

Grenier, M., & Yeaton, P. (2019). Social Thinking Skills and Cooperative Learning for Students with Autism. *Journal of Physical Education, Recreation & Dance*, *90*(3), 18–21. https://doi.org/10.1080/07303084.2019.1559675

Gull, F., & Shehzad, S. (2015). Effects of Cooperative Learning on Students' Academic Achievement. *Journal of Education and Learning (EduLearn)*, *9*(3), 246–255. https://doi.org/10.11591/edulearn.v9i3.2071

Gumbo, M. T. (2017). *An indigenous perspective on technology education.* Handbook of Research on Social, Cultural, and Educational Considerations of indigenous knowledge in Developing Countries.

Gupta, T., & Bhattacharya, S. (2015). Fostering thinking skills through six thinking hats in education. *Education India Journal: A Quarterly Refereed Journal of Dialogues on Education*, *4*(4), 54-74.

Golder, J. (2018). *Constructivism: A paradigm for teaching and learning*. International Journal of Research and Analytical Reviews, 5(3), 678-686.

Hammond, L. D., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2019). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, *24*(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791

Handayani, R. D., Wilujeng, I., & Prasetyo, Z. K. (2018). Elaborating Indigenous Knowledge in the Science Curriculum for the Cultural Sustainability. *Journal of Teacher Education for Sustainability*, *20*(2), 74–88. https://doi.org/10.2478/jtes-2018-0016

Hani, U., Petrus, I., & Sitinjak, M. (2017). *The effect of six thinking hats and critical thinking on speaking achievement.* Advances in Social Science, Education and Humanities Research, 82, 85-88.

Haradhan, K. M. (2018). Qualitative research methodology in social sciences and related subjects. *Journal of Economic Development, Environment and People*, *7*(1), 23. https://doi.org/10.26458/jedep.v7i1.571

Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). *Case Study Research: Foundations and Methodological Orientations*. Forum: Qualitative Social Research, 18(1).

Havenga, H. M. (2015). *Engaging in indigenous knowledge technology: Conceptualisation and contextualisation in problem- based environments*. AOSIS book .

Haverkort, B., & Reijntjes, C. (2011). *Diversities of World Views, Knowledge, Communities and Sciences and the Challenges of its Co-Evolutions.*

Hewson, M. G., & Ogunniyi, M. B. (2010). Argumentation-teaching as a method to introduce indigenous knowledge into science classrooms: opportunities and challenges. *Cultural Studies of Science Education*, *6*(3), 679–692. https://doi.org/10.1007/s11422-010-9303-5

Hudha, M. N., & Jayanti, Y. M. (2018). *Inquiry-Discovery Empowering High Order Thinking Skills And Scientific Literacy On Substance Pressure Topic.* Jurnal Al Biruni,139–151.

Idang, G. E. (2018). AFRICAN CULTURE AND VALUES. *Phronimon*, *16*(2), 97–111. https://doi.org/10.25159/2413-3086/3820

Insights, E. (2020) ‘What is a research instrument?

Jacobs, G. M., Wang, A., Li, X., & Xie, Y. (2008). *"Making thinking audible and visible via cooperative learning."* International perspectives on education, 103-117.

Jacobs, K. R. (2015). *The classroom implementation of indigenous knowledge in the science curriculum by science teachers in the Western Cape province, South Africa (*Doctoral thesis, University of Cape Town*).*

Jacobs, S., De Beer, J., & Petersen, N. (2019). *The professional development of teachers in terms of their understanding, experience, and application of indigenous knowledge and cooperative learning in Life sciences education*.

Jansen, J. (2017). *Decolonising the university curriculum given a dysfunctional school system?.* Journal of Education, 68, 3-14.

Jautse, P.P., Thambe, N., & De Beer, J. (2016). *A day at the museum: A case study of how museums could partner with universities in teacher education.* Proceedings from ISTE International Conference on Mathematics, Science and Technology Education: Towards Effective Teaching and Meaningful Learning in Mathematics, Science and Technology.

Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory Into Practice*, *38*(2), 67–73. https://doi.org/10.1080/00405849909543834

Johnson, D. W., & Johnson, R. T. (2008). An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning. *Educational Researcher*, *38*(5), 365–379. https://doi.org/10.3102/0013189x09339057

Johnson, D. W., & Johnson, R. T. (2014). *Joining together: Group theory and group skills*. London, UK: Pearson Education Limited.

Johnson, D. W., Johnson, R. T., & Smith, K. (2014). *Cooperative learning: Improving university instruction by basing practice on validated theory*. Journal on Excellence in College Teaching, 25(3&4), 85-118.

Kabir, S. M. S. (2016). *Basic Guidelines for Research: An Introductory Approach for All Disciplines.* Book Zone Publication: Bangladesh.

Kapur, R. (2018). *The Significance of Social Constructivism in Education*.

Karacop, A., & Diken, E. H. (2017). *The Effects of Jigsaw Technique Based on Cooperative Learning on Prospective Science Teachers' Science Process Skill.* Journal of Education and Practice, 8(6), 86-97.

Kaya, H. O. (2014). *Revitalising African Indigenous Ways of Knowing and Knowledge Production.*

Kaya, H. O., & Seleti, Y. N. (2013). *African Indigenous Knowledge Systems and Relevance of Higher Education in South Africa.* The International Education Journal: Comparative Perspectives, 12, 30-44.

Kaya, M. F. (2013). *The effect of six thinking hats on student success in teaching subjects related to sustainable development in geography classes.* Kuramve Uygulamada Egitim Bilimleri. 13 (2), 1134–1139.

Kazeni, M., & Onwu, G. (2013). Comparative Effectiveness of Context-based and Traditional Approaches in Teaching Genetics: Student Views and Achievement. *African Journal of Research in Mathematics, Science and Technology Education*, *17*(1–2), 50–62. https://doi.org/10.1080/10288457.2013.826970

Keane, M. (2017). *Why Indigenous Knowledge has a place in the school science Curriculum.* University of Witwatersrand, South Africa.

Khupe, C. (2014). *Indigenous knowledge and school science: Possibilities for integration (*Doctoral thesis, University of Witwatersrand). Johannesburg: South Africa.

Kivunja, C. (2015). Using De Bono's Six Thinking Hats Model to Teach Critical Thinking and Problem Solving Skills Essential for Success in the 21st Century Economy. *Creative Education*, *06*(03), 380–391. https://doi.org/10.4236/ce.2015.63037

Knapp, C. E. (2014). *Place-based curriculum and pedagogical models: My adventures in teaching through community contexts*. New York: Psychology Press.

Korstjens, I., & Moser, A. (2017). Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, *24*(1), 120–124. https://doi.org/10.1080/13814788.2017.1375092

Kozulin, A. (2002). Sociocultural Theory and the Mediated Learning Experience. *School Psychology International*, *23*(1), 7–35. https://doi.org/10.1177/0143034302023001729

Kruger, D., & De Beer, J. (2019). *Infusing indigenous knowledge in the Life Sciences classroom: Design principles for creating an ethnobiological matrix.* Proceedings of Teaching and educational Institute of Social and Economic Sciences. International Institute of Social and Economic Sciences.

Kumar, R. (2011). *Research Methodology. A Step-By-Step Guide for Beginners* (3rd ed.). SAGE Publication.

Kumari, S. (2014). *Effectiveness of six thinking hats strategy on the development of parallel thinking, lateral thinking and general creativity in high school students (*Ph.D. Thesis).

Kumari, S. (2022). *Six thinking hats: An instructional strategy for developing thinking skills in education.* International Journal of Education, Modern Management, Applied Science and Social Science, 4(1), 168-173.

Kwanya, T. (2015). *Indigenous knowledge and socioeconomic development: Indigenous tourism in Kenya.* International Conference on Knowledge Management in Organizations.

Kyprianidou, M. (2012). *Technological systems for the composition of collaborative learning groups based on the learner's learning type* (PhD thesis). Thessaloniki: Aristotle University of Thessaloniki.

Laal, M., Naseri, A. S., Laal, M., & Khattami-Kermanshahi, Z. (2013). What do we Achieve from Learning in Collaboration? *Procedia - Social and Behavioral Sciences*, *93*, 1427–1432. https://doi.org/10.1016/j.sbspro.2013.10.057

Lajoie, S. P. (2005). *Cognitive tools for the mind: The promises of technology: Cognitive amplifiers or bionic prosthetics.* Intelligence and technology: Impact of tools on the nature and development of human skills, 5, 87-102.

Lamb, C., & Godlewska, A. (2020). On the peripheries of education: (not)learning about Indigenous peoples in the 1995-2010 British Columbia curriculum. *Journal of Curriculum Studies*, *53*(1), 103–123. https://doi.org/10.1080/00220272.2020.1774806

Lazarus, S. (2011). *Creating the melting pot: Some thoughts on the curriculum as a vehicle for integrating diverse pieces of knowledge.* In the Proceedings of the 3rd International Conference on the Integration of Science and Indigenous Knowledge Systems. University of Western Cape, Bellville: South Africa.

Lederman, N.G., Lederman, J.S., & Antink, A. (2013). *Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy*. International Journal of Education in Mathematics, Science and Technology, 1(3), 138-147.

Leoudi, A. (2018). *Investigation of adult learners' views on the use of active-participatory educational techniques in the context of a programme for learning Greek as a foreign language: The case of the Volkshochschule (People's University) of Graz, Austria (*Master's thesis). Patras, Greece: EAP.

Linsenmeyer, M. (2021). Brief Activities: Questioning, Brainstorming, Think-Pair-Share, Jigsaw, and Clinical Case Discussions. In: Fornari, A., Poznanski, A. (eds) How-to Guide for Active Learning. IAMSE Manuals. Springer, Cham.

Mahwasane, S., Middleton, L., & Boaduo, N. (2013). An ethnobotanical survey of indigenous knowledge on medicinal plants used by the traditional healers of the Lwamondo area, Limpopo province, South Africa. *South African Journal of Botany*, *88*, 69–75. https://doi.org/10.1016/j.sajb.2013.05.004

Majid, U. (2018). Research Fundamentals: Study Design, Population, and Sample Size. *Undergraduate Research in Natural and Clinical Science and Technology (URNCST) Journal*, *2*(1), 1–7. https://doi.org/10.26685/urncst.16

Mak-Mensah, E., Sam, A., & Hanson, R. (2018). Using cooperative learning to enhance pupils' understanding of the agortime-ziope district of Ghana. *European Journal of Basic and Applied Sciences, 1(5), 18-28.*

Mandikonza, C. (2019). Integrating indigenous knowledge practices as context and concepts for the learning of curriculum science: A methodological exploration. *Southern African Journal of Environmental Education*, *35*(1). https://doi.org/10.4314/sajee.v35i1.13

Manyana, X. Y. (2020). *Exploring affordances and hindrances when indigenous knowledge is integrated with the topic of waves and sound in a Grade 10 Physical Sciences township class* (Masters' thesis, Rhodes University). South Africa.

Masango, C. A. (2010). Indigenous traditional knowledge protection:prospects in South Africa's intellectual property framework? *South African Journal of Libraries and Information Science*, *76*(1). https://doi.org/10.7553/76-1-88

Mashoko, D. (2014). *Indigenous knowledge for plant medicine: Inclusion into school science teaching and learning in Zimbabwe*. *I*nternational Journal of English and Education, *33*, 2278-4012.

Mavuru, L., & Makhunga, K. X. (2020). *Relevance of indigenous knowledge integration in Life Sciences teaching: What do the teachers say?* Proceedings of EDULEARN20 Conference, 6556- 6563.

Mavuru, L., & Ramnarain, U. (2017). Teachers' Knowledge and Views on the Use of Learners' Socio-cultural Background in Teaching Natural Sciences in Grade 9 Township Classes. *African Journal of Research in Mathematics, Science and Technology Education*, *21*(2), 176–186. https://doi.org/10.1080/18117295.2017.1327239

Mavuso, M. P., Olawale, E., & Mkosi, N. (2021). *Integration of indigenous knowledge in the intermediate phase curriculum: A case of south african schools.* Research Papers on Knowledge, Innovation and Interprise KIE. Conference Proceedings, 1x, 7-19.

Mawere, M. (2015). Indigenous Knowledge and Public Education in Sub-Saharan Africa. *Africa Spectrum*, *50*(2), 57–71. https://doi.org/10.1177/000203971505000203

Mazzocchi, F. (2006). Western science and traditional knowledge. *EMBO Reports*, *7*(5), 463–466. https://doi.org/10.1038/sj.embor.7400693

Mazzocchi, F. (2018). *Why "integrating" Western science and indigenous knowledge is not an easy task: What lessons could be learned for the future of knowledge?.* Journal of Futures Studies, 22(3), 19-34.

McCombs, B. L. (2013). *The learner-centered model: Implications for research approaches.* Interdisciplinary handbook of the person-centered approach: Research and theory, 335–352.

Mc Knight, M. (2015). *Teachers' experiences of indigenous knowledge systems (IKS) found in the Life Sciences curriculum: A case study of Life Sciences teachers at a high school in the Pinetown District*. University of KwaZulu- Natal: South Africa.

McLeod, S. (2018). *Constructivism as a theory for teaching and learning*. Simply Psychology.

Mentz, E., & De Beer, J. (2019). *The use of Cultural-Historical Activity Theory in researching the affordances of indigenous knowledge for self-directed learning.* In: J. de Beer (Ed), *The decolonization of the curriculum project: The affordances of indigenous knowledge for self-directed learning.* Stellenbosch: AOSIS.

Mistry, J., & Mendonca, S. (2020). *Indigenous knowledge*. International Enyclopedia of Human Geography, 4.

Mji, G., Kalenga, R., Ned, L., Alperstein, M., & Banda, D. (2017). Indigenous knowledge exclusion in Education systems of Africans: Impact of beingness and becoming African. In P. Ngulube (Ed.), Handbook of research on social, cultural, and educational considerations of indigenous knowledge in developing countries. IGI Global.

Moichela, K. Z. (2017). *Integration of indigenous knowledge system in the curriculum for basic education: Possible experiences of Canada.* University of Pretoria, South Africa.

Mothwa, M. M. (2011). *Teachers' experiences of incorporating indigenous knowledge in the Life Sciences classroom*. University of Johannesburg: South Africa.

Msimanga, A., & Shizha, E. (2014). Indigenous knowledge and science education in South Africa: Remapping Africa in the Global Space. In Shizha, E (Eds.)*, Remapping Africa in the Global Space.* Rotterdam*:* Sense Publishers.

Murye, A. F., & Pelser, A. J. (2018). *Commercial harvesting of marula (Sclerocarya Birrea) in Swaziland: A quest for sustainability.* Selected studies in biodiversity.

Musitha, M. E., & Mafukata, M. A. (2018). Crisis of decolonising education: Curriculum implementation in Limpopo Province of South Africa. *Africa's Public Service Delivery & Performance Review*, *6*(1). https://doi.org/10.4102/apsdpr.v6i1.179

Ndlovu, H. L. (2016). *The role of traditional healers in hiv prevention in southern african society: The case of Eswatini.* Open Journal Systems, 5(1), 21-31.

Nicholas, G. (2018). *It's taken thousands of years, but Western science is finally catching up to Traditional Knowledge.* The Conversation, 15.

Nieman, W. A., Leslie, A. J., & Wilkinson, A. (2019). Traditional medicinal animal use by Xhosa and Sotho communities in the Western Cape Province, South Africa. *Journal of Ethnobiology and Ethnomedicine*, *15*(1). https://doi.org/10.1186/s13002-019-0311-6

Ng'asike, J. T. (2019). Indigenous knowledge practices for sustainable lifelong education in pastoralist communities of Kenya. *International Review of Education*, *65*(1), 19–46. https://doi.org/10.1007/s11159-019-09767-4

Ngcoza, K. M. (2018). *Decolonizing science education curriculum in higher education institutions: Reclaiming cultural heritage as a source of knowledge.* Paper presented at 26th Conference of the South African Association for Research in Mathematics, Science and Technology Education, University of Botswana, Gaborone.

Nie, W. W., & Aziz, A. A. (2019). *Utilizing De Bono's red, yellow and green thinking hats technique in answering hots based comprehension questions*. International Conference on Multidisciplinary Research in Social Sciences and Engineering, 128-139.

Noble, H., & Heale, R. (2019). Triangulation in research, with examples. *Evidence Based Nursing*, *22*(3), 67–68. https://doi.org/10.1136/ebnurs-2019-103145

Nurbianta, N., & Dahlia, H. (2018). The Effectiveness of Jigsaw Method in Improving Students Reading Comprehension. *ETERNAL (English Teaching Journal)*, *9*(1). https://doi.org/10.26877/eternal.v9i1.2416

Nyang, A., Adesina, F., & Osman Elasha, B. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change*, *12*(5), 787–797. https://doi.org/10.1007/s11027-007-9099-0

O'Brien, C., Van Wyk, B. E., & Van Heerden, F. (2011). Physical and chemical characteristics of Aloe ferox leaf gel. *South African Journal of Botany*, *77*(4), 988–995. https://doi.org/10.1016/j.sajb.2011.08.004

Odora Hoppers, C. A. (2017). *Culture, Indigenous Knowledge and Development*. Centre of Education Policy Development, Johannesburg South Africa.

Ogunleye, B. O. (2013). *Theoretical perspectives of cooperative learning: Implications for effective science teaching and improved academic achievement.* The Pedagogical Psychology.

Ojekwu, I. N., & Ogunleye, B. O. (2020). *Effects of jigsaw learning strategy on science students' performance and interest in biology in selected schools in rivers state, nigeria.* Sapientia Foundation Journal of Education, Sciences and Gender Studies, 2 (3), 325-334.

Okeke, C., & Van Wyk, M. (2015). *Educational research: An African approach*. Cape Town, South Africa: Oxford University Press.

Oleksii, L., Iryna, M., & Tomash, K. (2017). Forming students' motivation for creativity by means of edward de bono's "six thinking hats" Technique. *Science and Education*, *23*(8), 93–96. https://doi.org/10.24195/2414-4665-2017-8-14

Oliveira, B. R. M., Vailati, A. L., Luiz, E., Böll, F. G., & Mendes, S. R. (2019). Jigsaw: Using Cooperative Learning in Teaching Organic Functions. *Journal of Chemical Education*, *96*(7), 1515–1518. https://doi.org/10.1021/acs.jchemed.8b00765

Ongubure, A. A. (2013). *African indigenous knowledge: scientific or unscientific.* Journal of Humanities and social sciences, 5(1), 12-20.

Onwu, G., & Mosimege, M. (2004). Indigenous knowledge systems and science and technology education: A dialogue. *African Journal of Research in Mathematics, Science and Technology Education*, *8*(1), 1–12. https://doi.org/10.1080/10288457.2004.10740556

Onwu, G. O. M., & Mufundirwa, C. (2020). A Two-Eyed Seeing Context-based Approach for Incorporating Indigenous Knowledge into School Science Teaching. *African Journal of Research in Mathematics, Science and Technology Education*, *24*(2), 229–240. https://doi.org/10.1080/18117295.2020.1816700

Papageorgiou, V. (2015). *New Curricula as an innovation. Case Study of a Pilot New School (*Diploma Thesis). University of Thessaly, Volos.

Pawilen G, T. (2021). *Integrating indigenous knowledge in the philippine elementary science curriculum.* International Journal of Curriculum and Instruction, 13 (2), 1148-1160.

Payette, P., & Barnes, B. (2017). Teaching for Critical Thinking: Edward de Bono's Six Thinking Hats. *The National Teaching & Learning Forum*, *26*(3), 8–10. https://doi.org/10.1002/ntlf.30110

Petersen, N., Golightly, A., & Dudu, W. T. (2019). *Engaging pedagogies to facilitate the border-crossing between the Natural Sciences and indigenous knowledge: Implications for science teacher education*. In book: The decolonisation of the curriculum project: The affordances of indigenous knowledge for self-directed learning, 143-180.

Polit, D.F., & Beck, C.T. (2012). *Nursing research: Generating and assessing evidence for nursing practice.* Philadelphia, PA: Lippincott Williams and Wilkins.

Pretorious, E., De Beer, J., & Lautenbasch,G. (2014). *Professional development of science teachers: The A-team hybrid ecology of learning practice.* In U.J, Faculty of Science (Ed). Proceedings of the ISTE First International Conference. (pp. 553-566). Johannesburg, South Africa.

Pugh, K. J., Bergstrom, M. M., & Spencer, B. (2017). Profiles of Transformative Engagement: Identification, Description, and Relation to Learning and Instruction. *Science Education*, *101*(3), 369–398. https://doi.org/10.1002/sce.21270

Putra, F. G. (2015). Eksperimentasi Model Pembelajaran Kooperatif Tipe Teams Games Tournament (TGT) Berbantuan Software Cabri 3d di Tinjau dari Kemampuan Koneksi Matematis Siswa Fredi Ganda Putra. Al-Jabar : Jurnal Pendidikan Matematika, 6(2), 143–153.

Rahmawati, Y., & Ridwan, A. (2017). *Empowering students' chemistry learning: The integration of ethnochemistry in culturally responsive teaching***.** Bulgarian Journal of Science Education*, 26*(6)*, 813- 830.*

Ramadikela, P. M., Pudi, T. I., & Mokiwa, H. O. (2020). *Decolonising science: Challenging the South African Classroom through indigenous knowledge systems.*

Rankoana, S. A. (2017). *The use of indigenous knowledge in subsistence farming: Implications for sustainable agricultural production in Dikgale community in Limpopo province, South Africa.* Towards Sustainable Agriculture: Farming Practices and Water Use: Frontiers in Sustainability Series, *1*(1), 63-74.

Ranasinghe, R. (2015). The Transmission of Education across Generations: Evidence from Australia. *The B.E. Journal of Economic Analysis & Policy*, *15*(4), 1893–1917. https://doi.org/10.1515/bejeap-2014-0139

Rashid, Y., Rashid, A., Warraich, M. A., Sabir, S. S., & Waseem, A. (2019). Case Study Method: A Step-by-Step Guide for Business Researchers. *International Journal of Qualitative Methods*, *18*, 160940691986242. https://doi.org/10.1177/1609406919862424

Reddy, C. (2019). *The integration of Indian indigenous knoweledge into the SA Life Sciences curriculum* (Doctoral thesis). North West University, South Africa.

Reddy, L. A., Cleary, T. J., Alperin, A., & Verdesco, A. (2018). A critical review of self-regulated learning interventions for children with attention-deficit hyperactivity disorder. *Psychology in the Schools*, *55*(6), 609–628. https://doi.org/10.1002/pits.22142

Retnowati, E., Ayres, P., & Sweller, J. (2018). Collaborative learning effects when students have complete or incomplete knowledge. *Applied Cognitive Psychology*, *32*(6), 681–692. https://doi.org/10.1002/acp.3444

Ronoh, J. C. (2017). *Indigenous knowledge in the school curriculum: Teacher educator perceptions of place and position (*Master's dissertation, Nelson Mandela University). Port Elizabeth: South Africa.

Roseth, C. J., Lee, Y. K., & Saltarelli, W. A. (2019). Reconsidering jigsaw social psychology: Longitudinal effects on social interdependence, sociocognitive conflict regulation, motivation, and achievement. *Journal of Educational Psychology*, *111*(1), 149–169. https://doi.org/10.1037/edu0000257

Sabbah, S. (2016). The Effect of Jigsaw Strategy on ESL Students' Reading Achievement. *Arab World English Journal*, *7*(1), 445–458. https://doi.org/10.24093/awej/vol7no1.27

Şenol, E., Ercan, A., & Karatekİn, E. (2023). Weaning Reasons, Practices and Total Duration of Breastfeeding in Physician Mothers. *Namık Kemal Tıp Dergisi*, *11*(2), 133–138. https://doi.org/10.4274/nkmj.galenos.2023.85520

Sakata, N. (2022). Is learner-centred pedagogy associated with pupils' positive attitudes towards learning? The case of Tanzania. *Compare: A Journal of Comparative and International Education*, *53*(8), 1373–1391. https://doi.org/10.1080/03057925.2022.2036592

Schmidt, J. A., Kafkas, S. S., Maier, K. S., Shumow, L., & Kackar-Cam, H. Z. (2019). Why are we learning this? Using mixed methods to understand teachers' relevance statements and how they shape middle school students' perceptions of science utility. *Contemporary Educational Psychology*, *57*, 9–31. https://doi.org/10.1016/j.cedpsych.2018.08.005

Shava, S. (2013). The Representation of Indigenous Knowledge. In J. Dillon, M. Brody, R. B. Stevenson & A. E. Wals (Eds.), *International Handbook of Research on Environmental Edu-cation (pp. 384-393). London, UK: Routledge.*

Shava, S. (2016). *The application/ role of indigenous pieces of knowledge in transforming the formal education curriculum: Cases from Southern Africa*.

Shehu, A. (2021). Western Education versus Indigenous Knowledge of the Tarok in Plateau State, Nigeria. *Information Impact: Journal of Information and Knowledge Management*, *11*(4), 59–68. https://doi.org/10.4314/iijikm.v11i4.6

Shi, W., & Han, L. (2019). Promoting Learner Autonomy Through Cooperative Learning. *English Language Teaching*, *12*(8), 30. https://doi.org/10.5539/elt.v12n8p30

Shizha, E. (2012). *Neoliberal globalisation, science education and african indigenous knowledges.* Critical Perspectives on Neoliberal Globalization, Development and Education in Africa and Asia, 15–31.

Shizha, E. (2013). *Reclaiming our indigenous voices: The problem with postcolonial sub-Saharan African school curriculum*. Journal of indigenous.

Slaney, K. (2017). *Validating Psychological Constructs*. https://doi.org/10.1057/978-1-137-38523-9

Snively, G., & Williams, W.L. (2016). *Knowing Home: Braiding Indigenous Science with Western Science, Book 1*. University of Victoria, Canada.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Stake, R. (1995). *The art of case study research*. Thousand Oaks, CA: Sage Publications.

Stake, R. (2005). *The art of case study research*. Thousand Oaks, CA: Sage Publications. social development, *2*(1), 1-18.

Steenkamp, J., De Beer, J., & Petersen, N. (2019). *The conundrum of integrating indigenous knowledge in science curriculum themes: A review of different viewpoints*.

Syed Anzar Ahmed. (2017). *Career Transtition Program For Special Educational Needs.* European Journal Of Pharmaceutical and Medical Research, 4(11), 595–601.

Taherdoost, H. (2016). *Validity and reliability of the research instrument; How to test the validation of questionnaire/ survey in a research*. International Journal of Academic Research in Management, 5(3), 28-36.

Takele, M. (2020). *Practices and Challenges of Active Learning Methods in Mathematics Classes of Upper Primary Schools.* Journal of Education and Practice. 11(13), 26-40.

Taylor, D. L., & Cameron, A. (2016, January 2). Valuing IKS in successive South African Physical Sciences Curricula. *African Journal of Research in Mathematics, Science and Technology Education*, *20*(1), 35–44. https://doi.org/10.1080/10288457.2016.1147800

Theofanidis, D., & Fountouki, A. (2019). *Limitations and delimitations in the research process.* Perioperative nursing, 7(3), 155.

Theologis, E., Karakiozis, K., Fotou, K., Foulidis, X., Loulakis, M. & Papakitsos, H. E. (2017). *Teaching scenario of problem solving with the six hats thinking method.* Education Sciences, 2, 114 - 132.

Thurston, A., Topping, K. J., Tolmie, A., Christie, D., Karagiannidou, E., & Murray, P. (2010). Cooperative learning in science: follow-up from primary to high school. *International Journal of Science Education, 32(4), 501-522. https:// doi.org/10.1080/09500690902721673*

Tomaszewski, L. E., Zarestky, J., & Gonzalez, E. (2020). Planning Qualitative Research: Design and Decision Making for New Researchers. *International Journal of Qualitative Methods*, *19*, 160940692096717. https://doi.org/10.1177/1609406920967174

Tseng, S. S. (2019). Using Concept Mapping Activities to Enhance Students' Critical Thinking Skills at a High School in Taiwan. *The Asia-Pacific Education Researcher*, *29*(3), 249–256. https://doi.org/10.1007/s40299-019-00474-0

Ugwu, A.N., & Diovu, C.I. (2016). *Integration of indigenous knowledge and practices into chemistry teaching and students' academic achievement.* International Journal of Academic Research and Reflection, 4(4), 22–30.

UNESCO . (1998). *Our creative diversity* , Paris : UNESCO

UNESCO. (1999). Science Agenda: Framework for action. Science for the twenty-first century.

Van Der Stuyf, R. (2002). *Scaffolding as a teaching strategy. A*dolescent Learning and Development.

Van Wyk, B. E. (2008). A broad review of commercially important southern African medicinal plants. *Journal of Ethnopharmacology*, *119*(3), 342–355. https://doi.org/10.1016/j.jep.2008.05.029

Van Wyk, B. E. (2015). Die kulturele en praktiese waarde van inheemse kennis oor plantgebruike in die 21ste eeu. *Suid-Afrikaanse Tydskrif Vir Natuurwetenskap En Tegnologie*, *34*(1). https://doi.org/10.4102/satnt.v34i1.1349

Van Wyk, B. E., & Gericke, N. (2018). *People's plants: A guide to useful plants of Southern Africa.* Pretoria: Briza Publications.

Vaismoradi, M., Jones, J., Turunen, H., & Snelgrove, S. (2016). Theme development in qualitative content analysis and thematic analysis. *Journal of Nursing Education and Practice*, *6*(5). https://doi.org/10.5430/jnep.v6n5p100

Vhurumuku, E. (2011). High School Chemistry students' scientific epistemologies and perceptions of the nature of laboratory inquiry. *Chem. Educ. Res. Pract.*, *12*(1), 47–56. https://doi.org/10.1039/c1rp90007b

Vygotsky, L. S. (1962). *Thought and language.* Cambridge, MA: MIT Press.

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

Vygotsky, L. S. (1987). *Thinking and speech. The collected work of Vygotsky.* Problems Of General Psychology,*1*, 39-285.

Walshe, C., Ewing, G., & Griffiths, J. (2011). Using observation as a data collection method to help understand patient and professional roles and actions in palliative care settings. *Palliative Medicine*, *26*(8), 1048–1054. https://doi.org/10.1177/0269216311432897

Warburton, N., & Volet, S. (2012). Enhancing self-directed learning through a content quiz group learning assignment. *Active Learning in Higher Education*, *14*(1), 9–22. https://doi.org/10.1177/1469787412467126

Wiersma, W., & Jurs, S. G. (2005). *Research methods in education: An introduction.* Boston, MA: Ally and Bacon

Winchester, C. L., & Salji, M. (2016). Writing a literature review. *Journal of Clinical Urology*, *9*(5), 308–312. https://doi.org/10.1177/2051415816650133

Zidny, R., & Eilks, I. (2018). *Indigenous knowledge as a socio-cultural context of science to promote transformative education for sustainable development: a case study on the Baduy Community (Indonesia)*. In: I. Eilks, S. Markic & B. Ralle (eds.), *Building bridges across disciplines for transformative education and a sustainable future*,(P. 249-256). Aachen: Shaker.

Zidny, R ., & Eilks, I. (2020). *On the development of learning designs for the inclusion of indigenous science in the context of chemistry education to foster education for sustainable development*. Advances in Engineering Research, 209, 343- 349.

Zidny, R., Sjöström, J., & Eilks, I. (2020). A Multi-Perspective Reflection on How Indigenous Knowledge and Related Ideas Can Improve Science Education for Sustainability. *Science & Education*, *29*(1), 145–185. https://doi.org/10.1007/s11191-019-00100-x

Zinyeka, G., Onwu, G. O., & Braun, M. (2016). A Truth-Based Epistemological Framework for Supporting Teachers in Integrating Indigenous Knowledge into Science Teaching. *African Journal of Research in Mathematics, Science and Technology Education*, *20*(3), 256–266. https://doi.org/10.1080/18117295.2016.1239963

Zyngier, D. (2008). (Re)conceptualising student engagement: Doing education not doing time. *Teaching and Teacher Education*, *24*(7), 1765–1776. https://doi.org/10.1016/j.tate.2007.09.004

APPENDICES

Appendix A: Letter to the Limpopo department of education

P. O BOX 1384
MASEMOLA
1060
20 April 2023

The Head of department
Limpopo Department of Basic Education
Corner 113 Biccard & 24 Excelsior Street
POLOKWANE
0700
Sir/ Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT MOROKE CIRCUIT

I, Sefoka Thabelang Segopotse, a Life Sciences educator at a secondary school, in Moroke circuit hereby request a permission from the HoD of the Limpopo provincial Department of Basic Education to conduct an academic research in your school. I am a Master of science education student at the University of Limpopo, and as part of the requirements for the fulfilment of the degree, I am required to conduct a research and produce a dissertation. The title of my study is **"Exploring Grade 10 Life Sciences learners' views on the integration of indigenous knowledge- related topics using cooperative learning approach"**. The study is under supervision of Mr K. J Chuene, a lecturer in the Department of Mathematics, science and technology. Furthermore, document reviews (research scripts), observations and interviews will be used to collect data. This will be done outside normal school working hours; but during school days in the morning and afternoon.

The researcher will ensure that the school and learners' names would not be used for any purpose, nor will the information be shared that reveals their identity in any way. Information collected will be confidential, and will only be used for the purpose of the study. Additionally, there are no potential risks, and participants will be advised to withdraw from the study at any time they feel uncomfortable.

Furthermore, this study will contribute to the teaching and learning body of knowledge by identifying learners' views and the influence of cooperative learning approach when integrating IK in Life Sciences classrooms; as prescribed by CAPS document. The completed dissertation will be made available to all participants and educational bodies.

Any queries regarding the contents of this letter may be directed to:

Researcher: Ms T. S Sefoka at 072 6856 455 or thabelangsefoka@gmail.com

Supervisor: Mr. K.J Chuene at 015 268 3888 or karabo.chuene@ul.ac.za

Appendix B: Letter to the circuit manager

Enquiries: Ms Sefoka T. S

Persal no. 84481889

Contact details: 072 6856 455

(thabelangsefoka@gmail .com)

The Office of the Circuit Manager

Moroke Circuit

Sekhukhune East District

Private Bag X 1305

Atok

1120

Sir/ Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR INSTITUTION

I, Sefoka Thabelang Segopotse, a Life Sciences educator at ... Secondary School (Moroke Circuit), and a Master of Science Education student at the University of Limpopo. I hereby request permission to conduct my research tittled "Exploring Grade 10 Life Sciences learners' views on the integration of indigenous knowledge-related topics using a cooperative learning approach"; at your school (Poo Secondary). I am conducting this research under the supervision of a well-trained academic, Mr. K. J. Chuene; a lecturer in the Department of Mathematics, Science, and Technology Education. The study will use document reviews, observations, and interviews to collect data. This will be done outside normal school working hours, but during school days in the morning and afternoon.

I will ensure that the school's and learners' names will not be used for any purpose, nor will information be shared that reveals their identities in any way. Information collected will be confidential and will only be used for the purpose of the study.

Furthermore, the research findings will be shared with all the participants, the school, and educational bodies. They will all be most welcome to use them to assess learners' learning and teachers' methods of integrating indigenous knowledge in their lessons. Hence, attending the DBE call for integrating indigenous knowledge in Life Sciences learning.

Yours sincerely

SEFOKA T. S

Appendix C: Letter to the school principal

Enquiries: Ms Sefoka T. S

Contact details: 072 6856 455

(thabelangsefoka@gmail.com)

The Principal

Secondary School

P.O BOX 2091

Moroke

1154

Dear Principal

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR INSTITUTION

I am a Masters of Science Education student at the University of Limpopo. I hereby request permission to conduct my research titled **"Exploring Grade 10 Life Sciences learners' views on the integration of indigenous knowledge-related topics using cooperative learning approaches,"** at your school. Grade 10 learners will be the main research participants, and the study will collect data using document reviews, observations, and interviews**.**

I will ensure that the school's and learners' names will not be used for any purposes, nor will information be shared that reveals their identities in any way. Information collected will be confidential and will only be used for the purpose of the study. Furthermore, the findings will be shared with the learners and the school. The school will be most welcome to use the findings to assess learners' learning and teachers' methods of integrating indigenous knowledge in their lessons.

Yours truly

SEFOKA T. S

PLEASE ATTACH SIGNATURE BELOW:

I ..... the principal of ..... agree that the above mentioned study can be conducted in my school.

Principal signature:.....Date:.....School stamp:

Appendix D: Letter to parents and the learners to request for participant permission and consent form

Dear parent(s) and the learner, as your child Life Sciences educator and a Master of Science Education student at the University of Limpopo. I hereby request permission to include your child in my research titled "Exploring Grade 10 Life Sciences learners' views on the integration of indigenous knowledge-related topics using cooperative learning approach", which will take place at your child's school and class. Including your child in this study will help in collecting rich data using document reviews, observations, and interviews.

PLEASE NOTE THE FOLLOWING:

Participation is voluntary- learners are not forced to participate.

Decision to participate or not participate will not affect learners in anyway now or in the future.

No participant will be compensated or given marks for being part of this study.

It does not contribute to their SBA.

There is a right to withdraw from the study at anytime, without any explanation.

There are no foreseeable risk to your child by participating in the study.

Participant identity will remain confidential and anonymous.

Information collected will only be used for the purpose of this study and nothing else.

Should you have any questions or need any clarification, please do not hesitate to contact me.

Yours truly

SEFOKA T.S (072 6856 455 /thabelangsefoka@gmail.com**)**

PLEASE ATTACH SIGNATURES BELOW:

I.....the parent/ guardian/ caretaker of.....agree that my child may participate in the above mentioned study.

Parent/ guardian signature..... Date.....

I..... the Grade 10 learner at ... Secondary School agree to participate in the above mentioned study.

Learner's signature.....Date.....

Appendix E: Learner Assent Form

Dear learner

As your Life Sciences subject teacher and a Master of Science Education student at the University of Limpopo, I would like to include you in my research, titled "Exploring Grade 10 Life Sciences learners' views on the integration of indigenous knowledge-related topics using cooperative learning approaches," which will take place in your school and class. Including you in this will help in collecting rich data using document reviews (your research scripts), observations, and interviews.

PLEASE NOTE THE FOLLOWING:

- Participation is voluntary- you are not forced to participate
- Decision to participate or not participate will not affect you in anyway now or in the future
- No participant will be compensated or given marks for being part of this study. This does not contribute to your SBA.
- You have the right to withdraw from the study at anytime, without any explanation
- Your identity will remain confidential and anonymous
- Information collected will only be used for the purpose of this study and nothing else

Please inform your parent, guardian, or caretaker about your participation before you sign this letter. Signing your name at the bottom means you agree to be in this study. A copy of this letter will be given to your parent, guardian, or caretaker.

Regards

SEFOKA T.S (072 6856 455 /thabelangsefoka@gmail.com**)**

Appendix F: Learning activities

A: Organic compounds and Indigenous Knowledge

	**Common name:** **Scientific name:** **Cereal/seed/nut:** **Main nutrient(s):** **Function/ Use(s):**
	**Common name:** **Scientific name:** **Cereal/seed/nut:** **Main nutrient(s):** **Function/ Use(s):**
	**Common name:** **Scientific name:** **Cereal/seed/nut:** **Main nutrient(s):** **Function/ Use(s):**

  	**Common name:** **Scientific name:** **Fruit/seed/nut:** **Main nutrient(s):** **Function/ Use(s):**
 	**Common name:** **Scientific name:** **seed/nut:** **Main nutrient(s):** **Function/ Use(s):**

 	**Common name:** **Scientific name:** **seed/nut:** **Main nutrient(s):** **Function/ Use(s):**
 	**Common name:** **Scientific name:** **Fruit/seed/nut:** **Main nutrient(s):** **Fuction/ Use(s):**

B. Jigsaw method: South African Biomes and Indigenous knowledge

 	**Animal:** **Biome(s):** **Traditional/Medicinal uses:**
	**Name:** **Biome(s):** **Traditional/Medicinal uses:**

	**Name:** **Biome(s):** **Traditional/Medicinal uses:**
	**Name:** **Biome(s):** **Traditional/Medicinal ses:**
	**Name:** **Biome(s):** **Traditional/Medicinal uses:**

	**Name:** **Biome(s):** **Traditional/Medicinal uses:**

C. Support system in animals: Diseases that affect human skeleton

<u>Group learning based on De Bono's thinking hats</u>

Learners should state their views on whether there is a space for both western medicines and traditional medicines in South Africa.

Appendix G: Observation tool

Criteria	Comment
1. Culture	
Held indigenous knowledge and sharing of it	
Knowledge construction and negotiation	
Learner communication and interaction	
Learner attitudes and motivation	
2. Language	
Knowledge construction and negotiation	
Learner communication and interaction	
Learner involvement: being passive or active	
Decision making	
3. Zone of Proximal Development	
Held indigenous knowledge and sharing of it	
Knowledge construction and negotiation	
Learner communication and interaction	
Learner attitudes and motivation	
Learner involvement: being passive or active	
Time spent on various activities	
Decision making	

Appendix H: Interview questions for Focus Group

- **What are your experiences with learning Life Sciences this way?**
- **Are you comfortable sharing your views in this kind of learning environment?**
- **What can be improved about this learning environment and why?**
- **Are you learning anything from the group?**
- **How have they (the group) been helpful?**

Appendix I: Ethical clearance from UL

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 4713, Fax: (015) 268 2306, Email: moore.hutamo@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

MEETING: **04 April 2023**

PROJECT NUMBER: **TREC/107/2023: PG**

PROJECT:

Title:	Exploring Grade 10 Life Sciences learners' views on the integration of indigenous knowledge-related topics using a cooperative learning approach.
Researcher:	TS Sefoka
Supervisor:	Ms KJ Chuene
Co-supervisor:	N/A
School:	Education
Degree:	Master of Education (Science Education)

PROF D MAPOSA
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111-031**

Note:

i) **This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.**

ii) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.**

iii) **PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.**

Finding solutions for Africa

Appendix J: Permission from Limpopo Department of Education

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

CONFIDENTIAL

Ref: 2/2/2 Enq: Makola MC Tel No: 015 290 9448 E-mail:MakolaMC@edu.limpopo.gov.za

Sefoka TS

P O Box 1384
Masemola
1060

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above bears reference.

2. The Department wishes to inform you that your request to conduct research has been approved. Topic of the research proposal: **" Exploring Grade 10 Life Sciences learners' views on the integration of indigenous knowledge- related topics using cooperative learning approach"**

3.The following conditions should be considered:

3.1 The research should not have any financial implications for Limpopo Department of Education.

3.2 Arrangements should be made with the Circuit Office and the School concerned.

3.3 The conduct of research should not in anyhow disrupt the academic programs at the schools.

3.4 The research should not be conducted during the time of Examinations especially the fourth term.

3.5 During the study, applicable research ethics should be adhered to; in particular the principle of voluntary participation (the people involved should be respected).

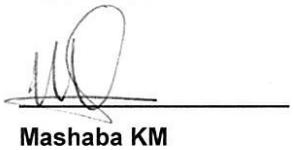
3.6 Upon completion of research study, the researcher shall share the final product of the research with the Department.

Cnr 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X 9489, Polokwane, 0700
Tel:015 290 7600/ 7702 Fax 086 218 0560

4 Furthermore, you are expected to produce this letter at Schools/ Offices where you intend conducting your research as an evidence that you are permitted to conduct the research.

5 The department appreciates the contribution that you wish to make and wishes you success in your investigation.

Best wishes.



25/04/2023

Mashaba KM **Date**

DDG: CORPORATE SERVICES

Cnr 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X 9489, Polokwane, 0700
Tel:015 290 7600/ 7702 Fax 086 218 0560

Appendix K: Approval from the circuit manager

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

MOROKE CIRCUIT

Enquiries: Mankgane NJ Tel: 015 619 0073/061 448 7627

From: Moroke Circuit Manager Date: 15 June 2023

Nkosi IM

To: Affected Selected School

Sekhukhune District Office

APPROVAL : CONDUCTING RESEARCH IN YOUR SCHOOL : SEFOKA TS

1. The above matter refers.
2. This letter serves to inform school principal that the bearer " TS Sefoka is a Master of Education (Science Education) student whose research topic is:

   "Exploring Grade 10 Life Sciences Learners' views on integration in the indigenous knowledge-related topics using a cooperative learning approach"

3. Permission to conduct research in the subject /school is granted.
4. Conditions attached to the permission are as follows:

4.1 The research should not interfere with teaching and learning process.

4.2 Please allow the research to interact with all intended stakeholders.

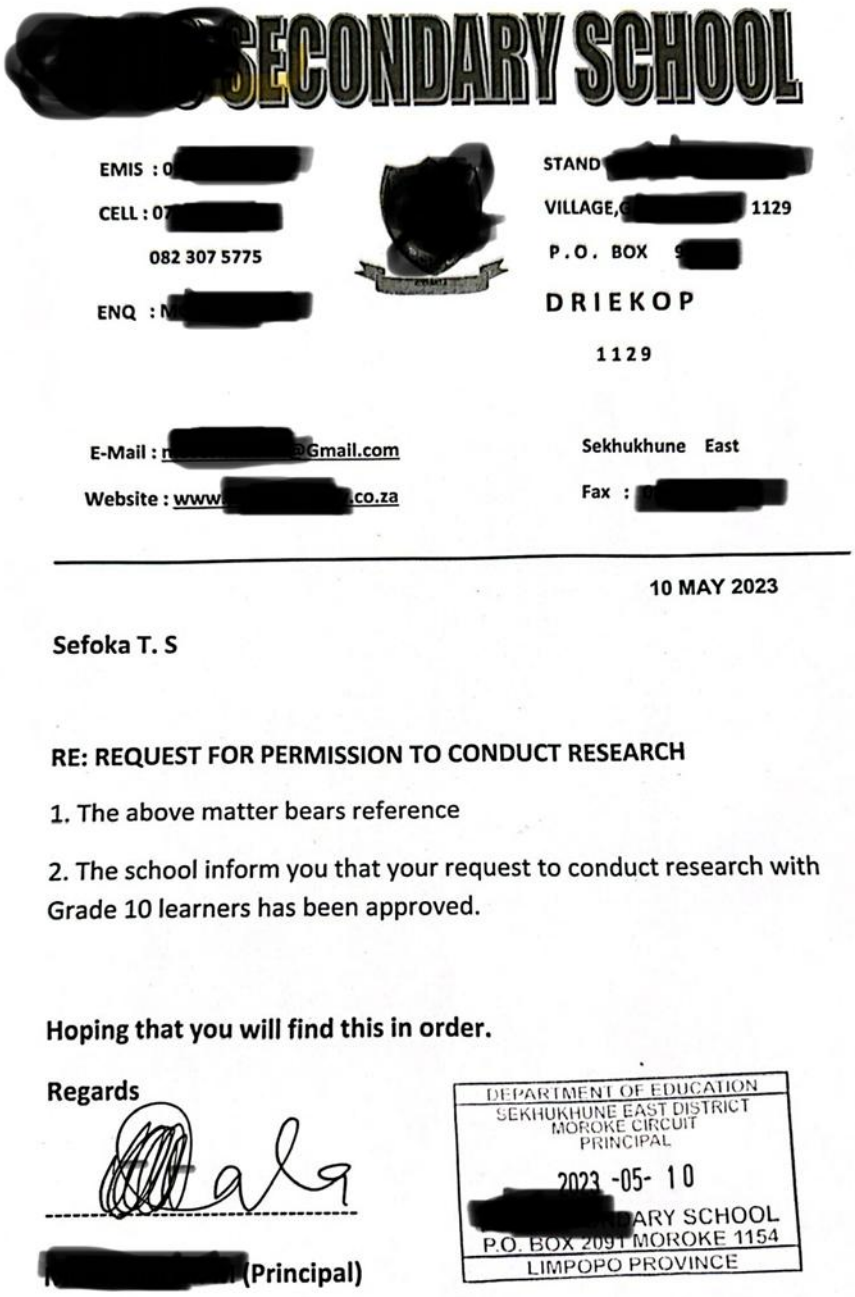
....

Nkosi IM Date

Circuit Manager

THE OFFICE OF THE CIRCUIT MANAGER
MOROKE CIRCUIT-MECKLENBURG;PRIVATE BAG X1305,ATOK,0749
TEL (015) 6190112/0118/0164: CELL:0828088278; FAX(015) 6190073/0866087516
Email: gobolodriefontein@gmail.com

Appendix L: Approval from the principal



[redacted] SECONDARY SCHOOL

EMIS : [redacted]
CELL : [redacted]
082 307 5775
ENQ : [redacted]

STAND [redacted]
VILLAGE, [redacted] 1129
P.O. BOX [redacted]
DRIEKOP
1129

E-Mail : [redacted]@Gmail.com
Website : www[redacted].co.za

Sekhukhune East
Fax : [redacted]

10 MAY 2023

Sefoka T. S

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above matter bears reference

2. The school inform you that your request to conduct research with Grade 10 learners has been approved.

Hoping that you will find this in order.

Regards

[redacted] **(Principal)**

DEPARTMENT OF EDUCATION
SEKHUKHUNE EAST DISTRICT
MOROKE CIRCUIT
PRINCIPAL
2023 -05- 10
[redacted] SECONDARY SCHOOL
P.O. BOX 2091 MOROKE 1154
LIMPOPO PROVINCE

Appendix M: Editor's declaration

PROF EDIT MBA

Marieta Grundling (MBA)

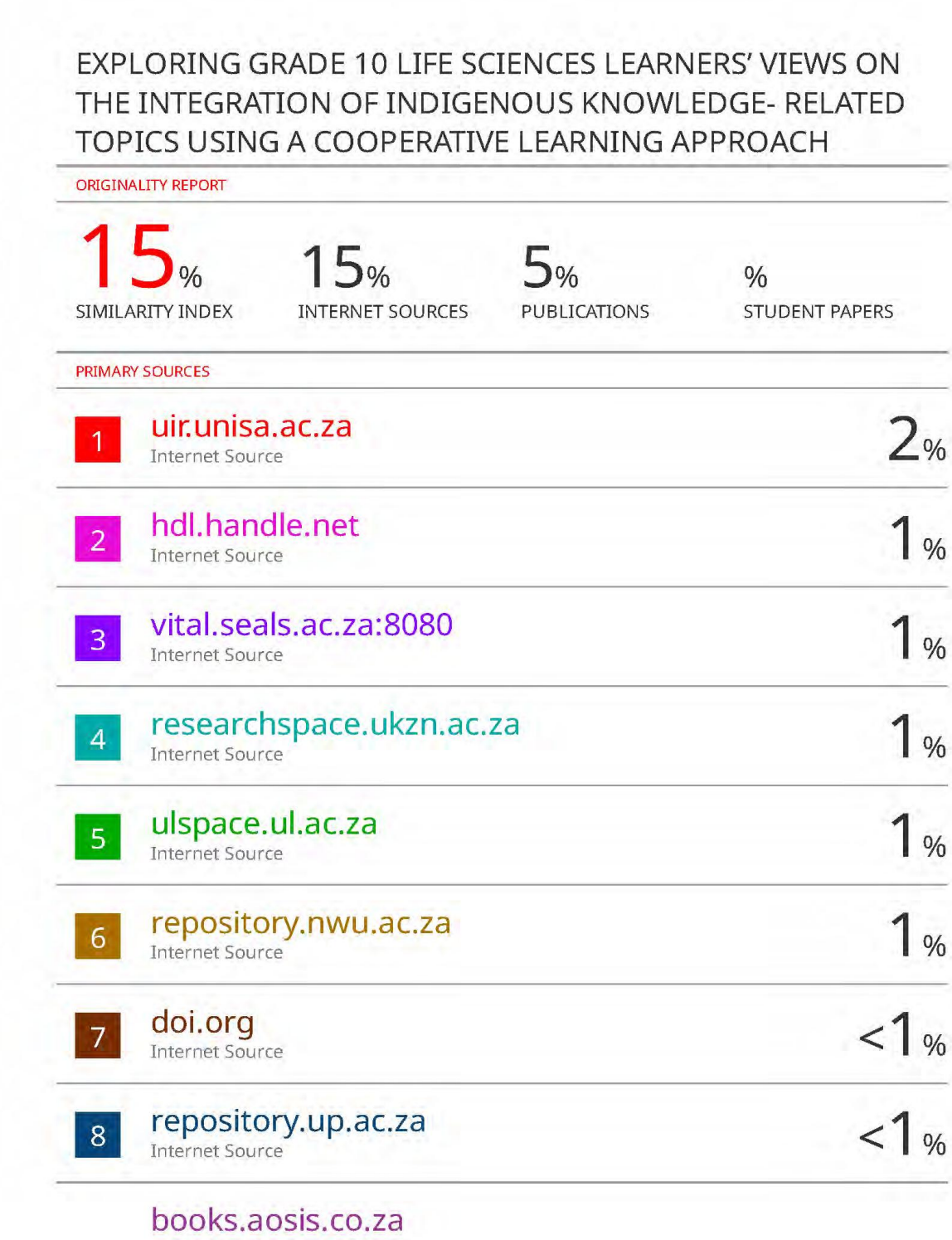
9 Akasia Street
Vierfontein
081 354 1596
edit@profeditmba.co.za
1 December 2022

To Whom It May Concern

This serves to confirm that the dissertation: **EXPLORING GRADE 10 LIFE SCIENCES LEARNERS' VIEWS ON THE INTEGRATION OF INDIGENOUS KNOWLEDGE-RELATED TOPICS USING A COOPERATIVE LEARNING APPROACH** by **SEFOKA THABELANG SEGOPOTSE** was edited. The language, presentation, and referencing system (both in-text and against the Reference List), were checked and corrected.

M Grundling
1 December 2022

Appendix N: Turnitin report



EXPLORING GRADE 10 LIFE SCIENCES LEARNERS' VIEWS ON THE INTEGRATION OF INDIGENOUS KNOWLEDGE- RELATED TOPICS USING A COOPERATIVE LEARNING APPROACH

ORIGINALITY REPORT

15%	15%	5%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	uir.unisa.ac.za Internet Source	2%
2	hdl.handle.net Internet Source	1%
3	vital.seals.ac.za:8080 Internet Source	1%
4	researchspace.ukzn.ac.za Internet Source	1%
5	ulspace.ul.ac.za Internet Source	1%
6	repository.nwu.ac.za Internet Source	1%
7	doi.org Internet Source	<1%
8	repository.up.ac.za Internet Source	<1%
	books.aosis.co.za	