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TEACHERS’ PERCEPTIONS AND EXPERIENCES OF THE INCLUSION OF INDIGENOUS KNOWLEDGE IN THE NATURAL SCIENCES CLASSROOM

by

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Submitted in accordance with the requirements for the degree of

MASTERS OF SCIENCE EDUCATION

to the

FACULTY OF EDUCATION

at the

UNIVERSITY OF JOHANNESBURG

SUPERVISOR: Prof JJJ De Beer

NOVEMBER 2016
DECLARATION

Student number: ...........................

I declare that the work contained in this dissertation is my own and all the sources I have used or quoted have been indicated and acknowledged by means of references. I also declare that I have not previously submitted this dissertation or any part of it to any university in order to obtain a degree.

Signature: __________________________

Foluke Victoria Akerele

Date
I dedicate this study to Almighty God the source of all wisdom for His help and grace made available to me. All the glory and honour goes to Him for seeing me through the completion of this research work. He has been my strength and support all the way.

My special appreciation goes to my wonderful supervisor, Prof Josef De Beer. You have been a great pillar and a mentor, thanks for your patience, guidance and support. Your intellectual contributions and positive criticism has gone a long way in making this study a reality.

A word of appreciation goes to my senior pastor and my spiritual mentor, Pastor Samuel Abiodun Wright. Thanks for your spiritual and financial support throughout the course of my studies in South Africa.

My gratitude is extended to my family members, my parents Mr Albert Akerele and Mrs Folayemi Akerele for your support, encouragement and giving me a solid educational heritage. To my siblings, Olumuyiwa Akerele, Olusola Akerele, Opeyemi Adetoyi and Dr Toyin Sonubi, thanks for your love and encouragement always.

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I wish to express my gratitude to all the members of my church, Redeeming Hope Christian Centre, Amsterdam, my friends and colleagues for your support and encouragements throughout this study. God bless you all.
SYNOPSIS

This study aims to investigate the perceptions and experiences of a group of Natural Sciences teachers' in the Gert Sibande District (Dundonald Circuit and Piet Retief Circuit) in Mpumalanga regarding the inclusion of indigenous knowledge (IK) in the Natural Sciences classroom. This study is important in an era where the ‘decolonialization’ of the curriculum, or the adoption of a more Afrocentric approach in education, is receiving attention. The National Curriculum Statement (NCS) that was introduced in 2005 and the Curriculum and Assessment Policy Statements (CAPS) in 2012 require teachers to integrate school science with Indigenous Knowledge Systems (IKS). The inclusion of indigenous knowledge necessitates that the teacher has suitable pedagogical content knowledge of the subject, understands the nature of indigenous knowledge (its tenets) and knows how to relate and teach CAPS topics in conjunction with indigenous knowledge in the classroom. Also, a teacher must devise appropriate teaching methods taking cognisance of the nature of science (NOS). According to Grenier (1998), an indigenous knowledge system is the sum total of the knowledge and skills possessed by people living in a particular geographical area that enables them to get the most out of their environment. Warren (1991) defines indigenous knowledge as the ‘local knowledge that is unique to a given culture or society’.

Research shows that many teachers do not possess the academic content knowledge that would enable them to teach indigenous knowledge systems in the science classroom in a competent manner. This research adopted a design-based approach (with some elements of phenomenology, since I captured teachers’ lived experiences of dealing with IK) that provided the richness of data and answers to the research questions (Brink, Van Der Walt & Van Rensburg, 2006: 191), namely - how do Natural Sciences teachers’ experience inclusion of indigenous knowledge in the Natural Sciences classroom and what are the challenges that they face? Purposive sampling was used and the participants were selected from schools in the Dundonald Circuit and Piet Retief Circuit in Mpumalanga Province. Data was collected by means of classroom observations, artefacts (such as teachers' lesson plans), questionnaires and personal interviews. This study captures the ‘lived experiences’ of a selected
group of four teachers. Open-ended questionnaires were designed to determine their views of the nature of science (NOS) (Abd-El-Khalick, 1998), as well as their views on the nature of indigenous knowledge systems (VNOIK) (Cronje, De Beer & Ankiewicz, 2015). In this study, these methods and instruments were chosen because they provide extensive data, clear and detailed accounts of actions in spoken and written text (Creswell, 2009).

During the analysis of the data I used Saldana’s (2009) technique for coding. Codes and categories, and eventually emerging themes, from the focussed personal interviews were identified. Classroom observations were analysed using the Reformed Teaching Observation Protocol (RTOP), which is an observational instrument that can be used to assess the degree to which science instruction is reformed (Sawada, Pibum, Turley, Falconer, Benford, Bloom & Judson, 2000). The findings were integrated with literature and third-generation Cultural Historical Activity Theory (CHAT) was used as a lens to describe teachers’ lived experiences. CHAT provides a useful tool to assist in capturing teachers’ lived experiences, since it effectively captures tensions in an activity system (in this case, the Natural Sciences classroom, and the challenges and barriers experienced by teachers in incorporating indigenous knowledge in Natural Sciences learning).

Findings from this study revealed that none of the teachers who participated in the intervention had informed views on the nature of science while the majority had a partial view of the nature of indigenous knowledge (NOIK), at the start of the intervention. Therefore, it was difficult for them to integrate indigenous knowledge and the tenets of the nature of science in their classrooms. Lesson observations prior to the intervention revealed that teachers only payed little attention to IK in their classrooms with little or no involvement of the learners. The research wanted to see if a short learning programme (SLP) might improve the pedagogy of the teachers and to what extent the transfer of the proposed integration, which was addressed in the professional development intervention, occurred in the science classroom. Unfortunately, some of the teachers only mentioned examples of indigenous plants and taught indigenous knowledge in a superficial manner- even after the intervention. Whereas the intervention definitely made teachers more aware of the affordances of indigenous knowledge in the classroom, limited change occurred in teachers’
classroom practice. This supports literature findings that state that teacher professional development is best served by longitudinal and systemic interventions.

During the lesson observations that were done after the interventions, there were very little evidence of the teaching of indigenous knowledge, or an enhanced focus on the syntactical nature of the subject, that emphasize the tenets of the nature of science, or the tenets of indigenous knowledge. This emphasises the importance of supporting teachers in an on-line community of practice.

This study has made a methodical contribution to the body of existing knowledge by further confirming and validating the Views of the Nature of Indigenous Knowledge (VNOIK) instrument developed by Cronje, De Beer & Ankiewicz (2015). VNOIK is a very useful instrument in determining the views of science teachers regarding the nature of indigenous knowledge and to measure the effect of a short learning programme on teachers’ pedagogical content knowledge (PCK) development. The practical contribution of the study was to develop design principles for a short-learning programme, and during this design-based research (DBR), the SLP was offered twice to teachers. Furthermore, theoretically, this research has been able to elaborate on the advantages of including indigenous knowledge in the Natural Sciences classroom.

Since the #RhodesMustFall student protests in 2015, the problems around transformation that bedevil education in South Africa has been center staged. Mbembe (2015:9; 2016:32) writes that ‘there is something profoundly wrong when syllabi designed to meet the needs of colonialism and Apartheid continue well into the post-Apartheid era’. Mbembe poses the question what directions an education system should take in a South Africa wishing to break with neo-colonialism. Indigenous knowledge and its incorporation in the school curriculum will therefore become increasingly important, and it is hoped that this study contributes to this discourse.

I suggest that indigenous knowledge be seen as relevant in the 21st Century in examining the knowledge systems that have worked for enduring communities. The value of indigenous knowledge becomes clear when we look at Gibbon’s (2000) distinction between mode 1 and mode 2 knowledge production. Gibbons describes mode 1 knowledge production as restricted and informed by the academic insights of a select few (this has characterised science education for decades). Mode 2
knowledge is more inter-disciplinary, and gives due credit to context. Gibbons (2000:161) describes it as knowledge production where “…society ‘speak back’ to science. The idea of science communicating with society is familiar enough. Now, society is speaking back to science. Reverse communication is generating a new kind of science, let us call it context-sensitive. In epistemological terms, context-sensitive science is new in the sense that it produces socially robust knowledge that is, knowledge likely to be reliable not only inside but also outside the laboratory”.
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CHAPTER ONE

CONCEPTUALIZATION OF THE PROBLEM: A CRITICAL REVIEW OF SCIENCE EDUCATION IN A TIME OF PLEAS FOR THE DECOLONIALIZATION OF THE CURRICULUM

1.1 BACKGROUND TO THE PROBLEM

The new South African curriculum known as the National Curriculum Statement (NCS) introduced in 2005 and the Curriculum and Assessment Policy Statements (CAPS) introduced in 2012 require that teachers integrate school science with Indigenous Knowledge Systems (IKS). In an era where the decolonization of the curriculum in South Africa receives a lot of attention, it is important to focus on developing teachers' pedagogical content knowledge to effectively implement indigenous knowledge in the classroom (Le Grange, 2016; Dismelo, 2015; Chetty & Knaus, 2016). Equally important is to use pedagogies in the classroom that will equip learners with 21st century skills, and to promote self-direction in learning.

This places a high premium on teachers' pedagogical content knowledge (PCK). Effective teaching requires a special combination of both content knowledge and pedagogical knowledge. This combination is known as pedagogical content knowledge (PCK) (Conley, 2010; Shulman, 1986) and demands that teachers are both researchers and life-long learners in order to develop this knowledge.

Using or implementing indigenous knowledge in the classroom is not simple. Firstly, the teacher must access it, understand it and to be able to relate it to the subjects being taught in the classroom and devise appropriate teaching methods to pay justice to this knowledge systems. The Eurocentric approach that has dominated education in South Africa, has led to a marginalisation of indigenous knowledge, and teachers were never trained in infusing their teaching with IK. This is a pity, since indigenous knowledge holds affordances for science education. One of the major reasons for poor
performance and lack of interest in science is the inability of teachers to make the subject interesting and for the learners to participate because of pedagogies such as ‘chalk and talk’ according to Petersen (2010). A constructivist approach will enable the teacher to see the importance of building on the learners’ previous knowledge by their encouraging the learners to bring their IK to the classroom. This will help the learners to understand the relevance of science in their daily life and increase their interest (De Beer & Whitlock, 2009).

Many factors influence learners’ learning of science and achievement. However, teachers seem to have the most significant effect on learners’ academic achievement (Ball, Hill & Bass, 2005). When teachers lack the suitable approach to teach a particular content, it will be difficult for teachers to transform content knowledge into a form that can be understood by learners. This is not surprising because a teacher can only explain what he/she understands to another person successfully (Kousar, 2010). Shulman (1986) states that ‘content knowledge and pedagogical knowledge are inseparable rather they interact together as pedagogical content knowledge (PCK)’. He expressed the view that pedagogical content knowledge is the content knowledge related to teaching because it enables the transformation of the subject matter into a pedagogically useful form. (Rohaan, Taconis & Jochems, 2010; Smith 1999). McDermott (2006) emphasises that teachers need to understand their subjects they teach at a greater level. Many teachers were trained at the former Colleges of Education and have limited content knowledge (Rollnick, Bennet, Rhemtula, Dharsey & Ndlovu, 2008), as this learning did not provide them with a comprehensive understanding of what they were going to teach. When teachers are educated in a manner that provides a thorough pedagogical approach, they can offer quality instruction promoting learners’ conceptual understanding.

Problems relating to the teaching of Natural Sciences (NS), such as teachers’ lack of PCK on how to include IK into their classrooms’, has impacted negatively on the quality of teaching and practice, and hence the enjoyment and learning of science by learners. This has resulted in a general decline in learners’ interest and enjoyment of science (Adams, Doig & Rosier, 1991; Speering & Rennie, 1996; Goodrum, Hackling, Rennie, & Hart, 2001; Adimado, 2013). Science education is not inflexible, it should often develop from curiosity, inquiry and discovery. Many teachers provide little or no motivation or opportunity for imagination and curiosity. Learners need to understand
the world around them and rationalise decisions on important issues. There are diminishing numbers of learners seeking science-related studies and the reasons are evident as learners develop increasingly negative attitudes to science during the secondary school years (De Beer & Ramnarain, 2012). This has caused a shortage of skilled science professionals in the workplace and a great shortage of qualified science teachers in our schools making it difficult to provide innovative and interesting scientific experiences in schools (Adimado, 2013). This is a serious concern because the reduction in numbers involved in science appears predominantly in the nations that have increasing demands for science and technologically based professionals. This emphasises the need for a society that is knowledgeable and interested in science.

Teachers’ views on the nature of science (NOS) is another aspect requiring investigation. Vhurumuku, (2010) states that teachers’ views on the nature of science have a great impact on their teaching of science in the classroom. The nature of science refers to the key principles and ideas that provide a description and understanding of science, as well as characteristics of scientific knowledge and the understanding of the teacher determines how s/he engages and teaches the learners. The teacher’s knowledge of the NOS will influence the decision on and how science is taught in the science classroom. Does a teacher’s pedagogy honour the tenets of the nature of science, and the syntactical nature of the subject? A learner should have a good understanding of the nature of science, the influences of ethics and biases in the Natural Sciences classroom, and the interrelationship between science and technology, IK and society (Department of Education, 2003:12).

Aikenhead (2006) argues that learners from a district will learn to appreciate science when they see it as being meaningful to them and bringing IK to the science classroom makes science relevant to the learners improving their understanding. (This is in line with Gibbons’ (2000) notion of mode 2, or context-sensitive science). Learners can realise that the same plants that surround them and that they see each day are relevant in everyday use (e.g. as medicines or food) and that they also form part of science. Curricula must be designed and adapted to apply to learners’ lives and environment developing their interest, knowledge, understanding, abilities and experiences. Learners need to realise that what is learned in the science classroom is significant in every aspect of life and encouraged to consider how science-based issues affect their own lives and reflect on the moral principles that reinforce science
as a subject to create positive interest. It will further encourage active participation of the learners during lessons because learning about their environment is more real to them than an abstract topic. Teaching and learning science then become exciting. An appreciation of the history of scientific discoveries and the relation to IK and different world views helps to enrich our understanding of the connections between science and society.

Before 1998, South African schools were using a curriculum that was strictly divided into subjects which encouraged learners to read and pass examinations and not actively participate in the classroom or any practical application of what is learned in their day-to-day living (Jansen & Christie, 1999). Kruger and Adams (1998) called this type of curriculum ‘recitation script’. Learners are passive and have no choice in what they learn or the method of learning. Effective learning requires a learner to accept responsibility for his/her learning. An important part highlighted in CAPS is that learners should be encouraged to bring their own indigenous knowledge into the science classroom.

The principle of inclusivity dictates that all learners should be involved in science as a subject that embraces their diversity and cultural backgrounds and be able to contribute and participate in what is learned in the Natural Sciences classroom. With their different cultural backgrounds, they have different ways of perceiving the world around them. Despite the good intentions of policy makers regarding this new curriculum, teachers acting as curriculum policy implementing agents have not received adequate training or support on how to implement this policy in the classroom. There is a huge gap that exists between the intentions of policy makers and the implementers in schools (Maluleke, 2013).

The process of transforming education policy into practice is not an easy task, regardless of the level from which it emanates. According to Hope (2002:40-44), there are many obstacles to implementing the curriculum, including differences or apathy among those executing the process, lack of resources, insufficient time and disagreement about how results can be achieved. Research has shown that policy implementation internationally and in many educational reforms designed to improve the quality of learning is far from achieving its objectives (Morris & Scott, 2003:71-84).
Indigenous knowledge can be seen as a tool for promoting learning. According to DeWalt (1999), indigenous or local knowledge has been defined as knowledge that is unique to a given culture or society and communities. This local expertise and cultural practices belonging to a community are communicated orally through the generations and have the potential to influence teaching and learning situation significantly in the science classroom. The incorporation of indigenous knowledge into school work can serve to motivate learners as they begin to see that recognition is given to activities in their communities. This can produce a sense of achievement and pride, as the knowledge arises directly from their real life experience, and equally, demonstrates the relevance of science in our daily lives. Also, it should be noted that this inclusion fits exactly into the constructivist philosophy, which asserts learners develop their understanding from previous experience (Donald, Lazarus & Lolwana, 2006). Therefore, the knowledge and experience that learners bring to the science classroom are an important component of the learning process. Introducing Indigenous knowledge to the science classroom will encourage active participation of the learners which may further stimulate their interest. Social cultural theory is mostly based on the work of Vygotsky (1978), a constructivist and this views learning as best taking place in a social environment. This provides a complex description of the dynamic contexts and the processes through which learning and development occur. Vygotsky emphasised that learning and development take place through social interaction with people (Vygotsky, 1978). The theory explains learning and development as taking place through social interaction meaning that it is an interactive process where the educator and learner engage in talking or dialogue.

A learner-centred approach ensures a high level of engagement and active participation by the learner in the classroom (Nilson, 2010). The ultimate criterion of a good teaching and learning process is effective learning where the student learns by becoming involved and actively participating in the lesson (Astin, 1985). Learning should not be a spectator sport whereby learners simply sit in the classroom listening to the teacher, memorising and answering as required. Learning can be passive when the process only entails routine memorisation, whereas learning with active participation by learners imparts values of confidence, initiative and ability to generate or construct their own knowledge (Gallo, 2004). Learning must involve interaction whereby learners relate lessons to their past experiences and apply it to their daily
lives (Piaget, 1955). When learners are taught to recite what they hear or read without critically interacting and discussing the information, independent thinking skills are not developed as different perspectives are not explored (Mrowicki & Lynch, 1991). Also, it is difficult for learners to internalise the lesson when they are passive spectators and are not encouraged to think reflectively.

The lack of professionally qualified teachers in the Natural Sciences classrooms could also be one reason for not introducing IK in our classrooms, however, this is expected due to the shortage of qualified experts in this field. Unlike many developed countries, most teachers did not study or major in Natural Sciences at tertiary education level. Many of them graduated in other disciplines and were opted (or were co-opted) to teach Natural Sciences as a result of the shortage of qualified teachers. It is likely, therefore, that such teachers may not have Natural Sciences knowledge to enable them to handle the introduction of indigenous knowledge into their classrooms.

1.2 CURRICULUM IMPLEMENTATION IN SOUTH AFRICAN EDUCATION CONTEXT

The evolvement of democracy in South Africa brought with it many changes to the education system. Prior to 1998, South African schools were using a curriculum that was established by the apartheid regime. In 1999, Outcome-Based Education (OBE) was introduced and was renewed in 2000 due to the challenges encountered in its implementation. The first curriculum revision was the Revised National Curriculum Statements Grade R-9 (2002) and further implementation challenges resulted in another review in 2009. In 2012, the two National Curriculum Statements for Grades R-9 and Grades 10-12 were combined in a single document known as the National Curriculum Statement Grade R-12, which builds on the previous curriculum and updates it, aiming to provide clearer specifications for the syllabus for each term in schools. It represents a policy statement for learning and teaching in South African schools (DoE, 2011).
The National Curriculum Statements (NCS) emphases the following (Petersen, 2010:18):

- social transformation
- outcome-based education
- high skills and knowledge level integration and applied competence
- progress integration and portability
- inclusivity
- consistency environmental and social justice value on indigenous knowledge systems
- credibility
- quality and efficiency

Also, it emphases the value of indigenous knowledge systems, acknowledging the rich history and heritage of South Africa as being important contributors to nurturing the values contained in the constitution. The new curriculum faced obstacles in implementation due to the nature of the contents and the standard of education that was expected from the teachers. This gave way to a revised curriculum which states clearly that IK should be included in the Natural Sciences classrooms. The NCS expresses that inclusivity should be central to the organisation in planning and teaching at each school. This can only happen if all teachers have a proper understanding of how to organise their teaching to encompass the diversity in their classrooms.

The NCS was built on the values of the nation’s constitution which aims to correct the wrong of the past by establishing a society based on democratic ethics, social justice, equality and human rights.

In a new South Africa, it is important to transform the curriculum inherited from the apartheid regime. It is believed that education and the curriculum have an important role to play in realising these aims. One of the three specific aims of the Natural Sciences, according to CAPS, is that learners should understand the value of Natural Sciences and indigenous knowledge in society and the environment. Learning science in schools should produce learners who understand that what they are learning can be relevant to their daily lives. Examples of such applications are issues like improving
water quality, growing food without damaging the land and building energy-efficient houses, etc. (DoE, 2010).

The NCS and the refined CAPS for Natural Sciences expect teachers to infuse IK into their teaching. The question arises as to whether all NS teachers are able to cope with these challenges and if sufficient support is provided to teachers to comply with the requirements of the NCS/CAPS?

The new curriculum focuses on the need of the learners rather than that of others involved in the educational process such as teachers and administrators. This approach has great implications for the design of curriculum, course content and interactivity. It puts learners first, concentrates on learners’ needs, abilities, interests and learning styles with the teacher as the facilitator of the learning process.

There can be many obstacles to implementing the curriculum which include an individuals’ indifference or apathy towards the policy, lack of resources, insufficient time for implementation and disagreement about how to achieve results.

To be able to implement the new curriculum, teachers need resources including training, support services and professional development, which at this time are not in place.

1.3 WHAT IS THE GAP THIS STUDY ADDRESSES?

The aim of this study is to explain the participating teachers’ experiences of incorporating indigenous knowledge in the Natural Sciences classroom from Gert Sibande District, Mpumalanga (Dundonald and Piet Retief Circuit). This includes how the intervention (short learning programme) impacted on their pedagogical content knowledge (PCK), and whether a more nuanced understanding of indigenous knowledge led to transfer in the Natural Sciences classroom. Guidelines were provided during the short learning programmes to assist in the development of teachers’ pedagogical content knowledge in teaching indigenous knowledge as part of the school curriculum.
Objectives:

1. To determine whether Natural Sciences teachers have the necessary pedagogical content knowledge to address indigenous knowledge in a scientifically sound way.

2. To identify the problems that teachers experience in infusing indigenous knowledge in their teaching using third-generation Cultural Historical Activity Theory (CHAT) as a lens.

3. To look at ways of introducing indigenous knowledge better and using it as a tool to promote learning and arousing learners' interest in Natural Sciences classroom.

4. To determine how the short course on indigenous knowledge influence teachers' pedagogy.

5. To establish what the role of communities of practice are in the continuous professional development of teachers.

6. To distil design principles from the first cycle of interventions (short learning programme), to inform the re-conceptualisation of a second course.

It is acknowledged that many Natural Sciences teachers find it difficult to incorporate indigenous knowledge in their classrooms due to inadequate pedagogical knowledge of teaching this subject and their views of the nature of science. Most importantly, this study will assist in refining a short learning programme for science teachers. The study will, therefore, have a design-based research approach that includes an element of phenomenological studies (since I also wanted to describe the teachers’ “lived experience”). The short learning programme was mostly laboratory based, focussing on various experiments to test the potency of the acclaimed indigenous plants that are used for healing in the local communities by using shoestring-methods suitable for poorly resourced classrooms.

Despite the fact that the curriculum document for Natural Sciences advocates for the inclusion of indigenous knowledge in the classroom, it provides very little information or guidance on how this should be achieved. Little attention has been paid to the factors influencing how teachers would make sense of the curriculum policy and how this understanding of policy implementation influences their response to these policies (Maluleke, 2013). Also, little indigenous knowledge content is provided in the
prescribed school text books making the inclusion of indigenous knowledge more difficult for Natural Sciences teachers in their lessons. This research looked at the area of educational policy implementation of how Natural Sciences teachers should include indigenous knowledge in their classrooms, highlight the problems that teachers face in this curriculum requirement and try to determine whether teachers have the necessary pedagogical content knowledge to effectively succeed in this regard.

This study focuses on the issues related to the incorporation of indigenous knowledge, and the lived experiences of four Natural Sciences teachers in the Gert Sibande District in Mpumalanga. In the study, I determine whether they have adequate pedagogical content knowledge and their views on nature of science. Furthermore, it will examine the role of a community of practice in helping the teachers’ professional development and how an intervention programme can help to improve their pedagogy to incorporate indigenous knowledge in a scientifically rigorous manner. This study unfolded in three stages:

1. Exploring teachers’ experiences of incorporating indigenous knowledge in the Natural Sciences classroom. This is the pre-intervention stage and was carried out through open ended questionnaire, observing the teachers’ lessons in the classroom, interviewing the teachers and analysing the lesson plans.

2. An intervention, in the form of a short learning programme offered by UJ, where teachers engaged with pedagogies to bring indigenous knowledge alive, in a scientific rigorous way, in the classroom. This took place in Gert Sibande District, Mpumalanga

3. A post-intervention stage, where the focus was on whether transfer takes place in the classroom. This was done through open-ended questionnaires, classroom observations, individual interviews with the selected teachers and analysing the lesson plans.

This study will contribute to the body of knowledge by focussing on Natural Sciences (NS) teachers’ experiences in incorporating indigenous knowledge in schools in Mpumalanga province and also provide guidelines to teachers on how they can
incorporate IK in the Natural Sciences classroom in a scientifically rigorous way by the organising a short learning programme for them.

1.4 RESEARCH QUESTIONS

The following six research questions guided this study:

1. How does the teachers’ pedagogical content knowledge (PCK) inform their infusion of IK in their teaching of natural sciences (NS) topics?
2. How do NS teachers experience teaching IK systems in the NS classroom, and what are the challenges that they face?
3. What are the affordances of indigenous knowledge for the development of affective outcomes in the natural sciences classroom?
4. How does a short learning programme on IK change the pedagogy of teachers?
5. What is the role of a community of practice in assisting teachers in their professional development to incorporate IK in a scientific rigorous way?
6. What are the design principles that should inform such IK interventions (short learning programmes)?

1.5 RESEARCH DESIGN

This is design based research (DBR) with elements of phenomenology, with the purpose of providing richness of data and answers to the research questions. This study explores how the teachers experience teaching IK systems in the classroom and how their pedagogical content knowledge (PCK) impact on their infusion of indigenous knowledge (IK) in their teaching of Natural Sciences as a subject. This research looked at the field or area of curriculum implementation in how teachers implement the new curriculum policy to include indigenous knowledge in the Natural Sciences classroom. Furthermore, it looks at how a short learning programme on indigenous knowledge improves the pedagogy of teachers and the role of a community of practice in assisting
teachers in their professional development to incorporate indigenous knowledge scientifically.

The research data collected during this research was qualitative with the use of open-ended questionnaires, classroom observations, artefacts such as lesson plans and individual interviews. Hence, the study adopted a qualitative method (Creswell, 2008). This data collection method is suitable for this particular study because it enables the investigation of how indigenous knowledge is being included in the Natural Sciences classroom, challenges faced by teachers in doing so and how a short learning programme could assist with their pedagogical content knowledge development in the inclusion of indigenous knowledge. This provided a clear and detailed account of actions verbally and in written text enabling the researcher to better understand teachers’ experiences and the challenges they encounter, which offered insight into the nature of these difficulties. According to Henning, van Rensburg & Smit (2004), qualitative research will provide an in-depth study and assist in revealing what happens, as well as how and why it happens.

This element of phenomenological study provided the richness of data and answers to the research questions (Brink, et al., 2006:191).

Purposive sampling was used in this study. Participants, all science teachers, were selected from three schools in Dundonald Circuit; Siyabonga Secondary School, SW Nhlapho Secondary School and Ligugu High School. Data collection methods included classroom observations (using the Reformed Teaching Observation Protocol, or RTOP), studying artefacts (such as lesson plans), questionnaires (e.g. the VNOIK instrument) and focussed personal interviews. Teachers from Amsterdam Circuit were also invited for the short learning programme. These two circuits were close to the researcher, therefore teachers were able to attend the short learning programme and it was convenient to visit the schools and carried out the classroom observations.

This study captured the ‘lived experiences’ of a selected group of four teachers. For this purpose, in-depth personal interviews with Natural Sciences teachers was undertaken. Data will be collected by means of open-ended questionnaires designed to determine teachers’ views of the NOS, as well as of the nature of indigenous knowledge systems, classroom observations, artefacts in form of lesson plans and
focussed personal interviews. In this study therefore, these methods were chosen because they provided abundant data, clear and detailed account of actions, as well as spoken and written text (Creswell, 2009).

An analysis of the data was done, and I used Saldana’s (2009) technique for coding, where codes, categories and emerging themes from the focussed personal interview will be identified. Classroom observations will be analysed using RTOP, an observational instrument that can be used to assess the degree to which science instruction is reformed (Sawada, Pibum, Falconer, Turley, Benford, Bloom & Judson, 2000). The findings were integrated with literature and third-generation CHAT (Engeström, 2001) was used as a lens to paint a portrait of teachers’ lived experiences. CHAT is a useful tool since it effectively captures tensions in an activity system (in this case, the Natural Sciences classroom, and the challenges and barriers in incorporating indigenous knowledge in Life Sciences learning). Triangulation was used to confirm the data gathered as more than one collection method is involved.

The validity/reliability/trustworthiness of the data was verified by making sure that data collected actually measures what is meant to measure. To ensure reliability, a detailed description of sampling, data capturing and analysis was undertaken to ensure that results are consistent with data collected. The standards for validity identified by Eisenhart & Howe (1992) was used as a guide, namely:

- Standard 1: A fit between my research questions, data collection and procedures and analysis techniques;
- Standard 2: Making credible reasons known for my specific choice of subjects, data-gathering procedures and analysis techniques;
- Standard 3: A clear description of the context of the study;
- Standard 4: External and internal value constraints will be discussed and the value of this study will be highlighted.
1.6 AN OVERVIEW OF THE DISSERTATION

Chapter Two of this study provides the literature review. The literature review was used to rationalise the need to study the research problem. This chapter will discuss the views of other researchers. Furthermore, CHAT that is used as a lens in this study will be introduced. The chapter will also include definitions of various terms like Nature of Science, Indigenous knowledge, Pedagogical Content Knowledge, etc. These constructs can be seen as the ‘intermediate theoretical concepts’ in Engeström’s language or the metaphors of filters will be utilised.

Chapter Three focuses on the research design and methodology. The research design with an element of phenomenological study was used as qualitative procedures. This was used to examine the participants in the setting where they work, how teaching and learning of Natural Sciences take place in their classrooms. The questionnaires are open-ended to permit the participants to generate expanded responses and to gather additional information from individual interviews. Classroom observations and lesson plans were also used as part of the data collection.

Chapter Four discusses the analysis of the data collected to make sense of information supplied by participants in the study and convert it to useful material. The analysis examines the data to determine individual responses and then forms a summary. The findings were interpreted and compared with the literature reviews.

Lastly, Chapter Five covers the discussions of the findings, conclusion and recommendations that will help the Natural Sciences teachers to incorporate IK in their classroom in a scientifically rigorous manner. It also highlighted information to add to the body of knowledge.
CHAPTER TWO

BORDER-CROSSING BETWEEN THE EPISTEMOLOGIES OF SCIENCE AND INDIGENOUS KNOWLEDGE SYSTEMS AND THE IMPLICATIONS FOR TEACHER PROFESSIONAL DEVELOPMENT

2.1 INTRODUCTION

Science education in South Africa is at a crossroad. Since the #RhodesMustFall student protests in 2015, the problem around transformation that bedevil education in South Africa has been center staged. Mbembe (2015:9) writes that “there is something profoundly wrong when syllabi designed to meet the needs of colonialism and Apartheid continue well into the post-Apartheid era”. Mbembe poses the question what directions an education system should take in a South Africa wishing to break with neo-colonialism. This makes this study on the affordances of indigenous knowledge in the science classroom timeous and relevant.

South Africa is celebrated internationally as an example of both biological and ethnic diversity. Southern Africa is rich in angiosperm species and those identified total over 21,000 (Mothwa, 2011). The country has outstanding bio-cultural diversity, rich and extensive traditions in herbal medicine which date back many generations. The traditional medicinal systems of different cultural groups and their herbal, animal and mineral material medica have ancient origins. There are at least 200,000 indigenous healers who are consulted by 60% of the country’s population and approximately 2,500 species of plants are used commonly as medicines in different parts of the nation (Gericke, 1994). Indigenous knowledge and cultural practices in many areas of the country, provides learners with a solid introduction to the scientific world. However, indigenous knowledge is relatively new to the South African school curriculum. Although indigenous knowledge has been with us for centuries, it has been neglected and omitted from science curricula (Kibirige & Van Rooyen, 2006). In the past, very few if any, higher education institution focused on the teaching of indigenous
knowledge in its teacher education programmes- highlighting the “Eurocentric canon that attributes truth only to the Western way of knowledge production” (Mbembe 2015).

Indigenous people’s views of nature have often been unjustly regarded as being naturally simple, primitive or inexperienced, reflective of an earlier generation and, therefore, from an inferior stage in human cultural progress (Knudton & Suzuki, 1992). More often, it is hardly recognised. Eisenhart (2001) pointed out that in science education culture was rarely conceptualised and ideas about cultural issues had clearly not influenced directions for reform. His assertion indicated the reality that ‘culture’ is historically marginalised in science education. This explains one of the reasons why IK has not been given much recognition in our science classrooms, a practice that Odora Hoppers (2004) describes as ‘knowledge apartheid’. The aforementioned points to inequalities in science education clearly need to be addressed (Van Elijck & Wolff-Roth, 2011). Indigenous knowledge is often referred to as one of the following: folk ecology, ethnoecology, rural people’s knowledge, marginalised knowledge and local oppressed knowledge. These collections of knowledge is built up by group of people through generations of living in close contact with nature.

Wood, Erichsen and Anicha (2013) highlight the fact that introducing indigenous knowledge in the science classrooms is a method of applying existing ideas in new ways and contexts and thereby constructing new tools for understanding. They further argued that as a community, we will not understand the teaching or learning of science until we attend to culture. This submission supported Carlone (2004) who stated that individuals’ values, beliefs and actions are shaped by cultural experiences. There is a need for the development of an educational system that supports diverse cultures and the indigenous knowledge that learners bring to the science classrooms (Bencze & Carter, 2011). The use of indigenous knowledge learners bring from their households assists their learning experiences and increases learning opportunities (Barton & Tan, 2009; Lee & Buxton, 2011).

The recognition of IKS as a valid source of knowledge may be traced to activists who have questioned and raised awareness of the exploitative approaches by the developed nations related to the environment and biodiversity, as well as the subsequent disempowerment of indigenous people in developing nations (DeWalt,
1999). While consideration of culture was not previously totally absent from science education, a growing body of literature now addresses these issues from diverse theoretical perspectives. In the last two decades, the concept of culture and IKS is becoming more conspicuous and attempting to be included in science education (Parsons & Carlone, 2013).

### 2.2 INDIGENOUS KNOWLEDGE

The advance of modern knowledge systems is based on previous knowledge. Therefore, it is highly important to recognise this knowledge which is rooted in the diverse cultural perspective learners bring to the science classroom as assets to learning (Chinn, 2006; Richmond & Kurth, 1999). Indigenous knowledge has been described as being developed through an informal evolutionary process and emerging over a long period of time. This development depends on the intergenerational transfer of intellectually-based resources passed via word of mouth through generations of traditional communities. Both IKS and western knowledge systems contribute to sharing information for specific purposes and include the investigation of the unknown and the resultant creation of knowledge through processes of integration of the new to the known. Unlike modern knowledge systems (MKS) or western knowledge system (WKS), indigenous knowledge system (IKS) are not generated within international systems of universities, research institutes and private firms and not always documented.

Indigenous knowledge systems exist in different forms. Forms of IK include weaving, hunting, agriculture, carpentry and the use of medicinal plants which are passed from the elder to the younger ones in the community. However, increasingly modern perspectives are a challenge to such modes of instructions and some IK is dying out because of the decreased need for them and lack of interest from the present generations (Appiah-Opoku, 2005).

Richards (1985) concluded, after working in West Africa, that practical knowledge of local people about the grasshopper (*Zonocerus variegatus*) in relation to the feeding and breeding habitat is the same as that of western trained ecologists. Furthermore,
sociologists have observed for centuries before the dawn of western science and civilisation in Africa that the Masai and other tribal herdsmen knew when rain would fall based on the behaviour of the Safari ant which moves to the wing phase of its reproductive cycle three weeks prior to rainfall.

According to George (1989), indigenous practice can be explained in conventional science terms. For instance, the indigenous practice of using a mixture of lime juice and salt to remove rust stains from clothes can be explained in conventional science in terms of acid/oxide reactions. Another example is the use of the brew made from the plant Vervine (Stachytarpheta) in the treatment of worms in children. The plant is considered in conventional science circle to have pharmacological properties but its correct usage has not yet been verified.

Another form of indigenous knowledge is food preservation. The local people have experience in preserving both raw and cooked food from decay before the advent of technology. Some make use of salt to preserve their meat while others sun-dry to prevent the activities of micro-organisms.

2.2.1 What is indigenous knowledge?

Indigenous or local knowledge has been defined as knowledge that is unique to a given culture or society and communities. It is local know how and cultural practices that belong to a community and are transmitted orally between generations (DeWalt, 1999). Indigenous knowledge is localised because it is the result of the interaction of the people in their territories and occurs among families and communities immersed in the whole culture and created through generations. These recreations take place as the indigenous people relate their stories daily in their language concerning the uses of plants to cure their sicknesses and diseases (Appiah-Opoku, 2005; Semali & Kincheloe, 1999).

Indigenous Knowledge is the total combination of the knowledge and skills which is possessed by the people of a certain area or community and has assisted them to maximise the most use out their natural environment (De Beer & Whitlock, 2009). They are able to harness their natural environment based on experience over long periods of use. IKS have been described as being ‘created through an informal
evolutionary process, growing over a long period of time’ (DeWalt, 1999). The development of this knowledge ‘depends on the intergenerational transfer of intellectually-based resources owned by oral tradition-based communities’ (Raseroka, 2002). This knowledge is held and put to use by people of the same culture and differs from what is obtainable in other cultures. Forefathers in Africa, although not school educated, discovered the useful properties of certain plants in their environment and succeeded in passing this knowledge to the following generations. In reality, they are not able to prove the chemical composition of these plants scientifically but based on previous experience they can tell which plants are beneficial and for what purpose.

According to Grenier (1998), an indigenous knowledge system is ‘the sum total of the knowledge and skills which people in a particular geographical area possess, and which enables them to get the most out of their environment’. Warren (1991) defines ‘indigenous knowledge as the local knowledge that is unique to a given culture or society’. It is a body of knowledge built up by a group of people through generations of living in close contact, often referred to as folk ecology, ethno ecology, rural people’s knowledge marginalised knowledge and local -oppressed knowledge (Appiah-Opoku, 2005).

As explained by Semali and Kincheloe, (1999), indigenous knowledge reflects the dynamic way in which the residents of an area have come to understand themselves in relationship to their natural environment and how they organise that folk knowledge of flora and fauna, cultural beliefs and history to enhance their lives and make choices about the environment where they live. For centuries, this environment has been the basis for their food, water, medicine and other natural sources that sustain them and their families. They understand valuable knowledge through information they gather from their own life experiences. Through trial and error, they discovered how to treat diseases, tend livestock, manage aquatic resources and provide health therapies, and how to preserve and pass on such local knowledge from one generation to the next.

Indigenous knowledge is the cognitive and wise legacy of the people as a result of their interaction with nature in a common territory. Balkin (1998), explained that cultural groups are populations of people who possess relatively similar collections of cultural information. Local people are made up of their cultural information, which grows and progresses through interactions with one another.
McClure (1989), views the term indigenous knowledge systems as that body of amassed wisdom that has grown from years of experiences and trial and error problem-solving by sets of people working to meet the challenges they face in their local environment, drawing upon resources they have at hand.

This researcher defines indigenous knowledge as the sum total of the knowledge and skills which is possessed by the people of a certain area or community and has helped them to get the most use out of their natural environment, which is achieved based on experience tested over long period of use.

2.2.2 Characteristics of indigenous knowledge

There are characteristics that are peculiar to indigenous knowledge. Some of them are found below:

- Indigenous knowledge is not stationary; it is tested over and over for validity to its owners through experience and through the infusion of new knowledge as appropriate; (De Beer & Van Wyk, 2011).
- Indigenous knowledge is usually generated within local communities. In other words, it is location and culture specific. It is mostly associated with people of the same culture; (Ogunniyi, 2004, Noblit, 2013).
- Indigenous knowledge serves as basis for decision-making and survival strategies for the people of a community; (Bohensky & Maru, 2011).
- Indigenous knowledge is not systematically documented. It is usually transmitted orally from generation to generation by the forefathers; (Agrawal, 1995; Senanayake, 2006)).
- Indigenous knowledge covers critical issues like primary production, human and animal life and natural resources management. The local people make use of indigenous knowledge to solve the issue of hunger, poverty, agriculture among others; (Ogunniyi, 2004; Aikenhead & Ogawa, 2007).
- Indigenous knowledge is rural in nature (Agrawal, 1995).

Table 2.1: Comparing the characteristics of the western and indigenous knowledge worldview
<table>
<thead>
<tr>
<th>Western knowledge</th>
<th>Indigenous knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Decontextualised – western knowledge is not specific to a content or culture. It is universal and transcends national and cultural boundaries</td>
<td>- Contextualised – specific to a content or culture of a particular people. Indigenous knowledge is generated locally and reflects the social and cultural values of the community</td>
</tr>
<tr>
<td>- Materialistic – it investigates objects. Scientists perform experiments or investigations when trying to solve problems</td>
<td>- Spiritual – indigenous knowledge is rooted in a strong belief system. Practitioners of indigenous knowledge observe nature to generate knowledge and give explanations about their observations. These explanations do not always have natural causes that are predictable</td>
</tr>
<tr>
<td>- Reductionist approach – focus on the main problem</td>
<td>- Holistic approach – Practitioners of indigenous knowledge when solving problems look at other probable source of the problems</td>
</tr>
<tr>
<td>- Rational – takes balance, coherent and logical approach</td>
<td>- Intuitive – uses in-built and natural instinct to solve problems</td>
</tr>
<tr>
<td>- Competitive in nature</td>
<td>- Cooperative in nature</td>
</tr>
<tr>
<td>- Individual – the western knowledge is not usually generated in a community but individual at different places</td>
<td>- Communal – indigenous knowledge is generated in the local community by the people and practised in the community</td>
</tr>
<tr>
<td>- Time is linear</td>
<td>- Time is circular</td>
</tr>
</tbody>
</table>

### 2.2.3 Advantages of indigenous knowledge in the Natural Sciences classroom

The South African government highlights the importance of cultural heritage and indigenous knowledge systems in development, planning and implementation of curricula by embarking on IKS programmes. Before looking at the major findings of this study, it is critical to first focus on the benefits of incorporating IK in the Natural Sciences classroom.

Hamilton-Ekeke and Dorgu (2015) explain that the inclusion of IK in the Natural Sciences classroom enhances educational effectiveness for indigenous learners and teachers by providing syllabi that adhere to an indigenous person’s own inherent perspectives, experiences, language and customs. They further emphasise that it will
help in raising awareness of individual and collective traditions surrounding indigenous communities and people, thereby promoting greater respect for and appreciation of various cultural realities for non-indigenous learners and teachers. The inclusion of IK in the Natural Sciences classroom will be advantageous to learners from different backgrounds as it will assist in better contextualising science, and show the learners how science serves modern society. This could also assist in reducing racism in the classroom and enhance the sense of community in a diverse group. The inclusion of IK can help to promote diversity by placing value on the knowledge that is characteristic of various cultures (Hamilton-Ekeke & Dorgu, 2015).

Indigenous knowledge can be seen as a means of handling social injustice which Odora-Hoppers called knowledge apartheid (Odora-Hoppers, 2004). The promotion of IK and its inclusion will enable those in Western and post-colonial societies to re-evaluate the inherent hierarchy of knowledge systems. IK has a transformative power for indigenous communities that can foster empowerment and justice and is important in establishing indigenous rights on a global scale.

Addressing indigenous knowledge in the Natural Sciences classroom will help to acknowledge the social identity of each learner. When learners’ cultures are appreciated and acknowledged, it might change the mind-set of those learners who are resistant to studying westernised science curricula and make learning a more positive experience. For these learners, the westernised science curriculum is often foreign and they often do not show interest. Inclusion of IK in the Natural Sciences classroom might encourage learners to develop interest in science, since they see the relevance of science in their daily lives. From this perspective, we should view IK from an embodied, situated and distributed cognition perspective (as will be explained later in this dissertation). The viewpoint of embodied cognition is that cognitive processes are deeply rooted in the body’s interactions with the world (Wilson, 2002). Learners develop their worldviews based on their situated engagement with people and the environment. Such cultural knowledge is co-constructed (and therefore distributed in the community) (De Beer, 2015). As mentioned, IK provides a good entry into the abstract world of science. Therefore, curricula must be designed and adapted to meet the interest, knowledge, understanding, abilities and experiences of learners. This enables learners to participate actively in the classroom, making teaching and learning of NS exciting. Teaching and learning strategies are shifted from being teacher-
centred to learner-centred. Learners are challenged to, for example, carry out research about various indigenous plants in their community thereby developing their intellects, and also realising that science serves society (Science-Technology-Society approach).

According to Van Wyk (2002), incorporating IK helps to provide ultimately a pedagogy that fosters cultural, social and identity factors that validate the learners' experiences. Educators could assist them to understand that their realities are socially constructed and inevitably will change over time and through exposure to different contexts.

Practically, inclusion of indigenous knowledge in the Natural Sciences classroom enhances better understanding of academic science content while accessing scientific language. This is because language of science is often considered to be ‘cognitively demanding’ and content reduced. On the contrary, the scientific knowledge of indigenous culture is considered to be less demanding cognitively than westernised science since it is based on experienced reality and has a vocabulary more accessible and familiar to the learners. Furthermore, it will encourage the learners to consider the ways in which science-based issues affect their own lives and to reflect on the moral principles that underpin science. It promotes respect for moral and ethical issues existing in our communities, which are related to science. For instance, the protection of intellectual property rights in a time where bioprospecting often leads to an infringement of the rights of the holders of IK can lead to rigorous debates in the science classroom. Learners are able to discover the relevance of science to their daily activities and achieve a broader knowledge of their environment.

Emphasising indigenous knowledge in the Natural Sciences classroom will present varieties of knowledge to learners from different backgrounds and increase their knowledge of the usefulness of the plants and life around them. This might also enable them to preserve the environment. For example, our plants will be preserved when learners understand their benefits as sources of food, medicine, furniture making and for the building of houses. It will reduce indiscriminate destruction of trees and bush burning. Some indigenous knowledge e.g. myths that were not understood by learners can be explained to them. For instance, boys are told not to urinate in a running stream, this they take as a taboo but scientifically it prevents pollution of our water supplies.
Indigenous Science has contributed so much in most fields of study. Numerous traditional peoples' scientific and technological contributions have been incorporated in modern applied sciences such as medicine, architecture, engineering, pharmacology, agronomy, animal husbandry, fish and wildlife management, nautical design, plant breeding and military and political science (Norman, Snyman & Cohen, 1996).

The inclusion of IK reveals diversity and inclusivity in the Natural Sciences classroom, which will build on learners' experiences and how they value the social and relational importance of identity (Yon, 2000:24). IK aims to be transformative, particularly for teachers in South Africa, across all subject areas in engaging learners in a form of knowledge construction where they will recognise themselves. IK strives to be inclusive, particularly of those views that have been historically excluded from knowledge construction, to encompass diversity of cultural, racial, ethnic and religious and to eventually lead to a better understanding (Posch, 2000:62) of the learners' social context and the sense of owning their knowledge.

The IK of a nation forms a major part of the required knowledge for notable or increasing development including skills, experiences and insights of the people applied to maintain or improve their livelihood. IK is a major asset for people especially those in the rural areas for their survival.

2.3 THE NATURE OF SCIENCE

Science studies the physical world, this include all both living and non-living things and is relevant in our day-to-day living. Scientists view the world as comprehensible and that basic rules and principles are the same everywhere. The law of gravity in America is the same in South Africa. Inquiry is part of the logical nature of science and scientists use particular skills when inquiring about nature that helps us to further understand the physical world and there is common understanding among scientists what makes an investigation scientifically valid. The mode of inquiry requires investigations, both qualitative and quantitative, which are undertaken using the five senses to observe nature, ask questions and generate problems about occurrence in the environment. In
addition, other instruments such as the microscope can be used to further assist scientific findings. Science is involved in every aspect of life, therefore, the importance of understanding the nature of science cannot be over-emphasised.

Scientists believe that events in the universe occur in regular patterns that are comprehensible through careful systematic study (AAAS, 1990). Also, that through the use of the intellect and various other tools, patterns in nature can be identified. Furthermore, scientists assume that the knowledge gained from studying one part of the universe is relevant to other parts. In other words, the whole system of the world is interrelated as knowledge of one aspect gives insight to the others, so the world can be viewed as a single system. However, science does not provide answers to all questions in life, but it can contribute to the discussion of some issues by identifying the consequences of particular action to assist in discovering the solution to the problem.

A major problem in our schools is that most teachers and learners do not have a good understanding of science and how to generate scientific knowledge. It is not enough for learners to learn about scientific knowledge which includes the facts, ideas, principles, theories and laws of science, as they should also endeavour to learn how these were established (Vhurumuku, Holtman, Mikalsen & Kolsto, 2006). Scientists have to undergo various activities to gather data to generate and substantiate new information. These include observation of nature using the five senses – sight, smell, touch, hearing, taste. Furthermore, they have to state hypotheses, conduct various experiments and analyse results from their findings. These activities are known as the scientific process and this needs to be understood in terms of the discovery and background of scientific knowledge to increase the perspective of this subject. The understanding of how science works enables the differentiation of science from non-science.

The nature of science is a crucial subject and it is essential that learners and teachers should have a good understanding and this cannot be generated or developed overnight, but results from a series of experiences with science. It could, therefore, be said that the previous knowledge of an individual plays a vital role in developing understanding of the nature of science. From these experiences, new facts, ideas,
beliefs, assumptions and values can be developed that relate to the scientific process, knowledge and how scientists carry out their work.

2.3.1 Definitions of nature of science

Before examining the definitions of nature of science, it will be beneficial to first identify some of the misconceptions about what it is and what it is not, as based on different experiences of people, there are a variety of definitions for the subject. In the 1960s, people tended to believe that understanding of the nature of science was the same as understanding scientific knowledge which is not correct. Having the understanding of the basic scientific concepts is not the same as having the understanding of nature of science, nor is the ability to perform scientific processes or apply the science process skills as believed in the mid-1960s up till 1970. It is possible for someone to be able to observe, state hypothesis, test predictions and carry out experiment and yet do not have understanding of the nature of science. It should be noted that there are different opinions about the nature of science.

The nature of science refers to the key principles and ideas which provide a description of science as a way of knowing, as well as characteristics of scientific knowledge. Many of these intrinsic ideas are lost in the everyday aspects of a science classroom, resulting in learners learning skewed notions about how science is conducted.

According to Vhurumuku et al. (2006), the understanding of the nature of science is defined by the ideas and assumptions related to scientific knowledge and the science process; it is not dependent on our knowledge of specific scientific laws or our ability to use science process skills. This implies that our understanding of nature of science is made up of the views, ideas, beliefs and assumptions we have about scientific knowledge. Understanding of Nature of Science is rooted in the ideas held about scientific observations and essentially, this includes comprehension of the concept that scientific knowledge has to do with a combination of both observation of the natural world and the scientists’ background, experience and biases. It is important to note that a perception of the role of experimentation is essential in developing a view of the nature of science.
Abd-El-Khalick, Bell and Lederman, (1998) defined the nature of science as the values and beliefs inherent in scientific knowledge and its development. Apart from the facts, laws and theories embedded in science, it also includes investigations, the attitudes, beliefs held by these scientists and the processes they used.

In this present age, it is important to be scientifically literate so as to know how to maintain and preserve our environment. For example, if we know the contribution of plants to our environment as suppliers of oxygen and preventers of soil from erosion, we will learn to treat our plants well and plant more trees where necessary. Science literacy will further help us to prevent pollution in our environment and protect ourselves from exposure to dangerous chemicals that could be harmful to human life. The nature of science is highly important in science literacy indicated in our Science curricula in schools.

2.3.2 Main ideas regarding the nature of science

There are some ideas, opinions and principles that are held to be true by scientists about scientific knowledge and scientific process. These principles are held as tenets of the nature of science which has to do with the nature of the world and knowledge that could be derived from it and these are crucial to understanding. The tenets are not in isolation but correlate with one another and characterise the nature of science (Bell, 2008; Peterson, 2011).

TENTATIVE BUT DURABILITY OF SCIENCE KNOWLEDGE: Change in knowledge is inevitable that is why modification of ideas, adjustment to observations and theories is allowed and not total rejection. It is possible for new theories to challenge the existing ones due to improvement in the technology and various instruments being used. Existing knowledge may be modified over time as previous finding are tested and challenged by scientists (Kuhn, 1996; Sterling, Greene & Lewis, 2002).

SCIENCE DEMANDS EVIDENCE: Scientific claims and facts are mainly based on evidence obtained through observations and measurements. Natural settings or experiments carried out in the laboratory can be used for the observations. Therefore, before scientific claims are accepted, observational or experimental evidence must be supplied to support the facts (Chen, 2006).
**NO UNIVERSAL STEPS IN SCIENTIFIC METHOD:** In science, there are no rigid steps to follow when conducting investigation or experiments. Some studies do not follow known scientific methods and yet are regarded as being of scientific value, however, certain procedures are necessary. Scientists often need to repeat experiments or observations before they can reach a conclusion and not necessarily through a sequential method (Chen, 2006; Chiapetta & Koballa, 2004; Hanuscins, Akerson & Phillipaon-Mower, 2006).

**THE DIFFERENCE BETWEEN AN OBSERVATION AND INference:** When we use our five senses to describe an event, it is called an observation. In addition, other instruments may also be used to aid our senses during observations, e.g. microscopes to magnify objects. Inference is when we make use of our past experience to make judgements based on what we have observed. An appropriate understanding of the nature of science should include the ability to distinguish between observation and inference (National Science Teachers Association, 2000).

**THE DIFFERENCE BETWEEN THEORY AND LAW:** In science, law describes what happens while theory explains why and how things happen (Vhurumuku et al., 2006). Laws are generated when occurrences are observed and supported by experimental evidence and describes relationships that can be observed or measured. For example, the first law of motion says an object remains at a state of rest unless an external force is applied and this is then explained by a theory. The explanation given for why and how an occurrence happened is known as theory and it must be consistent with what is observed. It has been discovered that several theories can be used to explain one observation.

2.3.3 Importance of teachers’ critical reflection on their own understanding of the nature of science

A teacher’s understanding of the nature of science will determine the success of teaching and learning of science in the classroom. A misconception of this subject by the teacher will cause learners to be taught only the scientific concept and neglects the scientific processes, as quality and content of reflection is significant for meaningful development and learning. A science teacher needs to constantly re-evaluate and reform existing theories in the light of new evidence due to development of technology
and science. The existing ideas, values, beliefs that form personal theories about science teaching and learning must constantly be reviewed as science knowledge is not static. It is important for teachers to critically reflect their own understanding of the nature of science because this develops through the teacher’s experiences with science over time. If a teacher examines his/her daily practices in the teaching of science, this can be used to develop his/her understanding of the nature of science. Reflection is a major tool for improvement and development in a teacher’s practice.

Teachers must develop resources to assist in the critical examination of their views of science teaching and learning and their own educational experiences (Nichols, Tippins & Wieseman, 1997). This requires innovative pedagogies, such as using classroom cases, to help teachers to construct and re-construct their knowledge about science (Irez & Cakir, 2006). Through critical reflection, learning and learning how to teach about NOS can be facilitated and also help to identify difficult areas and encourage teachers to discover the solutions to these problems to promote learning.

2.3.4 The impact of the knowledge of nature of science on teaching

It is a common saying that ‘you cannot give what you don’t have’. It is difficult to teach learners to appreciate the tenets of science, if the teacher does not have a thorough understanding of the nature of science. The teaching of nature of science in our science classrooms can only be achieved by well-trained, educated, informed and knowledgeable science teachers. Teachers differ in their opinion of the nature of scientific theories and processes therefore, their beliefs have great influence not only on lessons but also on the curriculum concerning the nature of scientific knowledge and has a great impact on the teaching process. This enables learners to be able to better engage in scientific process in addition to learning scientific concepts and to understand what characterises scientific knowledge and how it is derived. The insight of the teacher determines greatly how s/he engages the learners and conducts teaching in the science classroom. For example, if the teacher has the idea that scientific method must follow step by step procedures, it is difficult to adjust when the expected or desired result is not obtained. The teachers’ knowledge of the nature of science will also influence the decision on what is taught and how it is being taught in
the science classroom, particularly in determining whether a teacher will or will not include indigenous knowledge into the Natural Sciences classroom.

Proper understanding of nature of science is important in Science Education as it enables learners to think for themselves and be able to arrive at reasonable explanations and conclusions in matters with scientific dimensions. It will further enhance learners’ appreciation of science as an important element and correct various misconceptions. Also, adequate understanding will help learners to be well informed in their decision-making on science-based issues in their daily lives.

A proper understanding of the nature of science is essentially the notion that scientific knowledge is a combination of both observations of the natural world and scientists’ background, experiences and biases. An appropriate understanding of NOS should also include the ability to distinguish between observation and inference and it is important to note that the perception of the role of experimentation is highly essential in developing this view.

### 2.4 SOCIOCULTURAL THEORY

Sociocultural theory is mostly based on the work of Vygotsky (1978), a constructivist who views learning as best taking place in a social environment, and emphasizing semiotic tool mediation. It provides a complex description of the dynamic contexts and processes through which learning and development occur. Vygotsky emphasised that learning and development takes place through social interaction with people (Vygotsky, 1978). This means interactive learning whereby the educator and learner engage in talking or dialogue.

Sociocultural theory is a psychological theory that examines the importance of the contributions that society makes to individual’s development and stresses the importance of the interaction between developing people and their culture. Lev Vygotsky (1978) identified that the environment and community have great impact on the development of higher order functions in learners. This implies that society and environment of the learner contribute greatly towards learning of an individual. According to Vygotsky, ‘every function in the child's cultural development appears
twice: first, on the social level, and later, on the individual level; first, between people (inter-psychological) and then inside the child (intra-psychological)’ (Vygotsky, 1978:57). Vygotsky was a great thinker whose work on cognitive psychology and education became popular after his death.

Sociocultural theory focuses on the influence of adults and peers on individual learning as well as the effects of cultural beliefs and attitudes on learning of an individual. It is a theory of development that stresses the importance of socialisation on cognitive development.

Sociocultural theory explains learning and development from the point of view that learning takes place through social interaction. This means interactive learning whereby the educator and learner engage in talking or dialogue. This is referred to as mediation. According to Vygotsky, mediation through social interaction is the engine that drives learning and development (Donald, Lazarus & Lolwana, 2006). Learning is viewed as a social and cultural activity, that is taking place when there is interaction between two or more people and cultural because the culture is passed on from generation to generation. For example, in a certain culture people do things in a particular way and this is passed on to all members of the community.

According to Grimberg and Gummer (2013), this is a view that asserts that the sociocultural perspective has significant implications for teaching, schooling and education. The important aspect of this evolving outlook on human development is that higher order functions stem from social interaction. Vygotsky (1978) argues that the external social world in which a child has developed must be examined when trying to understand the child’s development and not only the study of the individual.

Looking at the involvement of sociocultural theory to understanding the development of communication, Adamson and Chance (1998) argued that the Vygotskian approach has two notable features to social interactions. The first feature is cultural based in nature. Custodians of culture tend to set emerging actions of an infant in their own cultural knowledge and background (Trevarthen, 1988). They perceive a growing child’s expressions as important within the human scope and view them as cultural learners who desire the guidance of an expert (Rogoff, 1990). The second feature is the concept of a zone of proximal development which unveils a usual way of
developmental change whereby an elder offers support before the infant can undertake a particular task. The infant progressively becomes perfect and independent through many experiences of reinforced manifestation which helps to make meaning out of the culture. Given the comprehensive nature of sociocultural theory, its educational implications for assessment, curriculum and instruction are wide-ranging. For example, sociocultural theory—in particular, the notion of zones of proximal development—would suggest that learners are not empty because they have prior knowledge (actual knowledge), which must be built upon to arrive at their potential. In contrast to traditional and static procedures that focus on being teacher-centred, mediated learning is concerned with being learner-centred and encourages learners to construct their own knowledge with the help of a mediator. Furthermore, while traditional measures see learners as empty vessels that need knowledge inserted, mediated learning ensures learners are actively involved in their own learning.

Instructional implications to be derived from this are informed by a sociocultural perspective, learning is thought to occur through interaction, negotiation, and collaboration. While these features are characteristic of ‘cooperative learning’, instruction that is informed by sociocultural theory is different in that there is also attention to the discourse, norms and practices associated with particular discourse and practice within the communities. Instruction is to give support to learners so as to be actively involved in the activities and use of tools in a way that is steady with the practices of the community to which learners are being acquaint with (Vygotsky, 1978). These views are constant with inquiry-based approaches, both the teachers and learners are joint inquirers, though the teacher serves as a mediator or facilitator of learning for the learners.

Sociocultural theory is very significant and valuable to learning situations. It stresses mediation which is the brain behind successful learning. It recognises the culture and background of the learners and encourages them to be active participants in building their own learning.
KEY CONCEPTS OF CONSTRUCTIVISM AND LEARNING

Constructivism emphasises that knowledge is not passively received but is constructed when individual engages in talk and activities about shared problem (Donald, Lazarus & Lolwana, 2006). Learning is a process by which individuals are introduced to a culture by more skilled member of the community. This process entails that learners appropriate the ‘cultural tools’ (precautions, terms) through their involvement in the activities of the culture.

2.5.1 The Zone of Proximal Development (ZPD)

The Zone of Proximal Development (ZPD) is an important concept in sociocultural theory. Vygotsky (1978) clearly states that the zone of proximal development ‘is the distance between the actual development level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers’ (p. 85). It involves connecting the familiar with the unfamiliar. Prior knowledge plays a great role in zone of proximal development this during learning. Principally, it is comprised of all of the knowledge and skills that a person does not yet have access to, but is capable of learning with guidance (Donald et al., 2006) the actual and potential levels of development. The actual refers to those accomplishments a child can demonstrate alone or perform independently; in contrast to potential levels of development as suggested by the ZPD—what children can do with assistance. The ZPD was regarded as a better, more dynamic and relative indicator of cognitive development than what children accomplished alone. Vygotsky used ZPD as a symbolic tool for explaining the interactions between individuals and their environment (Kozulin, 1997). In summary, productive interactions are those which orient instruction towards the ZPD; otherwise, instruction lags behind the development of the child. ‘The only good learning is that which is in advance of development.’ (Vygotsky, 1978:89)
2.5.2 Higher mental function

The human mind is an efficient structure that helps in thinking and assimilation processes. It can both perform at a lower or higher mental function depending on the type of assistance available. Higher mental abilities are far beyond the lower mental abilities in that the mind is able to plan, organise, solve problems, retain information etc. When support or scaffolding is available, lower mental function can be converted to higher mental function (Vygotsky, 1978).

2.5.3 Mediated learning

The advancement of a child’s intellectual development is made possible with the aid of skilful individuals who give support to the child by making use of the tools of the culture (Rogoff, 1990). This is usually done through mediation whereby an expert individual offers a temporary support to a learner and gradually withdraws this support as mastery is attained. Mediation is a process of facilitating learning in which learners progressively obtain knowledge. The more knowledgeable expert takes on the role of facilitator of learning during mediation and this is not permanent.
2.5.4 Scaffolding

A scaffold is normally a temporary structure erected around a building to support the building process and is gradually removed as it ceases to be needed. This can be compared to what happens when teacher scaffolds key knowledge structures and learning strategies for their learners, which helps the learner to reach a higher level of understanding. During the process of scaffolding, the mediator initially gives examples of key knowledge structures and strategies to the learner. As the learner begins to master the understanding and to actively internalise it, the mediator slowly withdraws the level of help or assistance she gives (Donald et al., 1997). Scaffolding is a process of enhancing learners’ understanding; teacher takes the learners halfway before withdrawing the support.

2.6 EQUITY LEARNING

Equity can be explained in terms of impartiality and justice (Hatfield & Rapson, 2007). In education, equity has to do with the right to learn, equal treatment and non-discriminatory practices in teaching and learning processes. Furthermore, it involves the development of teaching methods and practices that will benefit all learners irrespective of their socio-economic background. Boys and girls must be given equal opportunities and equal treatment in school. Equity is important so as to have equal access to resources and opportunity in the country, to give learners the privilege to
become productive members of the society and to be able to raise useful citizens qualified to handle the affairs of the nation. A society with learning equity will give access to all to learn freely irrespective of race, gender, colour, socio-economy background. Inequity on the other hand is when you don’t get what you deserve, a situation whereby people do not have the same opportunities for learning.

Learning equity can be viewed in four different ways.

- as equity of access to learning opportunities, materials and resources;
- as fairness and balance in content being taught and perspective of materials and facilitation;
- as the quality of the actual learning experiences and the extent to which those experiences are made relevant to the learners’ day-to-day living;
- as adequacy and success of learning. This type of learning that meets individual’s needs and allows all learners to perform well and benefit from education. (Akiba, LeTendre & Scribner, 2007).

### 2.7 PEDAGOGICAL CONTENT KNOWLEDGE (PCK)

Content knowledge is essential but it is not sufficient for teaching practice. Also important is the understanding of methodologies to make teaching and learning effective, which is termed pedagogical knowledge. For learning and teaching processes to be effective, teaching requires a special combination of both content knowledge and pedagogical knowledge. This mixture is referred to as Pedagogical Content Knowledge by Shulman (Conley, 2010:9). It is the blending of the content and pedagogy into an understanding of how to best teach the content to make it meaningful for learners.

Koehler & Mishra (2006) further introduced Technological Knowledge which refers to the digital and non-digital technologies and tools teachers use in classrooms to make teaching and learning processes possible. They named the mixture Technological Pedagogical Content Knowledge (TPCK). According to Koehler, Mishra & Cain (2013), the TPCK structure presented in Fig 2.3 reveals the multifacedness of the relationships
between the three forms of knowledge namely; pedagogical knowledge, content knowledge and technological knowledge.

A successful teaching and learning process can only take place when content knowledge is successfully communicated to learners (Marzano, 2007). PCK allows teachers to make content knowledge accessible to the learners by making use of the most successful teaching strategies. This could be achieved by having a good knowledge of the scientific content and knowledge about teaching and learning.

Pedagogical content knowledge enables teachers to understand the learners, their background and misconceptions they have in connection with specific topics. Teachers are required to: a) understand and value learners’ language and cultural backgrounds b) have knowledge of the nature of science; and c) be able to connect science to the learners’ experiences (Lee & Fradd, 1998; Lee, 2004).

Shulman defined Pedagogical Content Knowledge as ‘the most useful forms of representation of (topics), the most powerful analogies, illustrations, examples, explanations, and demonstrations – in a word, the ways of representing and formulating the subject that make it comprehensible to others’ (Shulman, 1986:9). Shulman’s concept stresses that a good teacher possesses the ability to make the content knowledge available to the learners by transforming knowledge into an accessible form by making use of pedagogical knowledge. This will require a lot of work on the part of the teacher and experience acquired over time.

According to Shulman (1986), pedagogical content knowledge (PCK) also includes an understanding of what makes learning of specific topics easy or difficult: the conceptions and preconceptions that learners of different ages and backgrounds bring to the learning of those most frequently taught topics and lessons (Shulman, 1986). This knowledge of each topic is different for each and depends equally on the knowledge of the learners and the specific environment where learning takes place.

Pedagogical content knowledge involves knowing what teaching approaches fit the content and, likewise, knowing how to arrange these elements of the content for improved teaching practice. This knowledge is not the same as knowledge in a discipline and equally different from the general pedagogical knowledge shared by teachers across disciplines. PCK is concerned with the representation and formulation
of concepts, pedagogical techniques and knowledge of what makes concepts difficult or easy to learn, comprehension of learners’ previous knowledge and theories of epistemology. It also involves knowledge of teaching strategies with appropriate conceptual representations, to address learner difficulties and misconceptions, and foster meaningful understanding (Killen, 2003). Furthermore, this involves awareness of what the learners bring to the learning situation that may be facilitative or dysfunctional for the particular learning task. Understanding learners includes insight into their strategies, prior conceptions, misconceptions and potential misapplications of previous knowledge, as well as the learners’ background.

Figure 2.3: Technological Pedagogical Content Knowledge (TPACK)
Source: Conley, 2010

Pedagogical content knowledge merges content knowledge and pedagogical knowledge (Conley, 2010). Thus, it does not refer to a simple consideration of both content and pedagogy, together but separate; but rather to an amalgam of content and pedagogy thus enabling transformation of subject matter into pedagogically powerful forms. PCK can be understood to signify how particular aspects of subject matter are organised, adapted and represented for instruction. If teachers are to be successful the issues of content and pedagogy need to be confronted simultaneously, making use of the strategies to teach the specific content knowledge. The manner in which subject matter is transformed for teaching is central to PCK and occurs when
the teacher interprets the subject matter, finds different ways to represent it and make it accessible to learners.

Pedagogical content knowledge brings about various methodologies which help the teacher to transform a particular topic into the form that is understandable to the learners. Teachers must understand the content intensely so as to identify what makes the topic difficult for learners, how to relate with other fields of knowledge and to everyday life, the misconceptions they brought to the classroom and the best teaching strategies to present the lesson. Pedagogical content knowledge research links knowledge to teaching with knowledge about learning forming a powerful knowledge base on which to build teaching expertise.

### 2.7.1 Facets of pedagogical content knowledge

Shulman (1986) defined ‘pedagogical content knowledge as teachers’ interpretations and transformations of subject-matter knowledge in the context of facilitating student learning’. He further proposed several key elements of pedagogical content knowledge also known as the facets of PCK:

- knowledge of science curricula (content knowledge);
- understanding of learners’ conceptions of the subject and the learning and teaching implications that were associated with the specific subject matter (learners’ knowledge of science);
- general pedagogical knowledge (teaching or instructional strategies);
- knowledge of assessment strategies;
- Orientation towards teaching science (Shulman, 1986).

A good teacher must master content knowledge to teach successfully and this will require knowledge outside of the class textbook by further researching the topic. Equally important is knowledge about teaching and learning known as pedagogical knowledge. Some academics are brilliant in their subjects but find it difficult to communicate this learning to others because they lack pedagogical knowledge. Also essential is knowing the learners, including knowledge of their background (social, economic), learning styles and previous knowledge on the subject matter so as to
accommodate diversity in teaching (Donald et al., 2006:18). Furthermore, understanding misconceptions and possible problem areas is essential.

2.7.2 Pedagogical Professional-Experience Repertoire (PaP-eR)

Every day, a teacher gains new experiences in teaching. Pedagogical professional experience repertoire (PaP-eR) provides a way of capturing the nature and complexity of PCK in totality and tends to explain the teacher’s skills in the teaching activities. This involves reflection which relates to the practice or day-to-day activities in the classroom as practice and professional development go hand in hand. PaP-eR offer narrative reports of a teacher’s PCK for a specific topic and reveals the thinking, reasoning and reflection on how to present a particular lesson in the classroom. The basis will be observations in the classroom, increased awareness of what is happening in your class and various notes made by the teachers, similar to case studies.

2.7.3 Content representations (CoRes)

Content Representations is one of the tools used to develop PCK (Loughran, Berry & Mullhall, 2006). This provides insight into the content chosen by the teacher and why, as well as how he approaches teaching a specific topic and set of learners. It comprises the ‘big ideas’ to be taught, the importance of this to the learners, teaching strategies and difficulties involved in teaching the ideas.

The centre of effective content teaching is the teachers’ pedagogical content knowledge. If the quality of teaching and learning is critical core content areas, then there is need to resist some old traditions in professional learning. Instead, the insights of experts who develop competence in subject-matter teaching should be recognised and expanded. Also, there should be commitment to high quality professional development targeted to develop this expertise. With this, there is support for the growth of the teacher as a person and a professional who can expertly lead a student to academic success.
2.7.4 Cultural Historical Activity Theory (CHAT)

CHAT – Cultural Historical Activity Theory originated from the work of Vygotsky and Leont’ev and was developed by Engeström and others who are disciples of Vygotsky (Kozulin, 1990). Vygotsky (1978) founded the cultural-historical psychology which served as the foundation for the present day Activity Theory. CHAT is a very practical approach and was developed by cognitive psychologists. They focussed on how to create understanding of the real world by drawing meaning or knowledge from various experiences and developing learning from those meanings. Inquiries that are based on CHAT combines three components:

- **System component** – this helps to draw meaning from situations;
- **Learning component** – this involves method of learning from those meaning that are constructed from situations;
- **Developmental component** – this enables an individual to expand those meaning in order to carry out activities.

Human beings engage in various activities on daily basis and each of these has its own objective and aims at achieving specific outcomes. An activity is carried out by using tools that will support its successful implementation. An activity is defined by the common outcomes towards which a team, a group, an organisation or something is working. There may be multiple goals or outcomes expected in an activity system. Kuuti (1994) defined activity as ‘a form of doing directed to an object’. He emphasised that transforming the object into an outcome by making use of mediating tools promotes the existence of an activity.

According to Engeström (1999), an ‘activity theory system is a multi-voiced formation. An expansive cycle is a re-orchestration of those voices, of the different viewpoints and approaches of the various participants’. Activity theory systems occur in cycles and is historical, so past cycles must be identified. It deals mostly with the description of meta theory rather than the prediction. The way the theory sees the activity systems goes beyond one actor or user, it is a collection of what goes on among the subject, object, the community, division of labour, tools that are used and roles of individuals involved in the activity system. It explains the roles of the artefacts motivations and
complexity of real life activity, issues of environment or community, history of the individual and the culture.

Activity theory aims to understand the mental capabilities of a single person. Nevertheless, it does not support or agree that an individual is an insufficient unit of analysis. One of the strengths of activity theory is that it serves as a bridge between the gap of an individual subject and social reality and helps in mediating activity by focusing on the practice (Scribner, 1997). It identifies the internalisation and externalisation of cognitive processes involved in the use of tools, as well as the changes or development brought about by the interaction. In activity theory, there are two stages. The first stage has to do with construction of knowledge. Collision or cognitive conflict usually results at this stage because new knowledge is conflicting with existing knowledge. The second stage has to do with internalising the new knowledge, reflecting on what is learned. The collision or cognitive conflict is hereby resolved at this stage.

The intention for the activity in activity theory is established through the tensions and conflicts within the elements of the systems.

Engeström (2001) shared some principles of CHAT which could be expanded to explain how CHAT works and how it can be used. In his first principle, he explained that the collective artefact which is a mediated and object-oriented activity system is the prime unit of analysis. With this, the artefact or tools used by the subject are used as a mediation tool to pass across the knowledge unto the object. The second principle is founded on the multi-voicedness of activity system, there is a community of multiple points of view, traditions and interest. The third principle is about the historical nature of activity system. This means that these activities take place over lengthy period of time. In the fourth principle, he pointed out that the central role of conflict as a source of change and development helps to make expansive learning to take place. No activity system is without contradictions and conflicts, that exist mostly between the community and the subject. Engeström stresses that conflict or tensions are common in these processes of learning a particular concept and activity system can be used as a lens through which one can observe these conflicts. Though he maintains that these tensions can be managed when they occur, they necessarily do occur (de Beer
& Henning, 2011). The fifth principle deals with the fact that there is the possibility of expansive transformations within the activity system.

### 2.7.5 Six elements of activity theory

Activity theory describes action through six inter related elements (Engeström, 1987) as seen in Figure 2.4.

- **Subject:** this is an actor engaged in activities. The subject is involved in engaging the object of the activity in a particular action. In a school setting, the subject can be the teacher. In this study, the subject will be the Natural Sciences teacher.

- **Object:** the object of an activity gives a determined direction, that which distinguishes one activity system from another is the difference in their objects. It is a set of purposes that help define and focus the activities within the system and help direct them towards the goal. The objects identified in this study are the development of teachers' PCK of the Natural Sciences teacher in order to effectively incorporate indigenous knowledge in the classroom and developing a more nuanced understanding of indigenous knowledge.

- **Artefact or Tools:** a tool is used to manipulate the environment to meet our needs. They can also be used to obtain information from the environment. Tools are used for accumulation and transmission of knowledge. They serve as instruments of mediation to pass across knowledge. Language is an important tool within the system. In the classroom, a tool can be power point, computer, games, pedagogy etc. Artefacts mediate all human action. Mediation between the subject and objects. A person’s actions upon objects are culturally mediated (Vygotsky, 1978). In this study, the tools are pedagogical content knowledge (PCK), CAPS and inquiry activities.

- **Community:** this describes those who are part of the group and are oriented towards the same object but are not directly involved with the specific action. In a classroom, the community involved will be learners, teachers, administration, principal etc. The community involved in this study includes the school, parents, Department of Education and learners.
- Rules: in a system, rules are essential because these serve as a guideline in the functioning and provide boundaries within the system. It includes the convention and rules regulating activities in the system. The rules applicable to this study include guidelines of NCS, rules of the school, general beliefs in the community, norms and values etc.

- Division of labour: involves division of activities among various actors participating in the system and linked to the roles of each person represented in the activities. This study provided the teacher as Mediator, Self-Directed Learner and an agent of change.

![Model of Activity System](image)

Figure 2.4: Model of Activity System
Source: Model of Activity System by Engeström (1987:78)

- Outcome: an activity is defined by the common outcomes towards which a team, a group, an organisation, a programme works towards achieving. There may be multiple goals or outcomes expected in an activity system. The outcome expected in the study is the effective inclusion of indigenous knowledge in the Natural Sciences classroom in a scientific rigorous way.

It is important to note that during the course of an activity there may be changes in roles. This implies that the person serving as the subject and members of the community may interchange their roles.

The model of activity system as shown in Figure 2.4 facilitates reflection on the part of the researcher who uses it, most importantly, when researcher plays a dual role of participant and observer in the study of activity system.
2.7.6 Conflicts within the activity system

Conflicts are fundamental concepts in activity theory and expose opportunities for creative innovations for new ways of structuring and enacting the activity. Engeström stated that within any human activity, conflicts or contradictions are inevitable, they emerge and evolve within and between each of the six corners of the activity model, i.e. subject, tools, object, rules, community and division of labour. Conflicts should not be seen as a sign of weakness, they are signs of richness, diversity and variety in the activity system and are not points of failure neither as obstacles to be overcome in order to achieve goals (Foot, 2001).

Conflicts may arise within components of an activity system and they are fundamental concepts in activity theory, example is when there are contradictions between rules and could also arise between components of an activity system, an example is between a community and the subject. Conflict can be experienced between activity systems, for instance tools used in an organisation and the community or the division of labour. It could have historical disturbance, which could be as a result of the difference between what is now and how it used to be, between a newly introduced tool and an old rule.

Tension could occur due to inappropriate or inadequate tools for the objects. In a classroom, tension or conflict could arise between the subject (teacher) and the community (administration or parents). For example, in a situation where the teacher requires a full period to teach a particular topic, the principal state the period for the day will be a half period due to sport activities taking place in the school that day.

CHAT can be used both as an object of research and also as a guide to practice. It is particularly useful as a lens in qualitative research methodologies, as it helps to provide understanding and analysis of a phenomenon, discovers patterns and makes inferences across interactions. It goes further to describe the phenomena and present the phenomena through a built in language about rhetoric. CHAT can help us to understand both the possibilities and the tensions in any system community which occurs at various times and places. It is useful as a reflection tool on the part of the researcher who is using it and helps to understand the mental capabilities of a single individual.
Theoretical substantiation of intermediate concepts

INTERMEDIATE THEORETICAL CONCEPTS
- TEACHERS’ PCK
- NATURE OF INDIGENOUS KNOWLEDGE (NOIK)
- NATURE OF SCIENCE (NOS)
- TEACHERS PROFESSIONAL DEVELOPMENT WITHIN COMMUNITY OF PRACTICE

Professional development within CoP

ANALYSIS
FOCAL DATA
(themes emerging from data)

Transcription of interviews, Selection of data, Pre-coding

RAW DATA
- VNOIK INSTRUMENT (PRE- AND POST-INTERVENTION)
- VNOS INSTRUMENT (PRE- AND POST-INTERVENTION)
- RTOP INSTRUMENT (FROM CLASSROOM OBSERVATION)
- INTERVIEWS
- ARTEFACT (LESSON PLAN)

Figure 2.5: Visual map guide of the interrelatedness of the intermediate theories
CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

3.1 INTRODUCTION

This chapter discusses the design strategies supporting this research study and the procedures, methods and techniques used for the collection of the primary data. Furthermore, the reliability and breadth of the data collection techniques will be analysed and build the platform to later assess the overall soundness of the conclusions.

This research study is design-based (DBR) which takes into consideration sound theoretical foundations such as the nature of indigenous knowledge and nature of science frameworks. A qualitative approach has been chosen because the researcher desires to understand meanings, describe and understand the lived experiences of teachers and their ideas, beliefs and values associated with Indigenous knowledge in the Natural Sciences classroom. The qualitative approach helps to understand the in-depth perspective of the participants and in addition, explores the meaning by observing in depth the process of how they include indigenous knowledge in their classrooms. Qualitative research does not only find out what happens but also why it happens and most essentially why it happens the way it does (Henning, 2004). The research methods were selected based on the problem investigated by this research, namely the teachers’ experiences in the inclusion of indigenous knowledge in the science classroom. Qualitative research is most appropriate when the researcher seeks to become more familiar with the phenomenon of interest, to achieve a deeper understanding of people’s views on a topic and to describe in great detail the perspectives of the research participants.

In qualitative study, the researcher strives to collect data in a non-interfering manner by attempting to study real-world situations as they unfold naturally without predetermined constraints or conditions that control the study or its outcomes.
(Merriam, 1998). Though findings in qualitative research are usually discussed in relation to existing knowledge, Oakley (2004) still warns that qualitative research requires that the biases, motivations, interests or perspectives of the researcher should be identified and be revealed throughout the study. This is because qualitative research acknowledges the researcher’s subjectivity and is inductive in nature.

This study is a design-based study with elements of phenomenology, since it focuses on discovering and expressing the essential characteristics of a certain phenomenon and capturing the participants’ lived experiences (Denzin & Lincoln, 2000). However, this is not a pure phenomenological study, since the researcher has pre-conceived theories informing this research. The main tools for data collection methods in this type of study are observation and interviews. Phenomenological strategies are particularly effective at revealing the experiences and perceptions of individuals from their own perspectives and, therefore, challenging structural or normative assumptions (Walsham, 2006).

According to Creswell (1998) a phenomenological study describes the meaning of the lived experiences for individuals about a concept or phenomenon. In the human sphere, this normally translates into gathering of in-depth information and perceptions through inductive qualitative research methods such as interviews and observation from the perspective of the research participants. However, as mentioned, the study is informed by constructivist theories such as CHAT, and this is why it is described as a design-based study with elements of phenomenology.

In addition, the chapter discusses the research methodologies and design used in the study including strategies, instruments, data collection and analysis methods, while explaining the processes involved in the study.

Classroom observation, face-to-face interviews, questionnaires and artefacts such as lesson plans were used as data collection methods. Furthermore, the justification for each of the data collection methods used in the study was discussed. Finally, in order to ensure trustworthiness of the research, appropriate criteria for qualitative research were discussed and triangulation was suggested and employed.
3.2 RESEARCH QUESTIONS AND OBJECTIVES

The formulation of research questions is of extreme importance in any research project (Yin, 1989) and requires deep insight into the field of the study because the research questions influence the method. Familiarity with the subject is a major tool that helps define an appropriate research question for a study. The researcher considered the questions to be answered were applicable to the research domain and would be useful in acquiring information to add to the existing body of knowledge.

RESEARCH QUESTIONS

The following six research questions guided this study:

1. How does the teachers’ pedagogical content knowledge (PCK) inform their infusion of IK in their teaching of natural sciences (NS)?

2. How do NS teachers experience teaching IK systems in the NS classroom, and what are the challenges that they face?

3. What are the affordances of indigenous knowledge for the development of affective outcomes in the natural sciences classroom?

4. How does a short learning programme on IK change the pedagogy of teachers?

5. What is the role of a community of practice in assisting teachers in their professional development to incorporate IK in a scientific rigorous way?

6. What are the design principles that should inform such IK interventions (short courses)?

Having formulated the research questions, it is equally important to outline the objectives to guide what is to be achieved during the research work. The objectives state exactly which outcome measures are going to be used within their statements and are important because they help to guide the development of the protocol and design of study, and also have a role in sample size calculations and determining the power of the study. According to Henning, van Rensburg and Smit (2004), the objectives of the research have a great impact on the type of research methods to be
used. Clearly defined objectives enlighten the manner of the research. They summarise what is to be achieved and these include obtaining answers to the research questions.

Below are the objectives which linked up to the research questions to be able to establish the purpose of this research.

1. To determine whether NS teachers have the necessary pedagogical content knowledge to address indigenous knowledge in a scientifically sound way.
2. To identify the problems that teachers experience in including IK in their teaching using third-generation Cultural Historical Activity Theory (CHAT) as a lens.
3. To look at ways of introducing IK better and using it as tool to promote learning and arouse learners’ interest in the Natural Sciences classroom.
4. To determine how the short course on indigenous knowledge influence teachers’ pedagogy.
5. To establish what the role of communities of practice are in the professional development of teachers.
6. To distil design principles from the first cycle of interventions (short learning programmes) to inform the reconceptualisation of a second course.

3.3 RESEARCH DESIGN

The research design can be described as the logic or master plan that describes how the study is to be conducted and how all the major components of the research study - the samples or groups, measures, instruments of data collection and analysis, among other things, work together to address the research questions (Oakley, 2004; Creswel, 2009). The research design gives directions from the underlying philosophical assumptions and data collection. Mouton (2001) adds that research design is viewed as the actualisation of logic in a set of procedures that optimises the validity of data for a given research problem and that research design helps to plan, structure and execute the research to maximise the validity of the findings. The research design guides the type of evidence required to answer the research questions and also
establishes that the evidence obtained enables the initial research question to be answered as clearly as possible.

This study aims to explore science teachers’ experiences in the inclusion of indigenous knowledge in the Natural Sciences classroom. Therefore, a short learning programme aimed at developing their PCK to make it easy and practical to include this in their classroom was organised. The researcher is to determine whether the activity (short learning programme) makes a difference in the results for participants.

Johnson (1995:4) suggests that when engaging in research that probes for deeper understanding rather than examining surface features, a qualitative research method should be employed. He states that qualitative methodologies are powerful tools for enhancing our understanding of teaching and learning.

Qualitative research produces findings not arrived at by means of statistical procedures or other means of quantification. The qualitative researcher is looking for illumination, understanding, and extrapolation to problems and situations (Strauss & Corbin, 1990). They further suggest that qualitative methods can be used to better understand any new phenomena and can also be used to gain new perspectives on existing objects or more in-depth information that may be difficult to convey quantitatively. Unlike quantitative research, qualitative research is able to take full account of the many interactional effects that take place in social settings. Qualitative research reports are more meaningful because they are mostly rich with details and insights into the participants' experiences of the world.

Qualitative research methods are useful in providing rich explanation to complex phenomena, following up on unique or unplanned events and discussing the experience and interpretation of events by various participants with widely different understandings and roles; giving voice to those whose views are rarely heard; conducting initial explorations to develop theories and to generate and even test hypotheses; and moving towards explanations (Anastas, 2004). The best qualitative research is systematic and rigorous, and it seeks to reduce bias and error, and to identify evidence that discounts initial or emergent hypotheses.

Qualitative research approach is suitable for this study because it will help to understand the perspective of participants on the nature of indigenous knowledge and
nature of science and in addition help to explore the meaning of these two concepts and their inclusion in Natural Sciences classrooms. Furthermore, the qualitative approach will help to examine the process by which the teachers incorporate IK into their teaching of Natural Sciences because of its interpretive, naturalistic approach to the subject. It tries to make sense of and to interpret phenomena in terms of the meanings people ascribe to them.

This approach generally aims to understand the perceptions and experiences of teachers to the inclusion of IK in their classrooms.

![Diagram](image)

Figure 3.1: Research Design Process for Cycle 1 (developed by the researcher).

As shown in Fig 3.1, the six research questions were formulated to provide answers or solutions to the research problem and to achieve the objectives set out in this research. The first research question- how does the teachers’ pedagogical content knowledge (PCK) inform their infusion of IK in their teaching of natural sciences was addressed using the questionnaire, classroom observations, interviews and lesson plans during the pre-intervention stage. The second research question based on how the natural sciences teachers experience teaching IK systems in the natural sciences classroom and the challenges they face was addressed by the semi-structured interview with teachers. The interventions were designed to address the third question by looking at various ways of introducing IK for the development of affective outcomes in the NS classroom. The post-intervention was designed to answer the fourth and the
fifth research questions. The fourth question on how a short learning programme on IK change the pedagogy of teachers was answered using the questionnaire, classroom observation, interviews and lesson plans (artefacts). During the interviews teachers were asked about their support base, and the role of communities of practice (RQ5). The last question focused on the identification of design principles that should inform such IK interventions. Both the pre and post intervention helped to provide answers to all the research questions.

Figure 3.2: Research Design Process for Cycle 2: developed by the Researcher.

3.4 RESEARCH METHODOLOGY

As mentioned earlier, the nature of the problem domain greatly determines the research methodology that is greatly influenced by the research questions. The research method refers to research design and data collection methods (Myers, 2009). It is the strategy whereby data is collected and analysed, and the generalisations and representations derived from the data. Denzin and Lincoln (2005) assert that qualitative research is naturalistic because it attempts to study the everyday life of people involved and communities in their natural setting, hence it is particularly useful to study educational settings and processes. There is usually uncertainty about the dimensions and characteristics of problem until
the end of the study. According to Myers (2009), one purpose of qualitative research is to help researchers understand people and their social and cultural contexts. This allows the complexities and differences of phenomenon being studied to be explored and represented. Creswell (2003) states that qualitative research uses a variety of processes including different knowledge claims, enquiry strategies, data collection methods and analysis.

It is also generally recognised that qualitative researchers are concerned with procedures involved in the research and not only the outcomes or products. As a result, account of the procedures or events is more valuable than the research. When it is imperative that understanding an incident as a function of personal interaction, the views of those involved and how the processes are described to characterise the occurrence, qualitative approaches are more appropriate than quantitative designs to provide the insight necessary to understand the participants’ role and their perceptions of the experience (Fraenkel & Wallen, 2009:429).

Design-based research was chosen for this study because it allows researchers to test whether an educational practice or idea makes a difference for individuals (Creswell, 2002). It helps to determine the impact of a procedural activity or intervention on individuals. Using the design-based research method, this has the advantage of assisting in the development of innovative designs for learning interventions and at the same time increasing theoretical knowledge about education (Hung, 2011, Leeman & Wardekker, 2011, Wang & Hannafin, 2005). This is useful in this study because it aims to help in the development of an innovative approach to professional development of science teachers to integrate indigenous knowledge in the natural sciences classroom. According to Greyling (2007:38), the advantage of design-based research also includes understanding the nature of contextualised educational problems by working closely with practitioners to generate educational transformation. This study worked closely with science teachers in order to understand the challenges of integrating indigenous knowledge in the natural sciences classroom.

The essential processes in this study include classroom observation, interviewing, pre- and post-questionnaires administered during the short intervention programme and documenting in detail the unique experiences of individual teachers in the inclusion of
indigenous knowledge into their classroom. The processes and analysis of the resulting descriptive data were all viewed by the researcher as an observer in the study. This approach allowed for collection of rich data from the phenomena under study and gave the researcher an opportunity to take into account the views of the participants of the nature of science and Nature of Indigenous Knowledge. The researcher provided a qualitative description of their experiences and used inductive analysis of data as most appropriate because all these procedures enhanced the possibility for objectivity, which would have been lost if a quantitative approach were to be used.

Usually in Design–based research, research is conducted through repeated cycles of design, implementation, analysis and revision. The process of the design-based research used in this study was as follows:

**CYCLE 1- FIRST INTERVENTION AT MAYFLOWER**

1. Exploring teachers’ experiences of incorporating indigenous knowledge in the Natural Sciences classroom. This was the pre-intervention stage and was carried out through open ended questionnaire, observing the teacher’s lesson in the classroom, interviewing the teacher and analysing the lesson plans.

2. An intervention, in the form of a short learning programme offered by UJ, where teachers engaged with pedagogies to bring indigenous knowledge alive, in a scientific rigorous way, in the classroom. This took place in Gert Sibande District, Mpumalanga.

3. A post-intervention stage, where the focus was on whether transfer took place in the classroom. This was done through open-ended questionnaires, classroom observations, individual interviews with the selected teachers and analysing the presented lesson plans.

Based on this cycle, I have distilled design principles for such interventions, and this informed the second cycle.
CYCLE 2. SECOND INTERVENTION AT PIET - RETIEF

1. Evaluation of effectiveness of the short intervention programme by analysing the data collected during the first intervention to inform the redesigning, revision and refining of the plan for intervention 2.

2. The pre-intervention stage was undertaken through open-ended questionnaires, observing the teacher’s lesson in the classroom, interviewing the teacher and going through the lesson plan. This included exploring teachers’ experiences of incorporating IK in the Natural Sciences classroom.

3. An intervention, in the form of a short learning programme offered by UJ, where teachers engaged with pedagogies to bring IK alive in a scientific rigorous way in the classroom. This took place in Gert Sibande District, Piet Retief, Mpumalanga.

4. A post-intervention stage, where the focus was on whether transfer takes place in the classroom. This was done by going through the processes I carried out in the pre-intervention stage.

This study also captured the ‘lived experiences’ of a selected group of four teachers from both cycles. For this purpose, in-depth personal interviews with Natural Sciences teachers was done. Data was collected by means of open-ended questionnaires designed to determine teachers’ views of the nature of science, as well as of and the nature of indigenous knowledge systems, classroom observations, artefacts in form of lesson plans and focussed personal interviews. These methods have been chosen for this study because they will give richness of data, clear and detailed account of actions, spoken and written text (Creswell, 2009).

The collection of qualitative data sources includes observation and fieldwork, interviews and questionnaires, documents and texts, and the researcher’s impressions and reactions (Myers, 2009). Collection of data in qualitative research is mostly derived from direct observation of behaviours, from interviews, written opinions or public documents (Sprinthall, Schmutte & Surois, 1991). Other sources of data include written descriptions of people, events, opinions, attitudes and environments or combinations of all these.
3.5 SAMPLING

In this study, purposeful sampling was used for data collection. When using qualitative research approach, the sampling method chosen has a notable effect on the quality of the research. The qualitative research has a principle of appropriateness which demands purposeful sampling and participants who are well informed and willing to share with the researcher (Morse, 1991). This has informed the choice of this sampling method employed here whereby teachers from semi-rural and very rural areas were selected to participate in the study. Patton (2002) establishes that the logic and power of purposeful sampling lies in selection of information-rich cases for in-depth study. Information-rich cases are those that provide the most information about the issues that are of central importance to the research. Merriam (1998) adds that purposeful sampling takes place when the researcher selects a sample, which provides the most material. Merriam and Tisdell (2016:97) also state that the researcher should aim to do sampling to “highlight what is typical, normal, and average”. In this study, the participants were selected according to the needs of the study and to give more credibility to the study. In this case, science teachers (mostly Natural Sciences teachers) were chosen. Eleven teachers participated in the first intervention while fourteen teachers participated in the second intervention. Purposeful sampling seeks information-rich cases to be studied extensively (Patton, 2002). The participants chosen were teaching Grade 8 and 9 Natural Sciences and agreed to participate in the research and the location was convenient and accessible for the researcher. Merriam and Tisdell (2016) remind us that a suitable sample should result in data saturation, and during the analysis I realised that data saturation has indeed been achieved.

3.6 RESEARCH INSTRUMENTS

The research instruments are the various methods of data collection used to collect data that answers the research questions as these determine which research instruments will be used in collecting data. For this hybrid qualitative study, with elements of both design-based research and phenomenology, multiple data collection
instruments were used (Creswell, 2008:74; Henning et al., 2004:32). This was guided by the fact that this research is majorly qualitative and basically phenomenological in nature and requires the use of instruments that will be able to collect in depth and rich data. In this study, interviews, classroom observation, questionnaires and artefacts (lesson plans) are used for data collection.

3.7 INTERVIEWS

Interviews provide the opportunity for face-to-face discussion with human subjects. Questions can be open-ended or closed. Open-ended questions provide a detailed idea of the variety of people’s opinions and feelings on the issue, enhancing their ability to think and explain in more detail and express their views more clearly. Closed-ended questions limit responses and prevent participants from freely exploring their real feelings or values. Furthermore, interviews help to unlock hidden feelings and emotions that could not be discovered through the use of questionnaires. Interviews are conducted to ensure that the participants can describe their experiences in an unconstrained manner, free from perspectives of the researcher or past research findings (Creswell, 2002). It also has the advantage of providing useful information when the researcher cannot directly observe the participants. The interviewer can pursue specific issues of concern leading to focussed and constructive suggestions thereby making the interview both significant and productive (Schneiderman & Plaisant, 2005). They further suggested that the use of interviews helps to obtain detailed information from the participants and with only a few participants, rich and detailed data could still be gathered. The direct contact with the participants often leads to specific, constructive suggestions. Interviews can be unstructured, structured, and semi-structured with individuals or may be focus-group interviews based on the need and the design of the research.

This study made use of semi-structured interviews to collect data with the characteristics of both structured and unstructured interviews and basically uses open-ended questions. This offered the advantages of both types of interview. For the purpose of consistency with all participants, the researcher has a set of semi-structured core questions for guidance so that the same areas are covered with each
participant. This allowed the researcher to use a more flexible approach when necessary by changing the sequence and wording of the questions as suggested by Johnson and Christensen (2008). As the interview progresses, the participant is given the opportunity to elaborate or provide more relevant information if he/she wishes to go further. The interview was conducted one-on-one with the participants in a quiet place to avoid distractions for approximately 40 minutes. Permission was sought from each participant to allow the recording of the interview so as to be able to make accurate transcriptions.

The interview guide for the semi-structured interview consisted of twelve questions as presented below:

### 3.7.1 The questions for the semi-structured interview

1. What do you understand by indigenous knowledge?
2. How do you incorporate indigenous knowledge in your teaching?
3. How does indigenous knowledge differ from Western Science?
4. What is your view on nature of science?
5. Why should indigenous knowledge receive consideration in natural sciences classroom?
6. What are the methodology and skills you use to incorporate indigenous knowledge in your lessons?
7. What are your experiences with the inclusion of indigenous knowledge in your lesson?
8. Where do you get information and relevant materials on indigenous knowledge?
9. How do you view the training that you received at university or college? Did it prepare you to teach indigenous knowledge?
10. How do learners and colleagues experience indigenous knowledge?
11. What support structures are available to help you in incorporation of indigenous knowledge?
12. How do you manage to infuse indigenous knowledge in a multicultural classroom?
3.7.2 Questionnaires

Questionnaires often seem a logical and easy option as a way of collecting information from people. As with interviews, closed or open questions can be used and respondents can be offered multiple choice questions to choose the statement which closely describes their response. Unlike interviews, a questionnaire has the advantage of capturing a wider audience but has the disadvantage that it cannot be customised to individuals as is possible with other methods of data collection. In this research, a structured open-ended questionnaire was used to enable participants to express their feelings. Qualitative methods ask mostly open-ended questions that are not necessarily worded in the same way with each participant. With open-ended questions, participants are free to respond in their own words, and these responses tend to be more complex than simply ‘yes’ or ‘no’ or ‘true’ or ‘false’ or choosing from multiple choice. Lederman et al. (2002) states that open-ended questionnaires avoid the challenge for participants feeling forced into making choices and allows them to explain their own views regarding the nature of science. Therefore, they advocate the use of open-ended questionnaires in order to gain an in-depth understanding of teachers’ views of the nature of science. Open-ended questionnaire enables participants to answer in their own words and express opinions without restrictions. In this regard, opinions are sought rather than numbers.

Four types of open-ended questionnaires were administered during this study to collect data. The first questionnaire developed by Abd-El-Khalick (1998) was used to determine the views of the teachers on the nature of science, the second questionnaire was used to determine the views of science teachers on the nature of indigenous knowledge (an instrument developed by Cronje et al., 2015) before and after the intervention. A third questionnaire was used before the intervention in order to determine how teachers integrate indigenous knowledge in their classrooms and the related challenges they experience. The last questionnaire was used after the intervention to determine how the teachers experienced the intervention, as well as suggestions for improvement of the intervention.
### 3.7.2.1 Questionnaire 1: Views on the Nature of Science (VNOS) questionnaire

**VNOS – Form C**

**Instructions:**
- Please answer each of the following questions. Include relevant examples whenever possible.
- There are no ‘right’ or ‘wrong’ answers to the questions. We are only interested in your opinion on a number of issues regarding science and indigenous knowledge.

1. What, in your view, is science? What makes science (such as physics, biology, etc.) different from other disciplines of inquiry (such as religion, philosophy etc.)?

2. What is an experiment?

3. Does the development of scientific knowledge require experiments?
   - If yes, explain why.
   - If no, explain why.

4. After scientists have developed a theory (for example the atomic theory, cell theory), does the theory ever change?
   - If you believe that scientific theories do not change, explain why.
   - If you believe that scientific theories do change explain why.

5. Is there a difference between a scientific theory and a scientific law? Explain the difference.

6. Science textbooks often represent the atom as a central nucleus composed of positively charged particles (protons) and neutral particles (neutrons) with negatively charged particles (electrons) orbiting the nucleus. How certain are scientists about the structure of the atom? What specific evidence do you think scientists used to determine the structure of the atom?

7. An athlete regularly competing in marathons struggles with cramps in his legs during the last part of a marathon and can sometimes not complete a marathon due to this. The athlete decides to consult a sports scientist to determine why his legs cramp during the last part of a marathon. What methods do you think will the sports scientist apply to assist the athlete and what possible advice do you think will he give the athlete?
8. AIDS causes much suffering among the people of South Africa. The government and other organisations are trying to help people cope with the disease. However according to the media, some scientists say that the HIV virus causes AIDS, while other scientists say that the HIV virus is not the cause of AIDS. How are these different conclusions possible if both groups have access to and use the same set of data to derive these conclusions?

9. Some claim that science is infused with social and cultural values. That is, science reflects the social and political values, philosophical assumptions, and intellectual norms of the culture in which it is practised. Others claim that science is universal. That is, science transcends national and cultural boundaries and is not affected by social, political, and philosophical values, and intellectual norms of the culture in which it is practised.

   - If you believe that science reflects social and cultural values, explain why.
   - If you believe that science is universal and not affected by other values, explain why.

10. Scientists perform experiments or investigations when trying to solve problems. Other than the planning and design of these experiments or investigations, do scientists use their creativity and imagination during and after data collection?

   - If you say yes, then at which stages of the investigations do you believe scientists use their imagination and creativity: a) during planning and design? b) during data collection? c) after data collection? Please explain why scientists use imagination and creativity.
   - If you believe that scientist do not use imagination and creativity, please explain why.

Figure 3.3: Views of nature of science questionnaire, Form C (VNOS – C).
Source: Adapted from Lederman, et al. (2002:509) and Dekkers & Mnisi, (2003:24)

3.7.2.2 Questionnaire 2: Views on the Nature of Indigenous Knowledge (VNOIK) Questionnaire

VNOIK questionnaire

Instructions:
Please answer each of the following questions. Include relevant examples whenever possible.
There is no ‘right’ or ‘wrong’ answer to the questions. We are only interested in your opinion on a number of issues regarding indigenous knowledge.

1. In your view what is indigenous (or traditional) knowledge? What makes indigenous knowledge different from other types of knowledge systems (such as Western knowledge)?

2. Practitioners of indigenous knowledge (e.g. elders, herbalists, traditional healers) observe nature to generate knowledge. Do they do experiments and tests in order to verify or validate this knowledge?
   - If yes, explain how they test or validate their knowledge
   - If no, explain why not.

3. Practitioners of indigenous knowledge observe nature and give explanations about their observations. Elders in a community can, for example, explain where lightning comes from. Do the elders always use natural causes to explain their observations such as lightning, or do they sometimes include supernatural causes in their explanations?
   - If they only use natural causes, explain why and give examples of some of the causes.
   - If they sometimes use supernatural causes, explain why and give examples of some of the causes.

4. Indigenous knowledge is transferred from one generation to the next over many decades and centuries. Does this knowledge stay the same or does it change over time?
   - If yes, explain why it stays the same
   - If no, explain the causes of such changes

5. *Hoodia gordonii* is a plant that was used by Khoi-San hunters to suppress their hunger and thirst when they went on hunting expeditions. How do you think the Khoi-San people come to know that this particular plant has these properties?
6. Sustainable development is an emerging concept that includes topics such as hunger, poverty and underdevelopment. Globally governments and organisations struggle to find solutions for these important issues. **Do you think** indigenous knowledge can be used to alleviate some of these problems?

   - If you say yes, please explain why and how indigenous knowledge can be used to solve these problems
   - If you say no, please explain why it cannot be used to solve these problems

7. An athlete regularly competing in marathons struggles with pain in his legs during the last part of a marathon and can sometimes not complete a marathon due to this. The athlete decides to consult a traditional healer to determine why his legs pain during the last part of a marathon.

   - What methods **do you think** the traditional healer will apply to diagnose the problem when consulting with the athlete?
   - What possible treatment or advice **do you think** he will give the athlete?

8. Myths are stories that are told in different cultures by elders from one generation to the other. **Do you think** myths and rituals play any important role in indigenous knowledge systems?

   - If yes, explain why and provide examples.
   - If no, explain why and provide examples.

9. Some claim that indigenous knowledge is infused with social and cultural values. That is, indigenous knowledge reflects the social and political values, philosophical assumptions, and intellectual norms of the specific culture in which it is practised. Indigenous knowledge is thus generated locally and can only be used in a specific area. It cannot be used universally in other contexts or globally to solve different problems.

   - Do you believe that indigenous knowledge reflects the social and cultural values of a specific community? Explain with the use of examples how indigenous knowledge reflects the social and cultural values of a local community.

   - Do you believe that indigenous knowledge can only be used in a specific area or do you believe it can be used in other areas or globally to solve problems? Explain your answer with examples.
10. Indigenous knowledge is passed from one generation to the other by elders. The elders are deemed very important and some people believe their ways of knowing (knowledge) is truth and cannot be challenged. Does this mean that current practitioners of indigenous knowledge must use this knowledge exactly as it was passed on to them, or can they use their creativity and imagination to modify the indigenous knowledge to solve current problems?

- If you say yes and believe that indigenous knowledge practitioners cannot change this knowledge, explain why. Use examples if possible.
- If you say no and believe that indigenous knowledge practitioners can change and modify their knowledge, explain why. Use examples if possible.

Figure 3.4: Views on the nature of indigenous knowledge questionnaire (VNOIK). Cronje, De Beer & Ankiewicz (2015)

3.7.2.3 Relating VNOIK Questions with nature of indigenous framework

As discussed in Chapter Two, the tenets of the nature of science framework when compared with nature of the indigenous knowledge framework nature of indigenous knowledge (NOIK) have many similarities, as the indigenous knowledge framework was developed to relate to and complement the framework it, but at the same time not compromising the important methods of comprehending indigenous knowledge. Table 3.1 explains the main tenets of NOIK and how it relates to the nature of science framework.

Table 3.1 Relating VNOIK questions with nature of indigenous knowledge framework (Cronje, De Beer & Ankiewicz, 2015)

<table>
<thead>
<tr>
<th>Tenet no.</th>
<th>Explanation of tenet</th>
<th>Related VNOIK Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>That indigenous knowledge is empirically and metaphysically based</td>
<td>1,5,8</td>
</tr>
<tr>
<td>2</td>
<td>That indigenous knowledge is resilient yet tentative</td>
<td>1,8,10</td>
</tr>
<tr>
<td>3</td>
<td>That indigenous knowledge is inferential yet intuitive</td>
<td>1,5,7, 8</td>
</tr>
<tr>
<td>4</td>
<td>That indigenous knowledge is creative and mythical</td>
<td>8,10</td>
</tr>
<tr>
<td></td>
<td>Statement</td>
<td>References</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>5</td>
<td>That indigenous knowledge is subjective</td>
<td>7,8,9</td>
</tr>
<tr>
<td>6</td>
<td>That indigenous knowledge is social, collaborative and cultural</td>
<td>8, 9, 10</td>
</tr>
<tr>
<td>7</td>
<td>That indigenous knowledge is wisdom in action</td>
<td>1,5,8</td>
</tr>
<tr>
<td>8</td>
<td>That indigenous knowledge is applicable and functional</td>
<td>5,7,8,10</td>
</tr>
<tr>
<td>9</td>
<td>That indigenous knowledge is holistic by nature</td>
<td>7,8</td>
</tr>
</tbody>
</table>

### 3.7.2.4 Third questionnaire: Teacher reflection on teaching IK

The third questionnaire consisted of three open-ended questions administered before the short learning intervention programme to determine why and how indigenous knowledge should be included in the Natural Sciences classroom. Also to find out if they experience any problem in its inclusion.

The questions are as follows:

1. Why should indigenous knowledge be taught or why it should not be taught in the classroom? Give a reason for your answer.
2. Briefly explain how you include indigenous knowledge in your lessons.
3. What are the problems that might prevent you from including indigenous knowledge in your classroom?

### 3.7.2.5 Fourth questionnaire: feedback on the IK Course

The fourth and the last questionnaire consisted of three open-ended questions and was administered after the short learning intervention programme to determine how these have equipped teachers to include indigenous knowledge in their classrooms. The following were the questions:

1. Why should indigenous knowledge be taught or why should it not be taught in the classroom? Give a reason for your answer.
2. Will you be better equipped in future to teach indigenous knowledge in your classroom? Does this course assist you in your professional development?
3. What were the highlights of this course for you?
The research was designed in such a way that the teachers (participants) did complete the PRE and POST VNOS and VNOIK questionnaires for the two cycles.

3.7.3 Observations utilising the reformed teaching observation protocol

An observation of participants in the context of a natural setting is the classic form of data collection in naturalistic or field research (Savage, 2000 & Goodwin, 2003). Observational methods assist in directly evaluating teachers’ involvement and engagement in the teaching and learning processes taking place in the Natural Sciences classroom. The use of observational data in this research is for the purpose of description of settings, activities, people and the meanings observed from the perspective of the participants. Observation helps to get deeper understandings than interviews alone, as it provides the context in which events occur and may enable the researcher to see things that participants themselves are not aware of, or that they are unwilling to discuss (Patton, 2002). Furthermore, observational data is very useful in discovering the discrepancies between what people say and what they actually do in the real sense. Observation is done to fully understand the real situation and experiences of NS teachers when including IK in their classrooms. In this research, the researcher was a passive observer and did not interact or interrupt the lessons. In the observation process, data collected contained enough descriptive material: did the transfer of new knowledge and skills take place and what difficulties were experienced in teaching IK? Participant observation is appropriate for collecting data on naturally occurring behaviours in their usual contexts.

The researcher played the role of an observer using observational methods of data collection and evaluation. This was done by watching how the teachers engaged with their learners to include indigenous knowledge in the Natural Sciences classrooms.

This method has the advantage of directly evaluating how the teachers encourage the learners’ involvement and engagement in the learning environment and in regards to the inclusion of indigenous knowledge in the Natural Sciences classrooms. Furthermore, it offers unique insight into the experiences of the teachers in the inclusion of indigenous knowledge, the challenges they face and whether they have the necessary PCK to be successful.
In order to structure the classroom observations, the Reformed Teaching Observation Protocol (RTOP) instrument was used (Appendix E). The RTOP provides a direct measurement of changes in teaching practice, as it is a standardised means for detecting the degree to which classroom instruction uses learner-centred approach (Sawada, Piburn, Falconer, Turley, Benford, Bloom & Judson, 2000).

RTOP conforms with the principles of constructivism in that it encourages the active engagement of learners in constructing their own knowledge and establishes validity and reliability and has proven to be useful in measuring reformed teaching by various researchers (Adamson, Banks, Burtch, CoxIII, Judson, Turley, Benford & Lawonson, 2003).

The RTOP has 25 items that are rated on a five-point scale ranging from (0) never occurred to (4) very descriptive. The total scores range from 0 to 100 with higher score reflecting a higher degree of reform. The form is categorised into five parts, the background information, contextual background and activities, lesson design and implementation, content and classroom culture. The form is also designed to accommodate thoughts and concerns of the observers after each item. This helps to achieve higher degree of consistency while using the RTOP.

I. Background Information: this gives the opportunity to provide essential information about the location of the class, grade level taught, the teacher, duration of observation and the subject.

II. Contextual Background and Activities: this describes the classroom setting, the lesson observed, relevant details about the learners and the teacher.

III. Lesson design and implementation: this is the first set of items to be rated. It should be noted that the rating can be done after the lesson has been observed through the video recording. This contains five items to be rated.

IV. Content: this is viewed in two ways.

a) Propositional Knowledge - the knowledge of what is, the level of abstraction and significance, the understanding of the teacher as per the lesson content and how the content is connected or related with other disciplines and day-to-day living of the learner. It is made up of five items to be rated.
b) Procedural Knowledge - this is how, it involves the various processes, learners engage in to arrive at conclusion and evaluate knowledge claims. This also contains five items to be rated.

V. Classroom Culture: this is the last section and consists of two parts. These are:
   a) Communicative Interactions: the form of interactions taking place in the classroom. A classroom where only the teacher talks is teacher-centred whereby a classroom where learners can interact among themselves and interact with the teacher is learner-centred. Here there are five items to be rated.
   b) Student/Teacher Relationships: intends to reflect whether the teacher encourages learners to be actively involved/participate in learning and serves as a support to enhance learners’ investigation. Five items are given to be rated here.

3.7.4 Artefacts (Lesson plans)

Lesson plans from the teachers interviewed were collected to establish the evidence that indigenous knowledge was included in their lessons. The lesson plan is a form of document that shed more light on the phenomenon under investigation. Documents could provide a valuable source of information if they are available as long as they are connected with the research questions (Henning et al., 2004). According to Nieuwenhuis (2007), written documents include published and unpublished documents, letters, reports, agendas, lesson plans and any other documents relevant to the research. In addition, he mentions that documents could serve to corroborate the evidence from other sources.

3.8 DATA ANALYSIS

Qualitative data analysis is linked to working with data, organising it, placing it in manageable units, synthesising it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others (Bogdan &
Data analysis involves the inspection, transformation and modelling of the collected data with the aim of discovering useful information to make conclusions and supporting decision-making. Raw data collected is transformed into useful information with data analysis. The choice of qualitative data analysis is determined by combinations of factors which range from the types of research questions being asked to the theoretical framework of the study and the appropriateness of the technique for making sense of the data (Cohen, Manion & Morrison, 2000). An important aspect of data analysis in qualitative case study is the search for meaning through direct interpretation of observations by and the experience of the researcher. Furthermore, data is collected and analysed to answer the research questions. The aim of analysis of qualitative data is to discover patterns, concepts, themes and meanings (Mouton, 2001). Qualitative research involves the use of inductive analysis of data reflecting the critical themes emerging out of the data (Patton, 2002). Analysis of qualitative data requires creativity, for the challenge is to place the raw data into logical, meaningful categories, to examine it holistically and to communicate this interpretation to others. Qualitative data analysis centres on the interrelated aspects of the setting, group or participants under investigation, as a whole case and not in separate parts.

When analysing qualitative data, it is important to remember that people differ in their experience and understanding of reality and that a social phenomenon cannot be understood outside of its context. The researcher must understand that human behaviour emerges slowly and non-linearly and that qualitative research describes phenomena or generates theory grounded on data. Researchers should look for exceptional cases that may yield insights into a problem or new data for further inquiry (Miles & Huberman, 1994).

The analysis is started with recognition of the themes emerging from the raw data which is known as open coding (Strauss and Corbin, 1990). During open coding, the researcher will identify and tentatively name the conceptual categories into which the phenomena will be grouped. This is aimed at creating descriptive, multi-dimensional categories which are the preliminary framework for analysis. Words, phrases or events that appear to be similar are grouped into the same category. These categories may be gradually modified or replaced during the subsequent stages of analysis. To ensure
data integrity, it is important that there is accurate and appropriate analysis of research findings.

3.8.1 Analysis of the interviews

In this study, the interviews with individual teachers were recorded and transcribed. Some open-ended questions were posed for the participants. Domegan and Fleming (2003) state that open-ended questions may only be categorised after the data has been collected. It was later transcribed word for word and the Saldana coding technique was used to analyse the data. After coding, similar codes sharing same traits were grouped into subthemes and these grouped into themes. Coding involves assigning each individual response with a value, normally a numerical value. It should be noted that coding is more than just labelling, as it leads the researcher from the data to the idea, which in turn, leads to all data relating to the identified idea (Richards & Morse, 2007:137). This open coding was undertaken manually as codes and themes were not predetermined and the three types of coding as explained by Saldana (2009) were used. These are in-vivo involving the use of exact word or quote from the participants as a code; descriptive coding summarises the words of the participants and value coding searches for attitudes, values and reflections of participants in data. During these processes useful information can emerge that is closely linked to their experiences. The individual responses were analysed, compared, categorised and subsequently triangulated and interpreted to draw conclusions.

3.8.2 Analysis of the VNOS questionnaire

The analysis of the VNOS questionnaire was done using the rubric developed by Cronje et al. (2015). This rubric uses three categories, the informed which carries two points, the partially informed which carries one point and the uniformed that carries zero point as indicated in the table below. The total points accrued by each participant are divided by ten which is the total number of questions to get the average. The average shows the overall view of the participants on the nature of science.
### Table 3.2: Anticipated responses to the VNOS questionnaire

<table>
<thead>
<tr>
<th>NOS aspect and VNOIK question no.</th>
<th>Informed view</th>
<th>Partially informed view</th>
<th>Uninformed view</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. What in your view is science</strong>&lt;br&gt;(Empirical aspect)</td>
<td>Exploring nature and its surroundings (plants etc.) and coming to a conclusion of how things work. Using one's senses to make observations and come to conclusions Knowledge or theories that can be tested by experiments, testing, thinking, repeatability Nothing is completely certain/subject to change Observational or experimental evidence to support knowledge claim, but does not establish absolute truth</td>
<td>Study of nature and its surroundings by using the process of observations, testing predictions. Facts based on proof Knowledge based on empirical evidence only Alludes to observations</td>
<td>The study of nature and its surroundings (earth, animals, plants) Everything is science. Knowledge that cannot change. How we study and understand nature Science is fact based and does not allow for personal views</td>
</tr>
<tr>
<td><strong>2. What is an experiment?</strong>&lt;br&gt;(Empirical aspect)</td>
<td>Scientists collect data in various ways and use this to explain ideas Supports rather than proves claims Cannot prove a theory or a hypothesis. It just discredits or adds validity to them Controlled way to test and manipulate objects while keeping all other objects the</td>
<td>There are certain steps to follow, but you can also use other methods Steps to follow to prove a theory/hypothesis</td>
<td>Is an exact method to follow scientific method Steps to follow to prove a theory/hypothesis</td>
</tr>
</tbody>
</table>
3. Does the development of scientific knowledge require experiments?
   If yes, explain why
   If no, explain why (Empirical aspect)

| 3. Does the development of scientific knowledge require experiments? | Experiments are not essential; some phenomena cannot be tested. Observation can also be used. Express belief in empirical basis for scientific knowledge, in contrast to at etc. BUT sees it as supportive but not able to prove scientific claims in any absolute sense. Sees scientific claims as a mix of observational, personal, social and cultural influences | Yes, scientific knowledge is based on experiments, but also on other influences | Yes, science cannot exist without experiments. Scientific knowledge is based entirely on experiments |

4. After scientists have develop a theory does the theory change?
   If yes, explain why?
   If no explain why? (Tentative, Difference between theory and law)

| 4. After scientists have develop a theory does the theory change? | Explains that science can change (including theories and laws). Theories are not the absolute truth and new information, data, other influences can change how scientists think of view phenomena. Also new technology | Some aspects of science can change for example theories, but laws cannot change. No mention is made of what (clear reasons) can make theories to change. Can change if new evidence is found | Science are facts that are proven and therefore theories cannot change |

5. Is there a difference between a scientific theory and a scientific law? Explain the difference. (Difference between theory and law)

| 5. Is there a difference between a scientific theory and a scientific law? Explain the difference. (Difference between theory and law) | Theories are used to explain phenomena using inferences. Theories cannot be directly tested. Laws are descriptive statements of relations between observable phenomena. Both are legitimate products of science. | Describes either law or theory correct, but some contradictory responses provided. | Theories become laws if new evidence comes to light. Implies that laws are superior to theories. Inappropriate description of both. Theories can change, laws cannot change. Theories are not tested yet. |
| 6. How certain are scientists about structure of atom. What evidence did they use? | Indicates that scientists interpret and make inferences in context and in relation to their own background. New data, technologies and cultural influences can cause science to change. | Alludes to fact that theories can change as new information comes to light. But laws cannot change. No mention is made of cause of change or contractions made. | Facts cannot change. Once a theory has been proven it cannot change. Scientists can see atoms. Very sure about structure of an atom. |
| 7. What methods do you think scientists apply and what advice? (Inferential) | Scientist will question, observe, run tests and based on all the investigations infer possible causes and advice. Can refer to indirect evidence. | Allude to scientist questioning the athlete, maybe run some tests to infer some answers. Can give definite answers. | Do not know. Scientists will run tests that will give him all the answers. Irrelevant answer |
| 8. Different conclusions possible from same set of data? (Theory-laden) | Mention that theories are robust but can change. Reasons can be due to new technologies or information that comes to light. Also refer to context and background of scientists. | Different conclusions can be to different due to different interpretations. Does not articulate why. | Scientists are objective. Cannot have different views. Differences in views due to unclear data. Further discoveries or study will lead to one correct view. Data that is not accurate or sufficient. |
| 9. Is science social and culturally infused or objective and universal? (Social & Cultural) | Agrees that cultural and social values and beliefs can have an influence. Explains on how it can have an influence and give examples. Refers to culture of science itself (rules of practice and evidence). Also influence of politics, religion, money etc. | Agrees that cultural and social values and beliefs can have an influence, but does not explain with example or contradicts. | Science is objective and should not be influenced by culture of social relations. |
10. Can scientists use creativity and imagination during data collection? (Creative and imaginative)

Indicates that creativity and imaginations are used by scientists all the time. During the whole process of observing and exploring nature. Resourcefulness in doing experiments, analysing data, making inferences and stating theories.

Creativity and imagination can play a role, but must be limited or avoided in some instances such as with data analysis or specific experiments. Creativity before scientific method is applied.

Creativity or imagination cannot play a role in science.

Refers to single scientific method.

Source: (Cronje, De Beer & Ankiewicz, 2015)

3.8.2 Analysis of the VNOIK questionnaire

The analysis of the VNOIK questionnaire was carried out by using the anticipated responses in conjunction with the rubric specially designed for this by Cronje et al. (2015). They identified three categories of responses, these are informed, partially informed and uninformed, just as the case with the VNOIS questionnaire analysis. Each question in the questionnaire has possible responses derived from literature on indigenous knowledge. The responses of each participant to each question was analysed by comparing these with the anticipated responses and then using the rubric to determine if the view is informed or partially informed or uninformed. The average for each participant was derived by adding the scores of all the total questions and dividing by total number of questions. This served as the overall view for the participant.
Table 3.3: Anticipated responses to the VNOIK questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Anticipated responses to questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>What indigenous knowledge is:</strong></td>
</tr>
<tr>
<td></td>
<td>Ways of knowing nature and skills by people living in a particular area (local) and society in order to enhance everyday lives</td>
</tr>
<tr>
<td></td>
<td>Derived from interactions between people and environment</td>
</tr>
<tr>
<td></td>
<td>Result of practical rendezvous in everyday life</td>
</tr>
<tr>
<td></td>
<td>Folk knowledge of flora and fauna</td>
</tr>
<tr>
<td></td>
<td>Cultural beliefs and history of their people – includes songs, rituals, dances, holy places</td>
</tr>
<tr>
<td></td>
<td>Spiritual beliefs (metaphysical) plays a big role, ancestors important</td>
</tr>
<tr>
<td></td>
<td>Include rituals, myths, customs and values</td>
</tr>
<tr>
<td></td>
<td>Mostly passed from one generation to the other orally, through imitation and demonstration, by paintings and artefacts</td>
</tr>
<tr>
<td></td>
<td>Collection of knowledge systems such as language, medicine, ecology, science, religion, agriculture, astronomy, architecture – more than just medicinal plants</td>
</tr>
<tr>
<td></td>
<td>Holistic and inclusive in nature – co-existence of spiritual, natural and human worlds</td>
</tr>
<tr>
<td>2</td>
<td><strong>Role of experiments?</strong></td>
</tr>
<tr>
<td></td>
<td>Facts generated by indigenous knowledge are derived through experimental observation and tests.</td>
</tr>
<tr>
<td></td>
<td>Generated through trial and error experiments, success and failure</td>
</tr>
<tr>
<td></td>
<td>Tested over many generations in the laboratory of life</td>
</tr>
<tr>
<td></td>
<td>Indigenous knowledge is empirical rather than theoretical knowledge.</td>
</tr>
<tr>
<td></td>
<td>Relies on intuition and evidence</td>
</tr>
<tr>
<td>3</td>
<td><strong>Natural and unnatural causes?</strong></td>
</tr>
<tr>
<td></td>
<td>Cannot separate indigenous knowledge from spirituality, beliefs and metaphysics</td>
</tr>
<tr>
<td></td>
<td>Explanations for observations in indigenous knowledge do not always have natural or logic causes that are predictable. Can refer to e.g. evil spirits, visions and myths in explanations.</td>
</tr>
<tr>
<td></td>
<td>Honouring of ancestors in explanations</td>
</tr>
<tr>
<td></td>
<td>The use of medicinal plants, for example, goes deeper than focussing on the chemical reactions occurring in the body, but consists of a holistic approach that includes the metaphysical and spiritual</td>
</tr>
</tbody>
</table>
### 4. Stays the same or changes over time?

Most of this wisdom in action is passed on over generations and stood the test of time (resilience), but each generation also adapts and adds change to this knowledge as their circumstances and environment changes in order to survive and solve problems. This new way of knowing is then passed on to the next generation.

Indigenous knowledge is fluid and transforming, constantly changing but often represented as static.

### 5. How is knowledge generated? *(Hoodia)*

- It is based on experience and needs that exist in everyday life.
- It is generated through trial and error.
- Tested over many generations and passed on from one generation to the next.
- Collective data base of observable knowledge.
- Repetition assists with retention.
- Ancestors or dreams inform traditional healers of elders on which plants to use.

### 6. Used to solve contemporary problems?

Indigenous knowledge is a source of wealth to solve current problems.

- Has a large role to play where modernisation has failed societies.
- Has stood the test of time, tested over centuries and can be used to solve contemporary problems.

### 7. Methods and advice?

**Methods:**

- Holistic approach – physical systems are examined holistically from social, historical and spiritual aspects.
- Importance of asking ancestors for help.
- Search for trigger that has created the disease in order to establish healing – may be metaphysical.

**Advice/treatment**

- Provide medicinal plants or *muthi*.
- Healing goes deeper than the medicine (*muthi*), includes energy and spirituality.
- Rituals and beliefs also play a role.
- Treatment is also holistic; addressing spiritual and physical.
### Role of myths

Indigenous knowledge is transmitted orally through stories and myths.

Imitation, demonstration and rituals play an important role.

Use of metaphors

Indigenous knowledge is made understandable through stories containing lessons.

### Reflect social and cultural values?

Indigenous knowledge does reflect social and cultural values of a specific community.

Knowledge is a critical part of culture, and adapted for a specific culture and environment.

Embedded in local social and cultural values of a certain group of people

Indigenous knowledge is situated within cultural traditions – it is not culture free.

**Applied locally or universally?**

Indigenous knowledge is transferred across communities, cultures and countries.

Threat of exploitation

Can be adapted to solve contemporary problems, but is unique to a given culture

If applied to other communities, functionality must be kept in mind

Sometimes distributed in fragments and not in totality

Contributions can be used to solve problems in different fields such as ecology, medicine, agriculture, mathematics, fisheries.

### Imagination, creativity

Indigenous knowledge is a living knowledge base and is dynamic and continually applying creativity and innovation to sustain the lives of people.

Generates new knowledge as new issues develop e.g. HIV/Aids

Indigenous knowledge is constantly being produced and reproduced.

Undergoes constant adaptation as needs of community change

---

*Source: (Cronje, De Beer & Ankiewicz, 2015)*
3.8.3.1 Rubrics for the VNOIK questionnaire

Unlike Lederman et al. (2002) who suggested two categories (informed and naïve) when coding teacher’s responses, Cronje et al. (2015) used three categories after realising that some participants had a view falling between informed and uninformed while analysing the questionnaires of the pilot group and therefore introduced a third category of a partially informed view.

Table 3.4: Rubrics for the VNOIK questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Informed view (I)</th>
<th>Partially informed view (PI)</th>
<th>Uninformed view (UI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mentions at least four of the anticipated answers or other tenets of indigenous knowledge</td>
<td>Mentions at least two of the anticipated answers or other tenets of indigenous knowledge</td>
<td>Mentions one or none of the anticipated answers or other tenets of indigenous knowledge</td>
</tr>
<tr>
<td>2</td>
<td>Answers yes, with an acceptable reason or example</td>
<td>Answers yes without explanation or with reason that is not acceptable</td>
<td>Answers no or not sure</td>
</tr>
<tr>
<td>3</td>
<td>Can include supernatural to explain causes. Gives examples of possible unnatural causes</td>
<td>Can include supernatural to explain causes. Does not give examples of possible unnatural causes or gives irrelevant explanation</td>
<td>Answers no just natural causes</td>
</tr>
<tr>
<td>4</td>
<td>Answers yes and no or yes, but, and explains the resilience of indigenous knowledge but that indigenous knowledge can be modified as needs of society changes</td>
<td>Answers just yes with correct explanation of why it stays the same or no with correct explanation of why it changes</td>
<td>Answers yes or not sure without any explanation</td>
</tr>
<tr>
<td>5</td>
<td>Comprehensive suitable explanation including at least two of the methods explained in Table 3</td>
<td>Short suitable explanation including at least one mentioned method in Table 3</td>
<td>Not sure or unsuitable explanation</td>
</tr>
<tr>
<td>6</td>
<td>Yes, with suitable explanation/ example</td>
<td>Yes, with no explanation or unsuitable explanation</td>
<td>Not sure or no</td>
</tr>
<tr>
<td></td>
<td>Provides one of the methods mentioned and advice/treatment</td>
<td>Provides either method or treatment/advice as suggested in Table 3</td>
<td>Not sure or unsuitable explanation</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>7</td>
<td>Suggests one of the possible responses in Table 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Answers yes with explanation or example</td>
<td>Answers yes without suitable explanation or example</td>
<td>Not sure or unsuitable explanation</td>
</tr>
<tr>
<td>9</td>
<td>Yes, it reflects social and cultural values plus explanation/example</td>
<td>Yes, it reflects social and cultural values plus explanation/example</td>
<td>No to both questions or unsuitable explanations</td>
</tr>
<tr>
<td></td>
<td>Believe it is universal/ transferrable/ partially transferrable with suitable explanation/example</td>
<td>Does not believe it can be transferred with no explanation</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Yes it can change with suitable explanation or it can be modified with explanation and/or example</td>
<td>Yes or partially but explanation is not suitable</td>
<td>Not sure or no</td>
</tr>
</tbody>
</table>

Source: *(Cronje, De Beer & Ankiewicz, 2015)*

### 3.8.4 Analysis of the classroom observation

The classroom observation was analysed with the help of RTOP, *(Sawada et al., 2000)*. The RTOP contains background information about the teacher, contextual background and activities with the description of the lesson observed. The relevant details about the learners and teachers were also included with the classroom setting. The RTOP was designed, piloted and validated by the Evaluation Facilitation Group of the Arizona Collaborative for Excellence in the Preparation of Teachers. It provides an operational definition of what is meant by reformed teaching especially in Mathematics and Sciences. RTOP uses a Likert scale that has ratings ranging from never occurred with zero (0) point to very descriptive with five (5) points *(Sawada et al., 2000)*.

The artefact (lesson plan) was critically examined to see how indigenous knowledge was incorporated in the lesson and to reveal deeper meaning by examining the
connection between the lesson plans and research questions to support evidence from other sources.

3.9 VALIDITY AND CREDIBILITY

Validity is a major concern in research work, as it reveals how the research findings match reality (Merriam & Tisdell, 2016). Various factors can render the research findings invalid, therefore, controlling these factors is a major concern and primary responsibility of the researcher. Validity in data collection ensures that the findings truly represent the phenomenon that the research claims to measure. Validity could be internal or external. Internal validity refers to the extent to which the findings accurately describe reality while external validity refers to the ability to generalise findings across different settings. This involves a trade-off between external and internal validity. One should be reminded of Maxwell’s (2013:121) concern that one can never really capture reality: “Validity is never something that can be proved or taken for granted. Validity is also relative: it has to be assessed in relationship to the purposes and circumstances of the research, rather than being a context-independent property of methods or conclusions”.

Credibility depends less on the sample size than on the richness of the information gathered and on the analytical abilities of the researcher. Credibility can be enhanced through triangulation of data.

The issue of reliability is equally important in qualitative research. There are three types of reliability as identified by Kirk and Miller (1986). These are the degree to which a measurement given repeatedly remains the same, the stability of a measurement over time and the similarity of measurements within any given time period. According to Peat (2002), there can be no validity without credibility.

To ensure reliability as earlier explained in Chapter One, detailed descriptions of sampling, data capturing and analysis were made to ensure that results are consistent with data collected guided by the standards for validity identified by Eisenhart and Howe (1992), namely:
Standard 1: A fit between research questions, data collection, procedures and analysis techniques.

Standard 2: Making credible reasons known for specific choice of subjects, data-gathering procedures and analysis techniques.

Standard 3: A clear description of the context of the study.

Standard 4: External and internal value constraints were discussed and the value of this study was highlighted.

3.9.1 Triangulation

Triangulation is a very important way of ensuring that data can be verified. This is a method that is useful in increasing validity of findings through deliberately seeking evidence from a wide range of sources and comparing these findings. After the interviews, administered questionnaires and classroom observations are complete, the findings from each are compared. If they coincide, that strengthens the validity that important issues have been identified. Miles and Huberman (1994) identified triangulation as an additional means of data analysis that involves using at least three different types of data and comparing them.

Patton (2002) identifies four different kinds of triangulation namely, method triangulation, data triangulation, triangulation through multiple analysts and theory triangulation. In this research, data triangulation and theory triangulation were the focus.

3.9.2 Triangulation of data: using cultural historical activity theory as a research lens

Some researchers such as Naidoo (2007), Hewson and Ogunniyi (2010) and Mothwa (2011) have revealed that teachers do struggle to include IK in the science classrooms. This is mostly due to lack of necessary pedagogical content knowledge among other factors. This generates tensions within the activity system making it difficult for teachers to include indigenous knowledge in the natural sciences.
Engeström (2007) and Meyers (2007) suggest using third-generation CHAT theory as the framework for analysing tensions and contradictions in an activity system. Botha (2012) argues that the use of CHAT as a framework will greatly assist policy makers to view the implementation of indigenous knowledge in Western based curricula. The natural sciences teacher is the subject in the activity system for the purpose of this study. According to Cronje (2011), the belief, culture, views on the nature of science and indigenous knowledge, as well as teaching and learning, have a great effect on how the natural sciences teacher makes use of available tools. The tools are the resources or artefacts that mediate the teacher’s activities including the CAPS curriculum documents, instructional media, strategies and laboratory equipment, techniques, activities and workshops. The rules in this study are the guidelines and instructions of CAPS and the Department of Basic Education, the rules of the school and classroom. It will also include the values and ethical considerations and customs of indigenous knowledge systems, as well as western science. The object is to equip science teachers with the necessary pedagogical content knowledge to include indigenous knowledge in the science classroom effectively in a more scientifically rigorous way.

The community involved in this activity system includes the school community (other teachers and learners) where the teacher works, the teachers participating in the intervention or in a community of practice with other schools, the officials from the Provincial Department of Education and the facilitators of the workshops. Division of labour refers to responsibilities, tasks and power relations expected from a science teacher. The natural science teacher in this activity system is involved in a school community and guided by the rules of the school and the Department of Education policies and has different roles to negotiate, such as scientist, teacher and also students. Tensions could arise within components of an activity system (e.g. among the rules), between the components of an activity (e.g. between rules and subject) and it can occur between two activity systems. Inadequate tools for the subject to achieve the object could give rise to tension. Tension could also arise between the community and the subject in their relationship resulting in the fear of including indigenous knowledge in the classroom. Furthermore, this could also be from lack of support from the community or the problem of whose indigenous knowledge to include in the classroom.
These tensions that exist among the components of the activity system will be further discussed in details in Chapter five.

3.10 ETHICAL ISSUES

Merriam and Tisdell (2016:260) make the claim that “the validity and reliability of a study depend upon the ethics of the investigator”. Since the research involves human participation, ethics must be considered. Whenever research is conducted on people, the wellbeing of the participants is the priority. Research ethics is mostly concerned with the interaction between researcher and the people they study. In this research I was reminded by the wisdom of Cohen et al. (2000:56): ‘Ethics is a matter of principled sensitivity to the right of others. Being ethical limits the choices we can make in the pursuit of truth. Ethics say that while truth is good, respect for human dignity is better’.

In this study, ethical issues were adhered to strictly. Three basic ethical research principles outlined by Orb, Eisenhauer and Wynaden (2001) were followed.

1. Ensuring respect for persons requires a commitment to guard the autonomy of research participants, and, where autonomy may be diminished, to protect people from exploitation of their vulnerability. The dignity of all research participants was respected and it was ensured that people were not used simply as a means to achieve research objectives. Also, an informed consent form was given to each participant.

2. To ensure beneficence of participants requires a commitment to minimising risks associated with research, including psychological and social risks, and maximising the benefits to research participants. This was achieved by assuring the participants that there were no risks associated with the research. The questionnaire was not designed to expose their weaknesses and there were no wrong or right answers.

3. Being on the side of justice requires a commitment to ensuring a fair distribution of the risks and benefits resulting from research. Those who take on the burdens of research participation should share in the benefits of the knowledge gained. In other words, the participants should also benefit from the knowledge acquired. This is ensured by involving the participants in the
intervention programme to help improve their PCK to teach IK in a scientific rigorous way in their classrooms.

To ensure that people understand what it means to participate in the research study so they can make a conscious and deliberate decision concerning their involvement, informed consent forms were issued. Since all the participants were literate, each participant received a written form to be signed describing the research to document his or her consent to participate.

Permission was obtained from both the UJ Faculty of Education’s Ethics Committee, as well as the North-West University (as my supervisor took on a new position at NWU during my study). (Ethical Clearance Certificates taken up in the Appendix). I also obtained permission from the Mpumalanga Department of Education. I provided the participants with a letter, explaining the aims of the research. Teachers were made aware of the fact that they participate voluntarily in the research, and that they could withdraw at any stage, without any consequences. They were also assured that their identities would not be revealed, and that pseudonyms would be used throughout the study.

3.11 CONCLUSION

This chapter has shed light on the path and processes that were chosen in order to answer the research questions. Those factors that guided the choice of qualitative research were also critically examined. The hybrid design-based research, with elements of phenomenology, was described so as to justify its appropriateness for the study. Furthermore, the various research instruments used to gather the data for the study were examined. Finally, the ethical issues were taken into consideration as well as validity and reliability of the study. The next chapter discusses in details the data analysis and interpretation.
CHAPTER FOUR

ANALYSIS OF DATA: THE CHALLENGES THAT TEACHERS FACE IN TEACHING INDIGENOUS KNOWLEDGE IN THE SCIENCE CLASSROOM

4.1 INTRODUCTION

This chapter presents the results of the data analysis and interpretation. The data collected will be presented and a critical analysis reflecting on the themes that emerged. The data was collected and then processed in response to the problems posed in Chapter One. Data was obtained from questionnaires (among others, the Views of the nature of science (VNOS), as conceptualised by Abd-El-Khalick, Bell and Lederman, (1998), and Views of the Nature of Indigenous Knowledge, developed by Cronje, De Beer and Ankiewicz (2015) administered to science teachers, individual interviews with science teachers, classroom observations (using the Reformed Teaching Observation Protocol, or RTOP instrument attached in Appendix E) and artefacts (lesson plans of teachers attached in Appendix F). Four fundamental objectives determined the collection of the data and subsequent data analysis. These goals were to determine whether NS teachers have the necessary PCK to address IK in a scientifically sound way, to identify the problems that teachers experience in including IK, to investigate better methods of introducing IK and the use of IK as a tool to promote learning and creating learners' interest in the Natural Sciences classroom and finally to produce design principles that could be used for an intervention integrating indigenous knowledge and school science since this is a design-based study. Data analysis entailed the breakdown of the data in order to obtain answers to research questions. Further, interpretation is undertaken to reduce data to an intelligible and meaningful form so that research problems can be studied and tested before a conclusion is drawn and these objectives were accomplished. The findings presented in this chapter demonstrate the potential for merging theory and practice.
4.2 FOUNDATION FOR INTERVENTION ONE IN THE GERT SIBANDE DISTRICT

Before the intervention took place, the researcher identified four teachers to participate in the classroom observations. Eventually one dropped out and there were three teachers. After getting their consent and obtaining permission from the Principal and by following all ethical procedures (refer to Chapter 3), the classroom observation was done as pre-intervention data collection to observe the teachers before being exposed to the intervention.

Letters of invitation for the two-day workshop/short learning training (SLT) were sent to many teachers in Dundonald/Amsterdam circuit in Gert Sibande District, Mpumalanga. Thirteen teachers attended although data from only 11 teachers was used. The major trend in this area is that majority of the teachers are teaching a subject (Natural Sciences) that was not a major in their degree or post-secondary education due to lack of qualified teachers.

Table 4.1: Profile of the 11 teachers in the Gert Sibande district

<table>
<thead>
<tr>
<th>NUMBER OF TEACHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENDER</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>SUBJECTS</td>
</tr>
<tr>
<td>Natural Sciences</td>
</tr>
<tr>
<td>Life Sciences</td>
</tr>
<tr>
<td>Physical Sciences</td>
</tr>
<tr>
<td>Maths and Physical Sciences</td>
</tr>
<tr>
<td>Technology and Maths</td>
</tr>
<tr>
<td>Economics</td>
</tr>
<tr>
<td>Life Sciences and Natural Sciences</td>
</tr>
<tr>
<td>Life Sciences and Mathematics</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Physical Sciences and Natural Sciences</td>
</tr>
<tr>
<td>Natural Sciences and Technology</td>
</tr>
</tbody>
</table>

**QUALIFICATIONS**

<table>
<thead>
<tr>
<th>Bachelor of Science</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Education</td>
<td>3</td>
</tr>
<tr>
<td>BSc and Diploma in Education</td>
<td>2</td>
</tr>
<tr>
<td>SED &amp; ACE</td>
<td>1</td>
</tr>
<tr>
<td>Honours in Education</td>
<td>3</td>
</tr>
<tr>
<td>BA Honours in Economics</td>
<td>1</td>
</tr>
</tbody>
</table>

Data collected from 11 teachers was used from the total number of 13 teachers that attended the workshop from various schools in the Amsterdam and Dundonald Circuit. This was because one of the participants completed the pre-intervention questionnaire but left before the end of the intervention due to an emergency. Another participant came late and could not participate in the pre-intervention questionnaire and only completed the post-questionnaire. Therefore, these two participants’ responses were not analysed due to incomplete data. The responses of the eleven participants were analysed from the pre- and post-intervention questionnaire. In this first intervention, the VNOS questionnaire was not applied to the participants due to time constraints and only the VNOIK questionnaires before and after the intervention were completed. However, the related questions of the VNOS were asked from the selected participants observed in the classrooms during a one-on-one interview and their answers recorded. Below are samples of responses from the VNOIK questionnaire during pre-intervention. The overview is represented in Table4.4 below.
Table 4.2: Samples of responses to VNOIK questionnaire during pre-intervention

<table>
<thead>
<tr>
<th>VNOIK Questionnaire</th>
<th>Uninformed</th>
<th>Partially Informed</th>
<th>Informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. What in your view is indigenous (or traditional) knowledge? What makes indigenous knowledge different from other types of knowledge (such as western knowledge systems)?</td>
<td>‘Indigenous knowledge is the study of people and their cultures or belief’</td>
<td>‘It is the local knowledge obtained from local environment. Unlike other forms of knowledge, it is acquired by interacting between people and their environment’</td>
<td>‘Indigenous knowledge is knowledge that is being passed by our ancestors from generation to generation verbally, some of the knowledge and experiences of our elders is passed as fairy tales but still have a gist of passed (past) experiences that can be encountered of apply in our times’</td>
</tr>
<tr>
<td></td>
<td>‘We must know the traditional knowledge in order to pass it to our future generation. It makes difference because it deals with traditional not the western knowledge. We must know how it works such as the traditional healers. They use the mixture for herbs’</td>
<td>‘Indigenous knowledge is the knowledge that is acquired by indigenous people. This knowledge is transferred from one person to the other’</td>
<td>‘Indigenous knowledge which is obtained by people as they interact with their environment. It is passed from generation to generation. The knowledge is specific to a certain culture. There is diversity in traditional knowledge due to the diverse cultures and beliefs’</td>
</tr>
<tr>
<td>Q2. Practitioners of IK (e.g. elders, herbalists, traditional healers) observe nature to generate knowledge. Do they do experiments and tests in order to verify this knowledge? Give a reason for your opinion.</td>
<td>‘Experiments are not done. Experiments involve using known exact quality and determining the effect’</td>
<td>‘No. They don’t do experiments from what I heard some receive the vision or dream of a particular plant and the disease to be treated by that particular plant some it is passed on to them from their forefathers’</td>
<td>‘Some do test to verify this knowledge. Because they give people the right medicine to prove that there are some forms of test or experiments’</td>
</tr>
<tr>
<td></td>
<td>‘No. They lack equipment and knowledge of how to do it’</td>
<td>‘They do not do experiments. They depend on their instinct or they believe’</td>
<td>‘In most cases practitioners receive particular prescriptions for individuals from’</td>
</tr>
<tr>
<td>Q3. Elders in a community for example explain where lightning comes from or observe nature and give their explanation. Do these explanations always have natural causes that are predictable, or do the explanations sometimes include unnatural or supernatural (metaphysical) causes as well?</td>
<td>‘No, they just use knowledge told by their parents’</td>
<td>‘Yes because their signs which they observe in order to predict’</td>
<td>‘Yes, it is believed that lightning can be sent to people through supernatural means’</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>‘They include unnatural. Yes, because they cannot be explained scientifically’</td>
<td>‘Some explanations have supernatural causes. Some believe that they can create lightning but not in the way scientist explain how lightning occurs’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Q4. IK is transferred from one generation to the next over many decades and centuries. Does this knowledge stay the same or does it change over time? | ‘No idea’ | ‘It changes cause of the fact that it can be distorted as it is not documented or written down. Thus it might be misinterpreted’ | ‘Depending on the society at times it does not change. This is because the knowledge is just passed on from the parent to child without any reason. At times faith is drawn in’ |
**Q5.** *Hoodia gordonii* is a plant that used by Khoi-San hunters to suppress their hunger and thirst when they went on hunting expeditions. How do you think the Khoi-San people came to know that this particular plant has these properties?

- **Accidentally.**
- **Observation of the plant that it can grow under harsh/hot climate**
- **By testing**
- **Indigenous knowledge is transferred from one generation to the next. They were taught by their parents or elderly people**
- **That could come as a dream to certain individual then he/she passes it or tries it and if applicable passes it to community to spread to different places**

**Q6.** Sustainable development is an emerging discipline that includes topics such as hunger, poverty, and underdevelopment. Globally governments and organisations struggle to get solutions for these important issues. Do you think IK can be used to solve these problems?

- **Yes! Because these practitioners if they could be certified and marketed if proven they really does apply to real life with money from patients' poverty and hunger could be minimised**
- **Yes! I believe the indigenous people have applied indigenous knowledge to problems**
- **Yes! Hunger, poverty and underdevelopment can suppress by government improving research in this areas of indigenous knowledge and encouraging them to incorporate it with formal education**
- **Yes! The knowledge can be used to develop communities. For example, establishing herbal gardens used to treat different ailments. People can come from other places to see these herbs. This can generate money for the community which can be used to develop the community jobs can also be created. People are taught how to harvest herbs in a sustainable way**
<table>
<thead>
<tr>
<th>Question</th>
<th>Response 1</th>
<th>Response 2</th>
<th>Response 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q7. What methods do you think a traditional healer will apply to assist an athlete who regularly competes in a marathon but now struggles with pain in his legs during the last part of a marathon and what possible advice do you think he will give to the athlete?</td>
<td>‘No idea’</td>
<td>‘Giving him/her herbal medicine’</td>
<td>‘Some would advise an traditional muthi that strengthen their muscles. Some can give muthi to improve the calculating system some can advise the athlete to send away evil spirits as they think of being bewitched as a curse’</td>
</tr>
<tr>
<td></td>
<td>‘The traditional healer should encourage the athlete to do more practice, give him some muthi for the leg’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q8. Myths are stories that are told in different cultures by elders from one generation to the other. Do you think myths and rituals play an important role in IKS? Explain your answer.</td>
<td>‘Yes! They lead to the earlier generation to ignore indigenous knowledge and lose interest’</td>
<td>‘Myths and rituals play an important role because they can be coming from the belief system and culture of people in the community’</td>
<td>‘Myth play a vital role because they have most of the IK is passed on’</td>
</tr>
<tr>
<td></td>
<td>‘Yes! It allows knowledge to be passed from one generation to the other’</td>
<td></td>
<td>‘Yes! They play an important role because they instil discipline, respect in the younger generation’</td>
</tr>
<tr>
<td>Q9. Does IK reflect social and cultural values? Explain your answer. Do you believe that IK is universal and be used globally to solve problems? If yes, explain why.</td>
<td>‘Indigenous knowledge reflects several cultural values of certain area or people living in that area. Yes, it cannot be used universally because of different believes’</td>
<td>‘Yes. Because certain cultures use certain herbs to heal the same diseases. It can be used globally because it has been working in our African countries’</td>
<td>‘Yes, IKS reflect cultural values because different cultures believe in different values. Yes, it can be used to solve problems globally if many governments do not undermine it</td>
</tr>
<tr>
<td></td>
<td>‘Yes, people tend to behave in a way that reflects their belief and cultural values which are passed from one generation to another. No’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Q10. Indigenous knowledge is passed from one generation to the other by elders. The elders are deemed very important and their ways of knowing (knowledge) is truth and not to be challenged. Does this mean that current practitioners using IK must use this knowledge as it is to solve current problems in the community or can they use their creativity and imagination?

‘Indigenous knowledge cannot change it. This avoids loss of some important concepts’

‘They should not use their creativity as this leads to changing the content of knowledge’

‘Yes they can discover knowledge which was used before or limitations in the methods used. Hence they can used creativity and imagination to add to the knowledge already existing’

‘Yes, because things have changed we cannot keep on using same knowledge that was used in the older days we need to change because things have change complete’

In question one, the rubric (Table 3.3) indicates that for a response to be informed it must have at least four responses from the anticipated answers or other tenets of indigenous knowledge and mention at least two out of the anticipated answers to be partially informed. A response is termed uninformed if it has only one or no items from the anticipated answer. Thus, the uninformed response – ‘indigenous knowledge is the study of the people and their cultures or belief’ - was stated since it does not include any of the anticipated answers.

4.3 ANALYSIS OF THE GENERAL QUESTIONS BEFORE THE INTERVENTION

The general questionnaires before the intervention consisted of three questions that were answered by the respondents and analysed. The responses were coded and narrowed down into subthemes. Below is the summary of the analysis.
**QUESTION 1. Why should IK be taught or not be taught in the classroom?**

<table>
<thead>
<tr>
<th>Sub-theme 1. To gain more knowledge about environment and culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘It should be taught in class because it enriches the learners about their environment and culture’</td>
</tr>
<tr>
<td>- ‘It should be taught so that learners can know their culture and other people’s culture. This will help them to know that we are equal in the eyes of the Lord’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 2. For better understanding of Science in the classroom, following constructivist approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘It should be taught as it enhances better understanding of the concepts by learners’</td>
</tr>
<tr>
<td>- <em>It should be taught. Learning is from known to unknown, informal learning first and then formal</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 3. To preserve Indigenous knowledge for the coming generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Indigenous knowledge should be taught in the classroom as it will provide a formal as well recorded form of IK, which when passed from one generation to the other, there won’t be much alteration’</td>
</tr>
<tr>
<td>- ‘It should be taught in the classroom to enlighten the learners. Some do not have elders to teach them because of the changing structures in family systems’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 4. To make clear the relationship between IK and Western Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘It should be taught carefully though because some pupils may fail to interpret the knowledge well and confuse it with the western knowledge’</td>
</tr>
</tbody>
</table>

It is obvious from the responses of the participants to question one that most do have some understanding of why indigenous knowledge should be taught in the natural sciences classrooms (although they only pay lip service to the inclusion in real life, as will be seen from the data). They identified that it will help the learners to gain more knowledge about their environment and culture and better understand science. Furthermore, some participants saw it as a means of preserving indigenous knowledge for future generations while others indicated that it will help to clarify the relationship between indigenous knowledge and western science.
QUESTION 2. Briefly explain how you include indigenous knowledge in your lessons.

<table>
<thead>
<tr>
<th>Sub-theme 1. Using local resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘By using all teaching aids from the surrounding. By using local examples common to learners’</td>
</tr>
<tr>
<td>- ‘It should be included through the surroundings through innovation and incentives’</td>
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<th>Sub-theme 2. Ask learners to make enquiries</th>
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<td>- ‘Let learners bring some of the plants that they know of their parents that heal certain diseases’</td>
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<td>- ‘Through group discussion and give homework’</td>
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<th>Sub-theme 3. By involving traditional practitioners</th>
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<td>- ‘According to the tradition all learners must know all the ancient things. I can call the herbalist to teach them about it’</td>
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<td>- ‘By calling/bringing a herbalist in class who will do experiment with learners’</td>
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<th>Sub-theme 4. Using practical examples</th>
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<td>- ‘e.g. giving learner examples such as when someone is bitten by a snake instead of going to the hospital or clinic, the person can eat the whole onion to stop the Venom from spreading’</td>
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<td>- ‘At any point when it deals with aspects that touch on the community I talk about it’</td>
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<th>Sub-theme 5. Inquiry-based learning</th>
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<td>- ‘Can teach a lesson on chromatography or extracting different elements substances from a leaf which can be used by herbalist’</td>
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<td>- ‘Ask questions about cultures and beliefs’</td>
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The responses of the participants indicated that some teachers only include indigenous knowledge in their lesson in passing as revealed by participant 10 - ‘At any point when it deals with aspects that touch on the community I talk about it’ while participant 8 said she has no idea. From the classroom observations, there was no evidence of any of the abovementioned methods of inclusion of indigenous knowledge in the lessons observed. It is, therefore, safe to assume that teachers are not well-versed in including effective pedagogies for teaching indigenous knowledge systems (taking cognisance of the tenets of the nature of indigenous knowledge) and, therefore, this intervention is needed.
QUESTION 3. What are the problems that might prevent you from including indigenous knowledge in your classroom?

1. Religion and beliefs
   - ‘Different beliefs’
   - ‘Knowledge of the matter (task of it).
     The nature of pupils/their traditions.
     My tradition and beliefs.
     My culture and also their cultural beliefs’
   - ‘It sometimes need an individual believe’
   - ‘Belief systems. Some religions do not belief in use of indigenous knowledge.
     They believe that it is demonic e.g. the Christians. So in a classroom of children coming from diverse backgrounds. But however if the children are taught to appreciate different cultures, they will be easier for them to accept’

2. Diversity in culture and tradition
   - ‘Learners come from different cultural backgrounds.
     Some learners think indigenous knowledge is back and outdated’
   - ‘Language, culture and ethics’
   - ‘Culture diversity’

3. Lack of knowledge on indigenous knowledge
   - ‘I don’t know much about indigenous knowledge’
   - ‘It’s not broad in its nature’

The participants viewed the inclusion of IK in the classroom as a means of enhancing better understanding and learners’ knowledge about their culture and environment. It is also a way of preserving IK for the next generation. However, a participant emphasised that caution should be taken when including IK in the classroom so as not to confuse the learners.

Responses to question two indicated that participants were not actually introducing IK in a scientific rigorous way in the classrooms and reveals a lack of the necessary pedagogical content knowledge. Most of the problems that were highlighted as reasons preventing participants from including indigenous knowledge in their classrooms ranged from religion and beliefs of both the teachers and learners to diversity in culture and tradition as well as lack of adequate knowledge on IK on the part of teachers. First of all, the effective resistance shows a lack of true understanding
of the tenets of the nature of science. It is true that the large learner diversity poses a challenge to teaching IK in the classroom, however, the philosophy supporting this intervention is to assist the teacher in developing a more self-directed learning approach and identify learning needs (to better facilitate learning in the diverse classroom). The basic approach to the intervention is based on Knowles’ (1975:18) definition of self-directed learning, namely ‘In its broadest meaning self-directed learning describes a process by which individuals take the initiative, with or without the assistance of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes’. We mostly provided examples of Khoi-San indigenous knowledge during the short learning programme. A teacher who has mainly isiZulu learners, would hopefully demonstrate self-direction, and do research on Zulu IK.

4.4 ANALYSIS OF VNOIK QUESTIONNAIRE AFTER INTERVENTION

After the intervention, the VNOIK questionnaire was administered to the participants again to see if their views had changed or improved. Their responses were coded using a scale of informed, partially informed and uninformed. Below is a sample of responses from the questionnaire. The overview is presented in Table 4.4.

Table 4.3: Samples of responses to VNOIK Questionnaire during post-intervention

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<thead>
<tr>
<th>Question</th>
<th>Uninformed view</th>
<th>Partially informed</th>
<th>Informed</th>
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<tr>
<td>1. What in your view is indigenous (or traditional) knowledge? What makes indigenous knowledge different from other types of knowledge (such as western)</td>
<td>‘It deals with the traditional knowledge and western knowledge is not the same with it’</td>
<td>‘Knowledge that originate from cultural and societies. It is not the kind of knowledge acquired through training’</td>
<td>‘It is knowledge that is passed from elders to their young ones from generation to generation. It is derived from how they interact with the environment. It encompasses the cultural and belief systems of people. It is different from western’</td>
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<td>Knowledge Systems?</td>
<td>'Indigenous knowledge is different because some of the things were done are not tested or proven. The only things that the western can do is to combine help one another'</td>
<td>'It is knowledge that is oral and pass from one generation to another by the elders'</td>
<td>'Knowledge in that there is no proper documentation on indigenous knowledge, no exams that are written to show that a person has acquired the knowledge'</td>
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<td>2. Practitioners of IK (e.g. elders, herbalists, traditional healers) observe nature to generate knowledge. Do they do experiments and tests in order to verify this knowledge? Give a reason for your opinion.</td>
<td>'No they lack necessary skills and equipment'</td>
<td>'Not really they believe in their prescription, they only rely on the patients’ reactions after medication'</td>
<td>'They actually use the scientific method to generate knowledge. That is observe, come up with hypothesis, develop a method to test the hypothesis and prove it'</td>
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<td>3. Elders in a community for example explain where lightning comes from or observe nature and give their explanation. Do these explanations always have natural causes that are predictable, or do the explanations</td>
<td>'Occurrence can be predictable because they believe if something odd that hasn't been done in the past result in calamity of some sort'</td>
<td>'It is a supernatural sometimes you cannot understand them'</td>
<td>'They do not have natural cause that are predictable, in case of lightning some traditional healers claim that they can create lightning in the supernatural'</td>
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<td>Sometimes include unnatural or supernatural (metaphysical) causes as well?</td>
<td>‘Yes, these explanations are acquired from one individual to another from one generation to another’</td>
<td>‘Yes, they have some signs which help them to explain what is most likely to happen’</td>
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<td>4. IK is transferred from one generation to the next over many decades and centuries. Does this knowledge stay the same or does it change over time?</td>
<td>‘It does not change because it is not tested’</td>
<td>‘Yes! If the other medicine is used to heal something it will be like that e.g. a lot for healing wounds it will be like that’</td>
<td>‘Generally it stays the same in some cases but some instances changes as the society changes. Some knowledge is also lost when dies as it is not written but generally orally transferred’</td>
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<td>‘Indigenous knowledge does change in terms of sometimes the quality to be used and procedures because some the procedures are not well documented. They are passed orally. This can cause misinterpretation and misunderstanding’</td>
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<td>5. Hoodia gordonii is a plant that used by Khoi-San hunters to suppress their hunger and thirst when they went on hunting expeditions. How do you think did the Khoi-San people came to know that this particular plant has these properties?</td>
<td>‘It can be accidentally’</td>
<td>‘They tried it and find it help them’</td>
<td>‘Might be through passing the knowledge orally by ancestors or one being shown the plant in a dream’</td>
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<td>‘By testing the plant by using knowledge pass to them by their parents’</td>
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<td>6. Sustainable development is an emerging discipline that includes topics such as hunger, poverty, and underdevelopment.</td>
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<td>‘Yes, IKS alone cannot solve the problem western science integrated with IKS can solve the problem’</td>
<td>‘Indigenous knowledge can help to suppress hunger, parity when we give it time. Yes, it can help, if we started giving it attention in research and also’</td>
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Globally governments and organisations struggle to get solutions for these important issues. Do you think IK can be used to solve these problems?

- If you say yes, please explain why.
- If you say no, please explain why

| Yes! The government provides the feeding scheme in our school. In the menu there are lot of traditional food such as beans and soya. That is the indigenous food’ | ‘Yes! Knowledge of these problems is better tackled by communities finding workable solutions that are practice. Indigenous knowledge could really assist e.g. hunger, thirst solving plants hoodia’ |
| ‘Yes! The government provides the feeding scheme in our school. In the menu there are lot of traditional food such as beans and soya. That is the indigenous food’ | ‘Yes! Knowledge of these problems is better tackled by communities finding workable solutions that are practice. Indigenous knowledge could really assist e.g. hunger, thirst solving plants hoodia’ |
| Yes! The government provides the feeding scheme in our school. In the menu there are lot of traditional food such as beans and soya. That is the indigenous food’ | ‘Yes! Knowledge of these problems is better tackled by communities finding workable solutions that are practice. Indigenous knowledge could really assist e.g. hunger, thirst solving plants hoodia’ |
| ‘The traditional healers might give the athlete, some medicine to rub on the legs or some muti to drink. So the medicine might be used external or taking orally (drink)’ | ‘The traditional healers will use a holistic approach to assist the athlete. That is physical, emotional and spiritual background. He can use the plants for making herbs and also give the athlete advice to practice so that he can be fit and also check diet’ |
| ‘The traditional healers might give the athlete, some medicine to rub on the legs or some muti to drink. So the medicine might be used external or taking orally (drink)’ | ‘The traditional healers will use a holistic approach to assist the athlete. That is physical, emotional and spiritual background. He can use the plants for making herbs and also give the athlete advice to practice so that he can be fit and also check diet’ |
| ‘The traditional healers might give the athlete, some medicine to rub on the legs or some muti to drink. So the medicine might be used external or taking orally (drink)’ | ‘The traditional healers will use a holistic approach to assist the athlete. That is physical, emotional and spiritual background. He can use the plants for making herbs and also give the athlete advice to practice so that he can be fit and also check diet’ |

7. What methods do you think a traditional healer will apply to assist an athlete who regularly competes in a marathon but now struggles with pain in his legs during the last part of a marathon and what possible advice do you think he will give to the athlete?

- ‘Traditional healers will give the athlete the herbs they were using by their ancestors or elders. They will tell him or her the herbs to use when is running or training’

- ‘The traditional healers will use indigenous knowledge to heal the pain. The athlete will be given some indigenous plants to apply on the painful part and he might even be treated supernaturally linking the pain with other spiritual sources’

- ‘Traditional healers will give the athlete the herbs they were using by their ancestors or elders. They will tell him or her the herbs to use when is running or training’

- ‘The traditional healers will use indigenous knowledge to heal the pain. The athlete will be given some indigenous plants to apply on the painful part and he might even be treated supernaturally linking the pain with other spiritual sources’
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<td><strong>8.</strong> Myths are stories that are told in different cultures by elders from one generation to the other. Do you think myths and rituals play an important role in IKS? Explain your answer.</td>
<td>‘Yes! They are demolishing the least trust that the younger generations have on indigenous knowledge’</td>
<td>‘Yes! It plays the important role in understanding the culture and also be self-discipline’</td>
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<td>‘Yes, myths play a vital role in IK because it helps to pass this information much easier and help people to remember as they will tend to put value and respect the IK’</td>
<td>‘Yes, myths and rituals are ways of transferring indigenous knowledge from one generation to another’</td>
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<td><strong>9.</strong> Does IK reflect social and cultural values? Explain your answer. Do you believe that IK is universal and be used globally to solve problems? If yes, explain why.</td>
<td>‘Yes, the indigenous knowledge reflects the cultural values of certain group of people living in a particular area. No, it cannot because people have different cultures and beliefs which make it hard to incorporate them in the main stream’</td>
<td>‘IK does reflect the social and cultural values of a certain society because the IK tends to differ from one community to another. Yes, it will because some of the knowledge has helped to solve health and economic problems. For example, it has helped to make areas to be sustainable developed’</td>
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<td>‘It does as its part of culture. What a community accepts, it tends to be a practical from generation to generation. ‘Depending on how it is interpreted it can be universal. As long as other communities accept and have common ground it can (a plant having different names but having the same effect)’</td>
<td>‘Yes indigenous knowledge is obtained from material that can be source locally. These materials have been used over time by specific group or culture because they are easily available. ‘Yes, indigenous knowledge is universal. Most material or substances that are used in indigenous knowledge can be obtained in the universe’</td>
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Indigenous knowledge is passed from one generation to the other by elders. The elders are deemed very important and their ways of knowing (knowledge) is truth and not to be challenged. Does this mean that current practitioners using IK must use this knowledge as it is to solve current problems in the community or can they use their creativity and imagination?

'It cannot be changed by an individual as this has been passed to him/her from previous generation. It can lessen the effect of the medicine or made it dangerous to the recipient.'

'Yes! They have to try and see whether is working or not and if it is working then they must use them.'

'Creativity and imaginations can be used in a fact that our world is as well changing, so some of the current problems need fresh creativity that can comply with it.'

'No, using imagination and creativity helps to bring some gap in indigenous knowledge.'

'It can solve problems but I strongly believe that more research should be done so that indigenous knowledge can be used adequately without affecting people negatively.'

'They can use indigenous knowledge to solve current problems in the community and also use creativity for new plants with medicinal value can be discovered which can be of great value to the community.'

Table 4.4: Summary of coded responses of participants in the first intervention

The first section (A) refers to the pre-intervention VNOIK responses and the last section (B) the post-intervention VNOIK responses. Thus 001A is the pre-VNOIK responses of Teacher 1 and 001B the post-VNOIK responses.

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<tr>
<th>Participant</th>
<th>Q1</th>
<th>Q2</th>
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POST-INTERVENTION RESPONSES

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<tr>
<td>003B</td>
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<td>004B</td>
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<tr>
<td>005B</td>
<td>UI</td>
<td>PI</td>
<td>PI</td>
<td>PI</td>
<td>PI</td>
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<td>I</td>
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<td>1</td>
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</tr>
<tr>
<td>006B</td>
<td>UI</td>
<td>UI</td>
<td>UI</td>
<td>PI</td>
<td>I</td>
<td>PI</td>
<td>PI</td>
<td>UI</td>
<td>PI</td>
<td>I</td>
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<td></td>
<td>UI</td>
<td>UI</td>
<td>UI</td>
<td>PI</td>
<td>I</td>
<td>PI</td>
<td>I</td>
<td>UI</td>
<td>PI</td>
<td></td>
</tr>
</tbody>
</table>

103
<table>
<thead>
<tr>
<th>Question</th>
<th>Uninformed</th>
<th>Partially informed</th>
<th>Informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>3</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>1</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>1</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>2</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>7.</td>
<td>1</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>8.</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9.</td>
<td>0</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>7</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Overall</td>
<td>0</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4.5: Table summarising number of uninformed, partially informed and informed views on VNOIK Questionnaire per question during pre-intervention
Table 4.6: Table summarising number of uninformed, partially informed and informed views on VNOIK Questionnaire per question during post-intervention

<table>
<thead>
<tr>
<th>Questions</th>
<th>Uninformed</th>
<th>Partially informed</th>
<th>Informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>2</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>1</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>0</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>0</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>0</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>9.</td>
<td>0</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>10.</td>
<td>2</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Overall</td>
<td>0</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 4.7: Comparison between pre- and post-intervention responses to VNOIK Questionnaire

<table>
<thead>
<tr>
<th>PARTICIPANTS</th>
<th>PRE-INTERVENTION</th>
<th>POST - INTERVENTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0.9 ≈ 1</td>
<td>0.8 ≈ 1</td>
</tr>
<tr>
<td>2.</td>
<td>1.1 ≈ 1</td>
<td>1.0</td>
</tr>
<tr>
<td>3.</td>
<td>0.9 ≈ 1</td>
<td>1.0</td>
</tr>
<tr>
<td>4.</td>
<td>1.1 ≈ 1</td>
<td>1.0</td>
</tr>
<tr>
<td>5.</td>
<td>0.9 ≈ 1</td>
<td>1.3 ≈ 1</td>
</tr>
<tr>
<td>6.</td>
<td>1.3 ≈ 1</td>
<td>0.9 ≈ 1</td>
</tr>
<tr>
<td>7.</td>
<td>0.7 ≈ 1</td>
<td>0.9 ≈ 1</td>
</tr>
<tr>
<td>8.</td>
<td>0.9 ≈ 1</td>
<td>1.6 ≈ 2</td>
</tr>
<tr>
<td>9.</td>
<td>1.1 ≈ 1</td>
<td>1.1≈1</td>
</tr>
<tr>
<td>10.</td>
<td>1.0</td>
<td>1.3 ≈ 1</td>
</tr>
<tr>
<td>11</td>
<td>1.6 ≈ 2</td>
<td>1.9 ≈ 2</td>
</tr>
</tbody>
</table>
Before the first intervention, ten out of eleven participants were partially informed while only one participant was informed. If the individual weightings of each participant before and after the intervention are compared, as stipulated in Table 4.7, a slight change in the views of the majority of the participants is observed. Although the overall view of four participants (1, 2, 4 and 6) still remains partially informed, their weighting dropped. Participants 3, 5, 7 and 10 increased in their weighting but still remain partially informed while participant 9 has not changed and remains partially informed. An improved and increased weighting of participant 8 is highly commendable from 0.9 to 1.6 (informed view). Similarly, the weighting of participant 11 (informed view) changed from 1.6 to 1.9. After the intervention, participant 8 improved from partially informed to fully informed with 43.8% while participant 11 that was formerly informed also improved with 15.8%. The views of participants on some of the aspects of indigenous knowledge did change. A few of the responses to indicate this change is illustrated in section 4.5 below. In total, two participants were fully informed after the intervention while nine participants remained partially informed. It is impressive to note that no one was uninformed before the intervention. This shows they all had some idea about IK though they lack the PCK on how to incorporate it in the classrooms. The total percentage of partially informed participants before the intervention was 90.9% but decreased to 81.8% while the percentage of informed participants increased from 9.1% to 18.2% after the intervention.

From the results in Table 4.7, it seems that there were only slight changes in the views of the participants on the nature of IK after intervention one. Critical analysis as to why the intervention had limited impact was essential and the question of which design principles could be added to ensure that training improves during the next intervention. One of the problems is that these teachers were not well-versed in microbiology terminology and procedures and although they enjoyed using the adapted Kirby-Bauer technique, they struggled with the language and concepts. It became obvious that the profile of the teachers should be investigated before the planning of interventions.
### 4.5 ANALYSIS OF GENERAL QUESTIONS AFTER INTERVENTION

The general questionnaire consists of three questions as discussed earlier (see Par4.3).

**QUESTION 1**

Why should indigenous knowledge be taught or not be taught in the classroom?

<table>
<thead>
<tr>
<th>Sub-theme 1. Improves knowledge of culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘it helps learners to know their culture and to respect elders also other people culture’</td>
</tr>
<tr>
<td>- ‘it will be taught in the classroom situation so that learners must know their culture’</td>
</tr>
<tr>
<td>- ‘it should be taught in classroom so that learners can understand better their environment and the community they live in’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 2. Better understanding of Science and expansion of knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘it should be taught; it helps learners to understand much better by interacting with their environment and unlocking abstract knowledge’</td>
</tr>
<tr>
<td>- ‘indigenous knowledge must be taught. Because learners need to expand their knowledge. To remove these stereotype that only western medicine is perfect’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 3. To preserve knowledge for the coming generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘it should be taught to preserve the knowledge and if possible integrate it with their own creativity’</td>
</tr>
<tr>
<td>- ‘it should be taught in the classroom so there can be proper documentation. Also knowledge can be passed from one generation to the other’</td>
</tr>
<tr>
<td>- ‘indigenous knowledge should be taught in the classroom. It empowers the learners to know what was done by the ancestors. To solve certain problems. Due to the change in family structures. Some children are living in broken homes, child headed home with no one to pass this knowledge to them. This is vital to ensure that knowledge is not lost but maintained from generation to generation as more knowledge is discovered and also to explain between myth and facts’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 4. As prior knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Students understand better what they know from home. It also helps in preservation of plants if they have the indigenous knowledge’</td>
</tr>
</tbody>
</table>
The majority of the participants agreed that IK should be taught in the classroom so as to improve learners’ understanding and participation. The researcher viewed it as unfortunate that the teachers did not mention that such IK teaching will give the learners a more advanced understanding of both the nature of science, and the nature of indigenous knowledge.

**QUESTION 2**
Will you be better equipped in future to teach IK in your classroom? Does this course assist you in your professional development?

<table>
<thead>
<tr>
<th>Sub-theme 1. Improved PCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>'it really helped me a lot to know how to present IK in my classroom’</td>
</tr>
<tr>
<td>'this course made me better equipped, especially on the methods that I can use to incorporate IK. The experiment on chromatography, microbiology helped me a lot. Also the method of De Bono’s thinking hats was a new discovery to me’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 2. Improved Contextual knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Yes, I will be better equipped because of the difference in the background of my learners’ (has helped to improve contextual knowledge)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 3. Improved content knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘I have been equipped on how and when to use the knowledge. I know better the plants’</td>
</tr>
<tr>
<td>‘Yes, I have gained a lot of knowledge from this workshop’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 4. Better equipped to become a master teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Yes, towards becoming a super teacher’</td>
</tr>
<tr>
<td>‘Yes! Because now I know that I am a super teacher’</td>
</tr>
</tbody>
</table>

After being exposed to some of the pedagogical knowledge that could help with the inclusion of IK in the Natural Sciences classroom, many of the participants agreed they were now better equipped to teach the subject in their classroom. Teachers, hopefully,
an improved understanding of the tenets of the nature of, after working in the laboratory on the Kirby-Bauer technique.
QUESTION 3

What were the highlights of this course for you?

<table>
<thead>
<tr>
<th>Sub-theme 1. How to better include IK in the Science classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Applying IK in classroom. Characteristics of a super teacher’</td>
</tr>
<tr>
<td>- ‘De Bono colour hats and that I can actually use it in a lesson in the classroom’</td>
</tr>
<tr>
<td>- ‘It was about the IK and the environment we live in and how we can use it to teach learners’</td>
</tr>
<tr>
<td>- ‘Applying indigenous knowledge in classroom. Characteristics of a super teacher’</td>
</tr>
<tr>
<td>- ‘Use of indigenous knowledge. Indigenous plants and their activities. Comparison of IK with western knowledge. Improving the quality of use of indigenous knowledge. How to teach better in the classroom’</td>
</tr>
<tr>
<td>- ‘To gain knowledge in the indigenous knowledge. You know difference medicinal herbs to educate others in future’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 2. Importance of inclusion of IK in the Science classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘The necessity of IK and how to apply it in our teaching and learning in class’</td>
</tr>
<tr>
<td>- ‘What is indigenous knowledge. How can it be incorporated into the science classroom? Why is indigenous knowledge important? Conflict between traditional methods and indigenous knowledge’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 3. Professional development</th>
</tr>
</thead>
<tbody>
<tr>
<td>- To know different kinds of indigenous plants and what they are used for. To know that I am a super teacher and what am I supposed to do in class. To respect learners when teaching’</td>
</tr>
</tbody>
</table>

It was obvious from the responses of the participants that they have learned from the various teaching strategies (namely: jigsaw method, and the de Bono’s hats strategy) explored during the intervention and categorically state the highlights of the course for them. Teachers (especially under-qualified teachers in rural areas) often have limited pedagogical repertoires to access. The teachers who attended this short learning programme have not previously encountered De Bono’s Hats and this was indicated as a definite highlight. Also, many teachers were not exposed to activities in the laboratory and the sessions on chromatography and the adapted Kirby-Bauer technique for anti-microbial testing were also highlighted.
**QUESTION 4**
What suggestions do you have to improve this course for future offering?

<table>
<thead>
<tr>
<th>Sub-theme 1. Conduct workshop at the beginning of the year</th>
</tr>
</thead>
<tbody>
<tr>
<td>'More hands-on microscope. The content was really good. Timing must be early in the year to implement the knowledge acquired'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 2. Group presentation should be included</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Give us topic either in physical science or life science we discuss. Allow a group to present in front and allow room for question it will be more interesting'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 3. More days</th>
</tr>
</thead>
<tbody>
<tr>
<td>'To attend more workshops to gain more knowledge in it'</td>
</tr>
<tr>
<td>'More days to finish the very educative course'</td>
</tr>
<tr>
<td>'More time should be given to the converse and inform more teachers to attend'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 4. Further research on indigenous knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>'To do more research on indigenous knowledge'</td>
</tr>
<tr>
<td>'The Department of Education to introduce indigenous in the curriculum'</td>
</tr>
<tr>
<td>'The suggestion should be incorporated in western education so that we enrich it with new ideas'</td>
</tr>
</tbody>
</table>

The responses to Question 4 indicated that most participants would like more workshops of this nature and extended so as to gain more. They all agreed it was an interesting session that could help their professional development.
Fig 4.1: Participants working in groups during the intervention programme (the teachers all provided written consent for the use of their photographs).
Fig 4.2: Participants learning how to introduce IK in a scientific rigorous way. Here they are extracting alkaloids from the sample of medicinal plants, to test its anti-microbial characteristics in the laboratory, using the Kirby-Bauer technique\(^1\).

\(^1\) The Kirby-Bauer technique is a way of testing the anti-microbial properties of muthi plants, and it is a strong feature in the short learning programme. It is of importance in this study, as it sensitizes teachers to the tenets of the nature of science, and the tenets of indigenous knowledge.
Fig 4.3: The HIV/AIDS activity. This activity was meant to provide teachers with an example of a pedagogy of play (Homo ludens = the playing human) and we picked up on the AIDS theme, when we discussed the anti-microbial properties of medicinal plants, and had a class discussion on the possibility that scientists could one day discover a cure for AIDS.
Fig 4.4: Participants were happy and motivated as they received a UJ certificate for attending the short learning programme. (The teachers all provided ethical consent that this photograph could be used in the dissertation).

During discussions on the findings from Cycle 1 of this DBR, it was realised that many of the teachers in this rural district do not have the necessary background knowledge that we had assumed. Firstly, the Kirby-Bauer technique for anti-microbial testing of plants, assumes that teachers have a basic understanding of elementary microbiology, e.g. terminology such as pathogenic, non-pathogenic, microbial growth, growth-inhibition zones, agar-diffusion, etc. and this did not apply to these teachers. Although they enjoyed the hands-on laboratory activities, many of them had difficulties understanding the theoretical foundation. A second problem was that teachers have limited exposure to educational jargon other than that of the CAPS curriculum. Some of them struggled to cope with the De Bono hats activity and they were also not clear on the tenets of the nature of science. This resulted in the identification of a number of design principles for the SLP during Cycle 2:
1. Provide teachers with an introductory lesson on microbiology terminology and techniques necessary for the Kirby-Bauer technique. The terminology that I assumed teachers would already know, such as pathogens, non-pathogenic bacteria, sterilisation, nutrient-agar growth media, Gram staining (of bacteria), among others were unknown to some teachers, and it was realised that this should be specifically addressed during the interventions in Cycle 2.

2. Schedule a session in which teachers are provided with techniques that would facilitate reflection and meta-cognition. The ‘hidden curriculum’ was to address teachers’ self-directed learning skills, and we emphasised aspects such as meta-cognition, problem-based learning, blended and cooperative learning all of which are important for Self-Directed Learning (SDL).

3. Provide a more comprehensive discussion on how De Bono’s Hats and Jigsaw method could be utilised as a pedagogy. Many teachers do not have repertoires of cooperative learning techniques.

4. Teachers have a very limited understanding of the tenets of the nature of science and a lesson should be devoted to these.

5. Conduct the short learning programme early in the year different to the first one that was done in November.

6. Allow teachers to work in groups and do group presentations so that assessment aspects of the SLP could be improved.

4.6 FOUNDATION FOR INTERVENTION TWO: PIET RETIEF, MPUMALANGA

Firstly, an appointment was made with the Principal of the Inquebeko Secondary School to ask for permission to use the school as venue for the intervention programme. After this, invitation letters were sent to Life-, Physical- and Natural Science teachers in Piet Retief, Mpumalanga – a semi-urban area, to attend a two-day short learning programme on how to incorporate indigenous knowledge in the science classroom. Some of the invitations were sent through the Principals, some through the Science Heads of Departments and some directly to the teachers. Nineteen teachers from various schools responded and attended the workshop,
though only fourteen participated actively in the pre- and post-questionnaire. This is because five of them were not teaching Natural Sciences or Life Sciences. Table 4.8 summarises the profile of the participants that attended the workshop. Only one participant has an Honours degree, seven obtained Bachelor’s degrees, two got National Professional Diplomas in Education (NPDE) and others hold Senior Teachers’ Diploma (STD) qualifications. The group consisted of nine males and five females and most of the participants taught two subjects ranging from grades 8–12. The majority taught Natural Sciences (9 participants) and only three teachers taught Life Sciences. Only four participants taught Physical Sciences, one of these did not teach Life or Natural science in combination with the Physical science. Two participants were teaching Technology and Mathematics while three were teaching Mathematics and Physical Sciences subjects. The same trend was noticed from the profile of the teachers in the second intervention as discovered in the first intervention, that is teachers teaching subjects that were not their majors in their post-secondary schools. This is actually due to unavailability of qualified teachers in this region.

Table 4.8: Profile of the Participants in the Second Intervention (Cycle 2 of the Designed Based Research) in Piet Retief district

<table>
<thead>
<tr>
<th>GENDER</th>
<th>NUMBER OF TEACHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>5</td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUBJECTS</th>
<th>NUMBER OF TEACHERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Sciences</td>
<td>5</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>2</td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>3</td>
</tr>
<tr>
<td>Life Sciences and Natural Sciences</td>
<td>2</td>
</tr>
<tr>
<td>Physical Sciences and Natural Sciences</td>
<td>1</td>
</tr>
<tr>
<td>Mathematics and Physical Sciences</td>
<td>1</td>
</tr>
</tbody>
</table>
4.7 ANALYSIS OF THE VNOS QUESTIONNAIRE

Findings from the VNOS questionnaire revealed that twelve participants were partially informed about the VNOS, two were uninformed and no one has an informed view. This is a very critical issue because it indicates the view of the teachers about the NOS and consequently affects how they include IK in their classrooms. The overview is Table 4.9.

Table 4.9: Samples of the responses to the VNOS Questionnaire

<table>
<thead>
<tr>
<th>VNOS Questions</th>
<th>Uninformed</th>
<th>Partially informed</th>
<th>Informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. What in your view is science? What makes science (such as physics, biology, etc.) different from other disciplines of inquiry (such as religion, philosophy etc.)?</td>
<td>'Sciences uses experiments to attempt to understand how things are done and how they are used'</td>
<td>'Science is the way in which people understand how the world operates and all things within and around it'</td>
<td>'Science is a way of critical thinking involving investigation, observation, research and making conclusions based on facts after a thorough experiment'</td>
</tr>
<tr>
<td></td>
<td>'Everything in Science pass the laboratory and be researched before it can be used'</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>'Science deals with models, hypothesis, experiments, facts and theories to formulate laws that are known as scientific laws but other disciplines do not need all these ideas to formulate laws'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2. What is an experiment?</td>
<td>‘Experiment is a way of getting fact by using apparatus or scientific diversity’</td>
<td>‘An experiment can be a practical investigation where you have apparatus that will be to carry out a particular instruction which involves aim, hypothesis, observation and results’</td>
<td></td>
</tr>
<tr>
<td>Q3. Does the development of scientific knowledge require experiments? Explain.</td>
<td>‘Yes so as to provide evidence in support of the perceived fact/knowledge. As well as to prove wrong certain things’</td>
<td>‘Yes, in order to test, observe and come out with the solution’</td>
<td></td>
</tr>
<tr>
<td>Q4. After scientists have developed a theory (for example the atomic theory, cell theory), does the theory ever change? Explain your answer.</td>
<td>‘NO. Before the theory is developed scientists study it by (i) testing it (ii) having hypothesis on it (iii) do experiments over it and observation (iv) write a theory on it (v) approved it’</td>
<td>‘Yes it changes due to series of practical experiment we realise some theory are changing’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘Do not change, because they have been practically’</td>
<td>‘Yes theoretical does change after conduct’</td>
<td></td>
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<tr>
<td>Question</td>
<td>Answer</td>
<td></td>
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</tbody>
</table>
| Q5. Is there a difference between a scientific theory and a scientific law? Explain the difference. | *Scientific theory* – that which need to be tested, more hypothesis  
*Scientific law* – that which has been proven that it will work and there is prove that it is working  
Yes. The law does not change, but theories can be changed into facts |
| Q6. How certain are scientists about the structure of the atom? What specific evidence do you think scientists used to determine the structure of the atom? | Periodic table should be used to find out more about elements  
Various theories and experiments were done by different scientists around the globe. Then their knowledge was used and came up with the answer |
| | Reflection of alpha particles by gold foil and electronic transitions. There’s is a possibility that the way we visualise the atom may change because whatever other evidence provided by other scientists like Schrödinger etc |

The text also mentions the importance of experimentation in scientific research and the role of theories in changing as new evidence is discovered. It explains the difference between scientific theories and laws, and provides examples of evidence used to determine the structure of the atom.
Q7. What methods do you think a sport scientist will apply to assist an athlete who regularly competes in a marathon but now struggles with pain in his legs during the last part of a marathon and what possible advice do you think he will give to the athlete?

- **‘They can use medicine from the first aid kid or consult a doctor to help him’**
- **‘I think he/she will tell the athletes to relax and stretch his/her legs and also put slonze on it’**
- **‘1. Experimental Method: whereby they will check the amount of oxygen flowing in his blood vessels. Accumulation of carbon dioxide in the muscle to cause cramps. Lactic acid in the muscles. 2. Inhalation of gases O₂ & CO₂’**
- **‘Ask for information like when it happens, how long it takes to recover, whether the athlete had enough practice at that level of competition, diet etc. the sport scientists will observe the athlete in training, monitor diet and rest periods. Advise him to train sufficiently, have enough warm up activity. Tests for any illness that may affect the athlete’s performance’**

Q8. Some scientists say that the HIV virus is causes AIDS while others say it is not. How are these different conclusions possible if both groups have access to and use the same set of data to derive these conclusions?

- **‘They are not possible if they are using same set of data. Either they are placed in different conditions, or may be the scientist did not follow the procedures correctly (one of the scientists). They need to test this together at the same time’**
- **‘I believe HIV cause AIDS because you become infected with HIV then HIV destroy all cells in your body then it leads to AIDS’**
- **‘The different conclusion can be possible if both groups have access to and use the same set of data derive these conclusions because it depends on their experimental observation and hypothesis’**
- **‘They might use different methods in carrying out this and it can also be affected by some factors like age, experience etc’**
- **‘Scientists can interpret the same set of data differently. There is also an element of subjectivity even though they are trained personnel’**

Q9. Do you believe that science reflects social and cultural values OR do you believe that science is universal and not affected by other

- **‘This is because facts that have been discovered by scientist are used worldwide. Scientist do not change the norms and standard of individual countries’**
- **‘I think science reflects social and cultural values because the scientist who begins to do his/her investigations, will be influenced by the society in which he/she lives in and the culture as well’**
- **‘I believe that science reflects social and cultural values, because we apply science daily without realising it. Little children apply it when playing eg. Making cars with cans or wires, add wheels so that the car can move. Granny taking’**
values? Explain.

'Science does not affected by other values, because scientists do research first before they introduce something to people and I don’t think that other values get affected by this.'

'Science reflect social and cultural values in the modern days because through many scientific breakthrough – like home appliances, clothing, weather/climatic conditions. Changes the cultural mentality etc. Science is universal because everything in the world is science. Demographic, topographical, natural resources etc.'

'Science reflects social and cultural values. When you look at invention you will see that certain things are popular with certain regions e.g. the interest with robots in Japan, China, Taiwan is higher than the rest of the world. The Blair latrine was developed in Africa because a larger part of the population still do not have access to flush toilets’

Q10. Scientists perform experiments or investigations when trying to solve problems. Other than the planning and design of these experiments or investigations, do scientists use their creativity and imagination during and after data collection? Explain.

'No. They can use their creativity and imagination because what they experience or investigate must be approved and should have been tested, observed and experimented before it is stated'

'Yes, scientist use imagination and creativity that is why there is hypothesis and aim when carry out experiments'

'They use imagination because if they are doing an investigation, there is a ‘hypothesis’. That is where they imagine what is going to happen at the end with whatever they are investigating with'

'Yes, after investigating they gather their information and come up with one thing. They use creativity for example, the periodic table was dis-organised and that scientists come up with atomic numbers and symbols that make it easy for us to understand it'

'Yes, I believe so, when imagining things, they come into existence. Scientist should and must be creative to come up with different ways of doing somethings. You make it happen. Sometimes we use data collected to come up with conclusion or use it to make final decisions about something. If...'
From the above, the responses indicated uninformed views because the participants deviated greatly from the anticipated answers as presented in Table 3.2. (see Chapter Three). Science does not only use experiments to understand how things are done and how they are used as responded by the participants, but rather science uses exploration of nature, the use of senses to make observations before reaching conclusions. Furthermore, knowledge and theories are tested by experiments, thinking and repeatability. It is clear that teachers, who work in a system that is examination-driven, do not give sufficient time on the tenets of the nature of science, and some had only a naïve understanding. This is something that should be addressed in teacher professional development programmes.

Table 4.10: Summary of coded responses of participants of VNOS questionnaire.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
<th>Q9</th>
<th>Q10</th>
<th>Overall</th>
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<tbody>
<tr>
<td>001</td>
<td>PI</td>
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<td>Weighting</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>2</td>
<td>2</td>
<td>0.6(≈ 1)</td>
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<tr>
<td>002</td>
<td>PI</td>
<td>UI</td>
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<td>UI</td>
<td>UI</td>
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<td>PI</td>
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<td></td>
<td>1</td>
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<td>0.2(≈ 0)</td>
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<td>003</td>
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<td>2</td>
<td>2</td>
<td>0.7(≈1)</td>
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</tbody>
</table>
The analysis of the VNOS Questionnaires indicates that none of the participants has an informed view on the nature of science while twelve participants have a partially informed view and only two have an uninformed view. This is of great concern because the teachers’ views on the nature of science has a correlation to how they teach science and incorporate IK in the classroom. Yezierski & Herrington (2011) point out that the teachers’ views of the nature of science are a crucial aspect in the development of their pedagogical content knowledge (PCK). This lack of a nuanced understanding of the tenets of the nature of science is one of the contributing factors to the transmission-
mode teaching in our schools at the expense of open-ended inquiry learning. Also, of course, the examination-driven education system, as discussed earlier is a factor. No post-intervention VNOS took place (see ‘Limitations of Study’ in Chapter 5). The reasons for this are twofold:

(a) The focus of my study is on teachers’ perceptions of the nature of indigenous knowledge systems, and not primarily on their views of the nature of science. However, as argued in Chapter Two, there are similarities between the indigenous knowledge and nature of science frameworks, e.g. both assume an empirical approach and emphasise tentative and creative approaches. The researcher argues that teachers views on the nature of science are going to influence their approaches and pedagogies in science education (also in teaching IK), and, therefore, wanted to determine their views.

(b) Due to the time needed to complete these questionnaires, we did not have sufficient time to also do the post-intervention VNOS questionnaire. However, while doing the classroom observations, the researcher sought evidence for an advanced understanding of the rules of science.

4.8 ANALYSIS OF THE VNOIK QUESTIONNAIRE BEFORE INTERVENTION

The participants completed the VNOIK questionnaire after the VNOS questionnaire was completed. They were able to do this in 55 minutes. Teachers’ responses to question one indicated that most of the participants were partially informed about what IK is and what makes it different from other types of knowledge. Question three, dealing with whether natural occurrences do have predictable explanations, resulted in fifty percent of the participants classified as having a partially informed view. Question 4 highlighted teachers’ ignorance on indigenous knowledge: none of them were informed on whether IK stay the same or whether it changes over time. In response to Question 9, half of the participants were identified as having an informed view and the answers provided corresponded with anticipated responses shown in Table 3.3. The responses of the informed participants contained much detail and
included appropriate examples. The conclusion drawn from the data is that the majority of the participants had a partially informed view on the nature of indigenous knowledge.

Table 4.11: Samples of responses to the VNOIK Questionnaire before intervention two

<table>
<thead>
<tr>
<th>VNOIK Questionnaire</th>
<th>Uninformed</th>
<th>Partially Informed</th>
<th>Informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. What in your view is indigenous (or traditional) knowledge? What makes indigenous knowledge different from other types of knowledge (such as western knowledge systems)?</td>
<td>‘To know where you are going to, you need to know where you are coming from. That is where indigenous fit in, it tells our history in order to understand our future’</td>
<td>‘Indigenous knowledge is a knowledge that a person acquires without performing experiments, test, collecting data and doing investigation but Western knowledge involves series of test, experiments, data collection and doing investigation to establish a hypothesis. Both could work but the only difference is the test and the use of instruments to carry out experiments and doing investigations to establish a fact’</td>
<td>‘Indigenous knowledge is knowledge derived from the elderly (old people) of different cultures, where they tell us which plants/animals and how these were used to cure/treat different ailments or illnesses. It differs from western knowledge because such a knowledge is not written down and no scientists were used or involved. Indigenous knowledge uses the plants and animals found in that area only’</td>
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<td></td>
<td>‘Indigenous knowledge usually is not tested by traditional people. It is sometimes not having correct measurement of ingredients compared to western knowledge whereby they use laboratories to test them, to measure them and to find out what they contain’</td>
<td>‘Knowledge rooted within a certain cultural group or geographical location. Western knowledge systems have become globalised and more systematic than traditional knowledge system. In indigenous systems there are certain guarded secrets and there is greater variation in the way knowledge is applied and passed on’</td>
<td>‘Indigenous knowledge is an act of probing into the metamorphorical mystery of nature by interactions, creativity, and innovation by believe, intellectual restrictions, and or transfer of knowledge from generation to generations through acquisition. IK is best suited for a particular area/enclave because it does not involve too many laboratory research, where it does it’s not global’</td>
</tr>
</tbody>
</table>
Q2. Practitioners of IK (e.g. elders, herbalists, traditional healers) observe nature to generate knowledge. Do they do experiments and tests in order to verify this knowledge? Give a reason for your opinion.

- "They do not do experiments because they don't have resources or laboratory."
- "No. They just use try and error method. They do not test anything but they just believe it will work for them."
- "Not exactly. They observe nature to generate knowledge. Some were taught or trained by their parents, some rely on their ancestors to reveal to them through dreams or consultations. Others know the plants; they use these themselves to prove that it does work."
- "Not always. Most of them they do not observe nature to generate knowledge. But it depends on their knowledge they experience. Some do observe nature to generate knowledge e.g. for healing people with some herbs."
- "I believe they do experiments and test for example they believe some certain things like lightning before rain so they can tell if it's going to rain or not. In the issue of birth, they also believe in certain things like resemblance of which they knew nothing about DNA."
- "Yes, these explanations have natural causes that are predictable because of their indigenous knowledge about the nature."
- "Yes sometimes it includes supernatural causes based on what they see or dream about."
- "From the fore-knowledge which the elders have these predictions are founded and proved to be true because they are happening the way they foresee them. They also believe that there is a supernatural being who make all these things happen the way they do."
- "No. Elders (some) believe people uses lighting to kill/to destroy other people. Some of their explanations are predictable but some are not because are unnatural."
- "Yes. It has natural causes that are predictable because if the wind is blowing at a certain speed, then you can able to tell the direction where the rain will be heading."
- "Explanations may be a mixture of both but some cases it's natural causes and predictable. For example, they will tell you hot summer morning will lead to thunderstorm in the afternoon or when explaining stomach ache there are natural causes and predictable. When it comes to things like lightning it usually..."
<table>
<thead>
<tr>
<th>Q4. IK is transferred from one generation to the next over many decades and centuries. Does this knowledge stay the same or does it change over time?</th>
<th>‘Stay the same because it does not move with the tide of ever changing moving world in terms of more sophisticated computerised equipment. IK is only through verbal knowledge transfer. If not transfer it died with the person forever’</th>
<th>‘It does change. Many years ago, elders was just used plants to heal any sicknesses. When that elder passed away, one in that family took over with the same knowledge but later he/she perform better’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5. <em>Hoodia gordonii</em> is a plant that used by Khoi-San hunters to suppress their hunger and thirst when they went on hunting expeditions. How do you think did the Khoi-San people came to know that this particular plant has these properties?</td>
<td>‘They got knowledge of this plant from their forefathers. (generation to generation).’</td>
<td>‘The Khoi-San studied the plant. They observe it and saw that the leaves of the plant can store water to make quench thirst and is was edible to suppress hunger’</td>
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<tr>
<td></td>
<td>‘Khoi-San was usually stay on the bush and living with plants’</td>
<td>‘Because the hunters would have experiment different types of plant before getting to know the plant that suppress their hunger and thirst’</td>
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<tr>
<td></td>
<td>‘Through Indigenous knowledge bequitted to them by their forefathers. Many years of observations, interaction with nature etc. Sometimes it can be gained through their metaphysical Sangoma way of doing things. Cultural believes that it can suppress their hunger and it is working for them’</td>
<td>‘Through experiment. I think that they noticed that if they’ve used this plant before hunting, they did not feel hungry or thirst’</td>
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<tr>
<td>Q6. Sustainable development is an emerging discipline that includes topics such as hunger, poverty, and underdevelopment. Globally governments and organisations struggle to get solutions for these important issues. Do you think IK can be used to solve these problems? • If you say yes, please explain why. If you say no, please explain why</td>
<td>’It can’t because they can use up the plant if use it unsustainably’</td>
<td>’I think so. Indigenous knowledge can help on how we can eradicate poverty and the food that can help us feel full for longer’</td>
</tr>
<tr>
<td>’No. IK cannot supply with such need’</td>
<td>’Yes it can be used in a way to solve because most people who are illiterates believe in indigenous knowledge’</td>
<td>‘Yes. If we can go back to our roots and see what our forefathers used to survive/to live without jobs and high salaries. They were eating more of vegetables and fruits. We need to use our nature as well to develop our universe’</td>
</tr>
<tr>
<td>Q7. What methods do you think a traditional healer will apply to assist an athlete who regularly competes in a marathon but now struggles with pain in his legs during the last part of a marathon and what possible advice do you think he will give to the athlete?</td>
<td>’The traditional healer will give the athlete anything that can boost his/her stamina nothing else. No possible advice that is good he can get from a traditional healer in this situation’</td>
<td>’Traditional healers will use water soaked with clothes particularly hot water to mop/massage the part of the body and then apply medicinal plants to rob the part even oil. Drink some concoction to suppress it’</td>
</tr>
<tr>
<td>’To run more and not relaxing’</td>
<td>’The healer will apply herbs or plants and bandage it and with time it could heal. The advice I’ll give to the athlete is to stick to what he knows if the indigenous healer seems better for him he must stick to it’</td>
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</tr>
</tbody>
</table>
Q8. Myths are stories that are told in different cultures by elders from one generation to the other. Do you think myths and rituals play an important role in IKS? Explain your answer.

| ‘Sometimes. Not always. Some myths are coming from what happened in the past’ |
| Yes, they help regulate people (kids, young and old) from doing things which are not meant for them e.g. there are herbs/medicines which are used by adults only, so stories were told to kids about such things’ |
| Yes it is important because it make us to have the vast understanding of indigenous knowledge’ |
| ‘They do because the myths and rituals are an integral part of the process of educating young people’ |
| ‘Yes it is important because it make us to have the vast understanding of indigenous knowledge’ |

Q9. Does IK reflect social and cultural values? Explain your answer.

Do you believe that IK is universal and be used globally to solve problems? If yes, explain why.

| No.’ |
| ‘Yes, so therefore it cannot be used globally because of different cultures.’ |
| ‘Yes. Because Western knowledge systems also started as indigenous knowledge until it was globalised through colonisation and missionary work. Nowadays Chinese medicine or eastern practices are spreading all over the world and becoming unacceptable’ |
| ‘Yes. Because we have different ethnic groups so people need to know how things are done in their ethnic group. And they will know that from elders.’ |
| ‘Yes. For example, cooking with fire was started somewhere, but now it is used globally.’ |
| ‘Yes. Where a person comes from has influences on his/her social and cultural values.’ |
| ‘Yes. Because where we have common knowledge which now is being used by scientists came from indigenous knowledge e.g. there are herbs for healing all diseases without being tested. (if a woman does not get...’ |
Q10. Indigenous knowledge is passed from one generation to the other by elders. The elders are deemed very important and their ways of knowing (knowledge) is truth and not to be challenged. Does this mean that current practitioners using IK must use this knowledge as it is to solve current problems in the community or can they use their creativity and imagination?

<table>
<thead>
<tr>
<th>Response</th>
<th>Commentary</th>
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<tbody>
<tr>
<td>&quot;I think it’s best if it is not changed as it is original because if it is somehow changed, may be best results won’t be obtained&quot;</td>
<td>&quot;It cannot be changed, it can cause some complications’</td>
</tr>
<tr>
<td>&quot;It can be used because of experience they have and they have seen many situations that makes them to know the end result of a particular problem’</td>
<td>&quot;IK is subject to change as all traditional healings of curing as different approaches of tackling it e.g. if you are not expected to pluck herbs as each herbs have different spirit that is controlling it. But now it change’</td>
</tr>
<tr>
<td>&quot;Yes creativity and imagination can improve the way we do things. Shaka Zulu changed the military strategies. If there was no creativity and imagination, then we would not notice a change from one generation to the other’</td>
<td>&quot;At times you can use it as it is but sometimes you can use your imaginations, and if there is a need test if it is correct or not’</td>
</tr>
</tbody>
</table>

4.9 ANALYSIS OF THE GENERAL QUESTION BEFORE INTERVENTION

The general questions consist of three open-ended questions. Below are the coded responses of the participants.

QUESTION 1- Why IK should be taught or why should it not be taught in the classroom?

Sub-theme 1. To gain more knowledge and right application

- ‘It should be taught to gain more knowledge about indigenous species and endemic plants and animals in our country. To be apply both indigenous knowledge compared to scientific knowledge’
- ‘It must be taught. Our young generation must have the knowledge of the past, how things were done and how were the good practice’
‘Indigenous knowledge widens the student knowledge’

Sub-theme 2. As a solution to social problem
- ‘It should be taught in the classroom because it will help learners in different ways: viz:- some kids are sick or have relatives who are sick, so if they’re taught indigenous knowledge, help could be in their environment and no need to pay money’

Sub-theme 3. IK is the basis of all other knowledge
- ‘Because we learn from the knowledge that we have (experience) and do overlapping to learn more’

Sub-theme 4. IK can be proven
- ‘It should be taught because it’s not costly and can be easily investigated’

Most of the participants agreed that IK should be taught in the classrooms because it can be used to solve problems in society and improve learners understanding of. But three participants felt it should not be taught because they felt it will be confusing and contradictory.

- ‘It should not be taught, it will confuse our learners’
- ‘It should not be taught because it may contradict learning of science’
- ‘It should not be taught as well because it contradicts with western well proven knowledge’

QUESTION 2. Briefly explain how you include indigenous knowledge in your lessons.

Sub-theme 1. Research projects
- ‘I will give a research project to the learners to ask their grandparent or elderly about indigenous plants and the diseases they cure’

Sub-theme 2. Experiments and Practicals
- ‘By letting learners experience fermentation in wine, or making bread using yeast
Building huts using sand
By making a cough mixture using leaves from plants asking from elders at home’
Sub-theme 3. Teacher-centred approach
- ‘By using the word of mouth, telling them what I was told when I grew up. Also by using newspaper cutting, if I come across something useful’
- ‘By giving or showing them what relates to the topic only so that they will not be confused’
- ‘In each lesson explain to learners how the thing that you are teaching them about started’

Sub-theme 4. Class Discussion
- ‘It is not easy, but when talking about health, I usually ask the learner to compare their own health to their grandfather or grandmothers’
- ‘Maybe if you teaching about plants, that’s where it fits in. you can tell them that our elders used to use plants before doctors came to our country there were no doctor so our elders uses different plants to make medicine to cure diseases that were there in those times’

Sub-theme 5. Building on learners’ prior knowledge
- ‘Most learners will easily understand what you will be talking about. Most learners are used to it’
- ‘I want my learners to know about the past, how they do things, their beliefs and move on to talk about the present’

It is evident from the data that some teachers still use chalk and talk approaches (teacher-centred) rather that learner-centred approach in their teaching. This lack of approach and pedagogical knowledge makes it difficult for teachers to introduce IK effectively. One participant concurred that it is not easy to incorporate IK in his classroom. It was encouraging though that some teachers referred to practical experimentation (e.g. fermentation processes) and another teacher gave a research project to the learners where they engaged in an ethnobotanical survey.

QUESTION 3. PROBLEMS PREVENTING THE INCLUSION OF IK

Sub-theme 1. Learners background
- ‘Learners are born by parents who do not care about the knowledge of the past
- Learners are use in the Western culture, eg they speak foreign language, they do not use their mother tongue fully’
- ‘Most learners are not staying with elder people. They are staying in town. Some learners are not interested in indigenous knowledge’
Sub-theme 2. Lack of IK-related materials in the school
- ‘Lack of supporting evidence and lack of reference material’
- ‘There are no books which specifically talk about indigenous knowledge’
- ‘If the history of what you are teaching about is not written down’
- ‘Not well balance knowledge, fact and figures through enough data to substantiate’

Sub-theme 3. Different beliefs and diversity
- ‘Environment. Culture. Different background’
- ‘Religious and cultural values’

Sub-theme 4. Lack of knowledge of indigenous knowledge
- ‘Not having enough knowledge of the plants that are in my surrounding’

Sub-theme 5. Fear of teaching Pseudoscience
- ‘Some of this things are not true, so it is dangerous to teach learners something that is not true (myths)’
- ‘You can’t prove the validity of it. You can’t make clear statements to the learners when they challenge you’

Question three addresses why teachers were not including IK in their classrooms. From the data collected, it was gathered this was because of the lack of IK-related materials in the classrooms.

Two participants viewed the teaching as Pseudoscience and that’s why they are not including IK in their classrooms.

A participant submitted that religious and cultural values were the challenges preventing the inclusion of IK in the classroom while others confessed that they lack the content knowledge.

4.10 ANALYSIS OF THE QUESTIONNAIRE AFTER INTERVENTION TWO

Table 4.12: Samples of responses to the VNOIK Questionnaire after the intervention.

<table>
<thead>
<tr>
<th></th>
<th>Uniformed</th>
<th>Partially informed</th>
<th>Informed</th>
</tr>
</thead>
</table>
1. What in your view is indigenous (or traditional) knowledge? What makes indigenous knowledge different from other types of knowledge (such as western knowledge systems)?

- **Knowledge we are born with. Indigenous knowledge is good and needs to be applied with an assistance of western knowledge. It differs because it uses the African way of healing or curing**
- **Indigenous knowledge is different from other types of knowledge because indigenous knowledge with varies from one culture to the other**
- **Indigenous knowledge that is vested in a specific culture or geographical location. Indigenous knowledge is mainly oral. It is not well recorded. Indigenous knowledge encompasses spiritual, and metaphysical aspects of life. It is holistic as opposed to western knowledge. Experimentation is involved but it's not as rigorous as western knowledge system**
- **It is knowledge of the past which is passed from generation to generation. It is different because it involves norms and standards and values of every nation. It is not based on experiment, hypothesis and evaluation**

2. Practitioners of IK (e.g. elders, herbalists, traditional healers) observe nature to generate knowledge. Do they do experiments and tests in order to verify this knowledge? Give a reason for your opinion.

- **Practitioners of indigenous knowledge do not experiment and test in order to verify this knowledge because it is an inborn knowledge**
- **No. They just dream it at night, then in the morning they wake up and mix what they dreamt of and apply it. They do not test it**
- **They sometimes do but it’s not as rigorous as Western knowledge practitioners. Though sometimes information is obtained through intuition or visions etc**
- **They do not, but it is something that one learns from the elders**
### 3. Elders in a community for example explain where lightning comes from or observe nature and give their explanation. Do these explanations always have natural causes that are predictable, or do the explanations sometimes include unnatural or supernatural (metaphysical) causes as well?

<table>
<thead>
<tr>
<th>As it is the culture of a person’</th>
<th>Test herbs on people or their patients’</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Yes it have natural causes that are predictable. Some of their observations are real’</td>
<td>‘Most of the things in indigenous knowledge are holistic beliefs which are metaphysical that also include facts and feelings’</td>
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<tr>
<td>‘Yes. Elders can look at the sky at night and if it’s clear, they will tell you that tomorrow it will be very hot’</td>
<td>‘They do not always have natural causes because they may involve supernatural causes’</td>
</tr>
<tr>
<td>‘They do not always have natural causes because they may involve supernatural causes’</td>
<td>‘Practitioners of indigenous knowledge sometimes give supernatural and explains as their sources of lighting e.g. witchcraft usually believe to form lightening to hit someone, and it looks happen because of the believe’</td>
</tr>
</tbody>
</table>

| Practitioners of indigenous knowledge sometimes give supernatural and explains as their sources of lighting e.g. witchcraft usually believe to form lightening to hit someone, and it looks happen because of the believe’ |

### 4. IK is transferred from one generation to the next over many decades and centuries. Does this knowledge stay the same or does it change over time?

<table>
<thead>
<tr>
<th>It stays the same, simple because we believe that what our grandfathers or elders are telling us is true. It stays the same as well because we turn to practice it after we are taught and we will pass the same message to our next generation’</th>
<th>It changes because now you can find scientists infusing IK with Science knowledge’</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘It doesn’t change, they using one and the same thing’</td>
<td>‘It doesn’t change since it is a cultural adopted practice that is handed over from generation to generation’</td>
</tr>
<tr>
<td>‘Indigenous knowledge does change. Culture itself is not really static. Because most of this knowledge is not documented, there are gaps for people to remove or add their own or create their own versions’</td>
<td>‘It is changing due to influence of technology and science theories’</td>
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</table>
5. *Hoodia gordonii* is a plant that used by Khoi-San hunters to suppress their hunger and thirst when they went on hunting expeditions. How do you think did the Khoi-San people came to know that this particular plant has these properties

- ‘Generational observation and found to be medicinal and effective’
- ‘They tested one and it worked and they adopted it’
- ‘They tested it and didn’t feel hungry after they ate it, that is how they came up with it’
- ‘They observed the plant. They became familiar with it, and they associate its characteristics by curing or suppressing hunger’

6. Sustainable development is an emerging discipline that includes topics such as hunger, poverty, and underdevelopment. Globally governments and organisations struggle to get solutions for these important issues. Do you think IK can be used to solve these problems?

- If you say yes, please explain why.
  - ‘Yes through aggressive drive to inculcate the IK into people as some of their approach/processes are not conflicting with science. Medicinal herbs, Agriculture, Agronomy etc’
  - ‘Yes, indigenous laboratories can be developed and people like Khoi-San who have more knowledge on plants do experiments and make herbs to cure diseases. Many people will spend less money on expensive drugs and save their money. Underdeveloped communities will benefit, get jobs’
  - ‘Yes IK is very useful and can help curb these problems’
  - ‘Since indigenous knowledge is knowledge of the past that is transferred from generations to generations, government can use this knowledge by consulting with the elders on how to survive since they survived in crucial times’

7. What methods do you think a traditional healer will apply to assist an athlete who regularly competes in a marathon but now struggles with pain in his legs during the last part of a marathon and what possible advice do you think he will give to the athlete?

- ‘He will use his knowledge of herbs which are able to give strength to the body and bring down the tension of the muscles. He will also advice the athlete to make certain
- ‘He might probably do some incisions on the athlete so that he can gain more energy. He might also tell him that there are forces working against his success’
precautions before doing the marathon

‘The traditional healer will give him herbs to heal the leg or massage his/her leg with oil to relieve the pain. He/she might advise him/her to eat or take certain herbs to prevent the pain during a marathon’

‘Traditional healer can give the athlete a traditional massage and medicine to boost his/her fitness. Medicine that can make him/her to have more energy’

‘May ask questions about the problem and prescribe herbs as therapeutic agents. May consult ancestral spirits’

‘The traditional healer will advise that athlete to take lot of water and eat beetroot. He will also check with the bones through ancestors the cause of that sickness.’

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<tr>
<th>8. Myths are stories that are told in different cultures by elders from one generation to the other. Do you think myths and rituals play an important role in IKS? Explain your answer.</th>
<th>‘No. Myth is not a fact. It is just a belief which people cannot rely on’</th>
<th>‘Yes, rituals and myths play a greater role’</th>
<th>‘Yes because it helps them to have vast understanding of indigenous knowledge’</th>
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<td>‘Yes. Sometimes myths can be true, because elders just tell you what they believe is right and if that thing can be proven scientifically you will find it’s the same as the elder has told you’</td>
<td>‘Yes the basis of indigenous practices are myths, the younger generation hears the stories and they also test to see if it works or not. If it works then they also continue the practice’</td>
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<td>Question</td>
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<td>9. Does IK reflect social and cultural values? Explain your answer.</td>
<td>'It does, in the area of consulting the Sangoma for luck, success, love etc</td>
<td>'Yes, because it is adopted by common people in a particular environment,</td>
<td>'Yes the practice is dependent on social and cultural values of the</td>
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<td>It is subjective because not many people believe it can solve problems globally e.g. the Scientist</td>
<td>practising the same social and cultural values.</td>
<td>community.</td>
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<td>'Yes, because it is adopted by common people in a particular environment,</td>
<td>No the practices or knowledge differs from place to place and country to</td>
<td>Yes, Chinese medicine and Indian medicine are now being practised in many</td>
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<td>practising the same social and cultural values.</td>
<td>country</td>
<td>parts of the world. So it can be globalised just like Western knowledge was'</td>
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<td>'No the practices or knowledge differs from place to place and country to</td>
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<td>'Yes. There are certain things that other culture believe in and others do</td>
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<td>not eg circumcision.</td>
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<td>Yes. One person started fire and put water and maize then a 'pap' was the</td>
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<td>product. Today that method is practised worldwide'</td>
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<td>10. Indigenous knowledge is passed from one generation to the other by elders. The elders are deemed very important and their ways of knowing (knowledge) is truth and not to be challenged. Does this mean that current practitioners using IK must use this knowledge as it is to solve current problems in the community or can they use their creativity and imagination?</td>
<td>'Yes I believe that indigenous knowledge cannot change it. Because they use plants as it is to solve that problem'</td>
<td>'They must work hand in hand with the Western Science in order to improve their standard of healing people'</td>
<td>'I think that IK practitioners can use their creativity and imagination to solve problems in order for IK to be more useful'</td>
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<td></td>
<td>'No. The current practitioners must allow other outsiders 'western science' to challenge them so that they will see another way of applying IK correctly'</td>
<td>'They must also be creative in attracting the new generation so that they are able to believe in their own culture'</td>
<td>'Yes. They can be creative to improve. They can also mix knowledge and come up with their own results'</td>
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</table>
Table 4.13: Summary of coded responses of participants to the VNOIK Questionnaire in the second intervention

UI = uninformed view (0); PI = partially informed view (1); I = informed view (2)

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<tr>
<th>Participant</th>
<th>Q1</th>
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|    | 001B |    |    |    | 001B |    |    |    |    |    |    |
|    | PI   | PI  | UI  | PI  | PI  | I   | PI  | I   | I   | PI |
|    | 1    | 1   | 0   | 1   | 1   | 1   | 2   | 1   | 2   | 2   | 1.2(≈1) |
|    | 002B |    |    |    | 002B |    |    |    |    |    |    |
|    | PI   | PI  | UI  | PI  | PI  | PI  | PI  | PI  | PI  | PI  | PI |
|    | 1    | 1   | 0   | 1   | 1   | 1   | 1   | 1   | 2   | 1   | 1.0(≈1) |
|    | 003B |    |    |    | 003B |    |    |    |    |    |    |
|    | I    | PI  | PI  | PI  | I   | I   | PI  | PI  | PI  | PI  | PI |
|    | 2    | 1   | 1   | 1   | 2   | 2   | 1   | 1   | 1   | 1   | 1.3(≈1) |
|    | 004B |    |    |    | 004B |    |    |    |    |    |    |
|    | I    | I   | PI  | PI  | I   | I   | I   | I   | PI  | I   |
|    | 2    | 2   | 1   | 1   | 2   | 2   | 1   | 2   | 2   | 1   | 1.6(≈2) |
|    | 005B |    |    |    | 005B |    |    |    |    |    |    |
|    | I    | I   | PI  | I   | PI  | I   | I   | I   | I   | I   |
|    | 2    | 2   | 1   | 1   | 2   | 2   | 1   | 1   | 2   | 2   | 1.6(≈2) |
|    | 006B |    |    |    | 006B |    |    |    |    |    |    |
|    | UI   | PI  | I   | UI  | I   | PI  | PI  | PI  | PI  | PI  | UI  | PI |
|    | 0    | 1   | 2   | 0   | 2   | 1   | 1   | 1   | 1   | 1   | 0   | 0.9(≈1) |
|    | 007B |    |    |    | 007B |    |    |    |    |    |    |    |
|    | PI   | UI  | UI  | PI  | PI  | PI  | PI  | I   | PI  | PI  | PI  |
|    | 1    | 0   | 0   | 1   | 1   | 0   | 1   | 2   | 1   | 1   | 0.8(≈1) |
|    | 008B |    |    |    | 008B |    |    |    |    |    |    |    |
|    | I    | PI  | UI  | PI  | PI  | PI  | PI  | PI  | I   | I   | PI  |
|    | 2    | 1   | 0   | 1   | 1   | 1   | 1   | 2   | 2   | 1   | 1.2(≈1) |
|    | 009B |    |    |    | 009B |    |    |    |    |    |    |    |
|    | I    | UI  | PI  | PI  | PI  | PI  | PI  | PI  | I   | PI  | PI  |
|    | 2    | 0   | 1   | 1   | 1   | 1   | 2   | 1   | 1   | 1   | 1.1(≈1) |
|    | 010B |    |    |    | 010B |    |    |    |    |    |    |    |
|    | I    | PI  | PI  | PI  | PI  | I   | PI  | PI  | PI  | PI  | PI  |
|    | 2    | 1   | 1   | 1   | 1   | 2   | 1   | 1   | 1   | 1   | 1.2(≈1) |
### Table 4.14: Comparison between the pre- and post-intervention responses to the VNOIK Questionnaire

<table>
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<tr>
<th>PARTICIPANT</th>
<th>PRE-INTERVENTION</th>
<th>POST-INTERVENTION VNOIK</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.9 ~ 1.0 = PI</td>
<td>1.2 ~ 1.0 = PI</td>
</tr>
<tr>
<td>2</td>
<td>0.7 ~ 1.0 = PI</td>
<td>1.0 = PI</td>
</tr>
<tr>
<td>3</td>
<td>1.4 ~ 1.0 = PI</td>
<td>1.3 ~ 1.0 = PI</td>
</tr>
<tr>
<td>4</td>
<td>1.7 ~ 2.0 = I</td>
<td>1.6 ~ 2.0 = I</td>
</tr>
<tr>
<td>5</td>
<td>1.1 ~ 1.0 = PI</td>
<td>1.6 ~ 2.0 = I</td>
</tr>
<tr>
<td>6</td>
<td>1.3 ~ 1.0 = PI</td>
<td>0.9 ~ 1.0 = PI</td>
</tr>
<tr>
<td>7</td>
<td>0.7 ~ 1.0 = PI</td>
<td>0.8 ~ 1.0 = PI</td>
</tr>
<tr>
<td>8</td>
<td>1.2 ~ 1.0 = PI</td>
<td>1.2 ~ 1.0 = PI</td>
</tr>
<tr>
<td>9</td>
<td>0.6 ~ 1.0 = PI</td>
<td>1.1 ~ 1.0 = PI</td>
</tr>
<tr>
<td>10</td>
<td>1.3 ~ 1.0 = PI</td>
<td>1.2 ~ 1.0 = PI</td>
</tr>
<tr>
<td>11</td>
<td>1.0 = PI</td>
<td>1.4 ~ 1.0 = PI</td>
</tr>
<tr>
<td>12</td>
<td>0.6 ~ 1.0 = PI</td>
<td>1.1 ~ 1.0 = PI</td>
</tr>
<tr>
<td>13</td>
<td>0.7 ~ 1.0 = PI</td>
<td>1.1 ~ 1.0 = PI</td>
</tr>
<tr>
<td>14</td>
<td>0.7 ~ 1.0 = PI</td>
<td>1.3 ~ 1.0 = PI</td>
</tr>
</tbody>
</table>
From the results it is clear that, two participants were fully informed after the intervention while the other twelve participants were partially informed. There was none that was uniformed both before and after the intervention. Actually, it was only one participant (Participant 5) that improved from partially informed to informed after the intervention. One of the participants though dropped in average but managed to maintain partially informed. It could be observed that eight participants improved after the intervention with a slight increase in average though they still remain partially informed (PI) while two dropped in average but remained partially informed. Furthermore, the responses of the participants after the second intervention indicated that the SLP helped to improve the PCK. It was also evident during the classroom observation that the SLP impacted positively on teacher’s PCK. The second intervention was therefore more successful than the first intervention, based on the fact that we re-conceptualised the SLP with the second intervention, after the disappointing results of Cycle 1. These are further discussed in paragraph 4.11 and 4.13. The fact that no assumptions were made about the teachers’ pre-knowledge this cycle (like we did in Cycle 1) meant that teachers developed a far better understanding of the pedagogies and procedures dealt with during the SLP. I have also realised though that such a limited short learning programme is not sufficient to assist all the teachers in obtaining a fully informed view of IK. A more systemic, longitudinal approach will be needed.

4.11 ANALYSIS OF THE RESPONSES TO THE GENERAL QUESTIONS AFTER THE INTERVENTION

The general questions before and after the intervention consist of three questions. Unlike the first intervention, similar questions were asked both during the pre-intervention and post-intervention stages.
1. WHY SHOULD INDIGENOUS KNOWLEDGE BE TAUGHT OR WHY SHOULD IT NOT BE TAUGHT IN THE CLASSROOM?

<table>
<thead>
<tr>
<th>Sub-theme 1. To gain more knowledge and right application</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘It should be taught because it addresses the issues learners deal with everyday and can make learner think out of the box and make learners integrate the two systems’</td>
</tr>
<tr>
<td>- ‘Yes, should be taught in the classroom so that people must know about their indigenous knowledge…….’</td>
</tr>
<tr>
<td>- ‘It should be taught because they need to know the past then the present’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 2. To preserve IK</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘It should be taught to preserve the norms and standard of every nation’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 3. It should be validated</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘No. It should not be taught because so many things need to be tested or proven their validity or their usefulness’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 4. As a solution to social problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘….It can also be used as an alternative means of solving problems’</td>
</tr>
<tr>
<td>- ‘It should be taught to help solve many problems that the society faces/experiences that would make us and the next generation to live longer’</td>
</tr>
<tr>
<td>- ‘It should be taught so that people can have alternative ways of solving problems. And not just one way’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 5. To promote social and cultural values</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Indigenous knowledge should be taught in the classroom because it reflect social and cultural values…….’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 6. IK can be proven</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘IK should be taught in classroom because - i. some of the facts can be investigated, tested. ii. Jigsaw method. iii. De Bono’s thinking hats.’</td>
</tr>
<tr>
<td>- ‘Indigenous knowledge should be taught because it is not everything that is totally wrong. Some animals are used as early warning systems and the outcomes are always true’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 7. IK is the basis of all other knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘……it is the one which is the foundation of all what is taking place observed by scientists’</td>
</tr>
</tbody>
</table>
After the intervention, many of the participants were now more enlightened and aware of indigenous knowledge. This is indicated by their responses to Question 1 which is why indigenous knowledge should be taught or not to be taught. Many responded that it should be taught so as to gain more indigenous knowledge since it is the basis of all other knowledge and also as a means of solving problems in our society. However, a participant insisted it must not be taught in the classroom because some of the knowledge is not yet proven.

2. BRIEFLY EXPLAIN HOW YOU INCLUDE INDIGENOUS KNOWLEDGE IN YOUR LESSONS

<table>
<thead>
<tr>
<th>Sub-theme 1. Teacher-centred approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Teaching about cure of different diseases e.g. stomach problems, nose bleeding, diarrhoea’</td>
</tr>
<tr>
<td>- ‘By telling learners a brief history of what you are presenting about…’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 2. Building on learners’ prior knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘By talking about what people believe in. learners also have their IKS from their societies’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 3. Integrating with other learning area</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Indigenous knowledge wouldn’t have content on their own but to integrated with other learning area’</td>
</tr>
<tr>
<td>- ‘I can only include it by making examples based on the indigenous knowledge’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 4. Research projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘I’ll give a project to my students to research about indigenous knowledge plants that are found in their locality with the help of their grandparents or the elderly and also what kind of diseases they cure’</td>
</tr>
<tr>
<td>- ‘By telling learners to interview the elderly in the community about the different plants that they know as well as their use’</td>
</tr>
<tr>
<td>- ‘When looking at different species of plants and different plants herbs, I can ask learners to go and make a collection of plants and their uses by asking from the elders’</td>
</tr>
</tbody>
</table>
Responses to Question 2 show that the participants really gained from the workshop on various pedagogy that can be used to include indigenous knowledge in the classroom. Many responded that they will incorporate indigenous knowledge by making their learners to have group discussions and engaging them in inquiry-based learning by giving them research project to do. One participant responded thus: ‘I’ll give a project to my students to research about indigenous knowledge plants that are found in their locality with the help of their grandparents or the elderly and also what kind of diseases they cure’. Though two participants still indicated a teacher-centred approach.

3. WHAT ARE PROBLEMS THAT MIGHT PREVENT YOU FROM INCLUDING INDIGENOUS KNOWLEDGE?

<table>
<thead>
<tr>
<th>Sub-theme 1. Lack of time and Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Lack of time and interest’</td>
</tr>
<tr>
<td>- ‘Lack of reference materials, stereotyping’</td>
</tr>
<tr>
<td>- ‘If I could not find history of what I will be teaching about’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 2. Learners’ background and factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Some of the learners are more westernised and there are now few elders with the indigenous knowledge. Time has also changed, our learners do not have any background about indigenous knowledge’</td>
</tr>
<tr>
<td>- ‘No problem. (it will depend on learners feeling about the topic) eg learners might feel that is old fashioned’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-theme 3. Religious belief and cultural diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- ‘Contradiction with other learners’ religion and culture’</td>
</tr>
<tr>
<td>- ‘The multicultural and social and religious values and moral practices’</td>
</tr>
<tr>
<td>- ‘The fact that even in the same community there are variations of the same IK makes it difficult to come out with a single outcome’</td>
</tr>
</tbody>
</table>
Sub-theme 4. Lack of Content knowledge

- ‘Lack of knowledge. Not having enough information about indigenous plants that we have and their use.’
- ‘Insufficient knowledge, informal approach etc.’

Challenges that may prevent them from including indigenous knowledge in their lesson ranges from lack of time and resources, religious beliefs and cultural diversity, lack of content knowledge and learners’ background. Some participants confessed that they lack the knowledge about the indigenous plants - ‘Lack of knowledge. Not having enough information about indigenous plants that we have and their use’. It is also evident that lack of resources is another major challenge preventing participants from including IK in their teaching - *Lack of reference materials, stereotyping*

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**Fig 4.5:** Participants having group discussion during the De Bono’s hat activity: Here participants are developing their pedagogical knowledge on how to use De Bono hat to teach HIV/AIDS.
Fig 4.6: Participants testing the anti-microbial power of *Aloe Vera*. Here the teachers practice microbial laboratory procedures.

Fig 4.7: Participants working in the laboratory: making bacterial smears on nutrient-agar petri dishes, and engaging with a simplified Kirby-Bauer technique.
4.12 ANALYSIS OF THE INTERVIEWS

The audio-taped recording from the teachers’ interviews was transcribed word for word. These transcriptions are provided in Appendix D. The Saldana coding technique was used to analyse the data. After coding the data, similar codes sharing same traits were grouped into categories. Furthermore, the similar categories were grouped to form themes. It was open coding done manually as codes and themes were not predetermined. The three types of coding as explained by Saldana (2009), were used in coding the data. These are in-vivo which involves the use of exact word or quote from the participants as a code; descriptive coding summarising the words of the participants when coding and value coding which searches out the attitudes, values and reflections of participants in data and uses them as code.
Table 4.15: Quotes, codes, categories and themes

<table>
<thead>
<tr>
<th>QUOTES FROM THE INTERVIEW</th>
<th>CODES</th>
<th>CATEGORIES</th>
<th>THEMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘………. because when talking about IK, they are something that are found locally’</td>
<td>- Origin of IK</td>
<td>1. Knowledge of IK</td>
<td>1. Perceptions of teachers regarding IK</td>
</tr>
<tr>
<td>‘IK I believe is the knowledge that are passed from ancestors, from the past.’</td>
<td>- Meaning of IK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Most of the time IK is conservative, people don’t want to share the idea with others. IK is not opened.’</td>
<td>- Conservative nature of IK</td>
<td>2. Differences between Western Knowledge and Indigenous Knowledge</td>
<td></td>
</tr>
<tr>
<td>‘IK it’s not been confirmed’</td>
<td>- Limitations in terms of testability and evidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘it makes learners to understand better.’</td>
<td>- Developing better understanding, participation and interest in learners</td>
<td>3. Reasons to include IK in NS classroom</td>
<td></td>
</tr>
<tr>
<td>‘it will make students to understand the subject much easier like because when you teach like concept something they are not familiar with, they might find the subject boring, you don’t even see them. But when you start with what they know, what capture their mind, if you talk of something they have seen so it will make it easy to understand, it’s easy for them to participate’</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘I won’t really say they do’</td>
<td>- Teachers not prepared to teach IK from school</td>
<td>1. Preparation</td>
<td>2. Teachers’ professional development in regards to IK</td>
</tr>
<tr>
<td>‘Natural Science?’</td>
<td>- Lack of understanding of nature of science</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
'…… the methodology I use is question and answer.'

<table>
<thead>
<tr>
<th>Challenges in teaching IK</th>
<th>Lack of Support</th>
<th>3. Learners’ factors</th>
<th>4. Lack of time</th>
<th>5. Religion and belief</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Little or no information in textbooks</td>
<td>- No adequate training from the department to teach IK</td>
<td>- Learners’ lazy attitude</td>
<td>- Completion of syllabus</td>
<td>- Teachers’ religious beliefs</td>
</tr>
<tr>
<td>- IK is orally transmitted</td>
<td>- No support from the school</td>
<td>- Learners living alone with no parents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Lack of IK-related material resources in school</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Learners’ contribution</td>
<td>- Teachers’ scaffolding</td>
<td>1. Instructional methods</td>
<td>4. Incorporation of IK in the NS classroom</td>
<td></td>
</tr>
<tr>
<td>- Little or no cultural diversity</td>
<td>- Support from other teachers</td>
<td>2. Addressing diversity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Consultations and communication with other teachers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Instructional methods
2. Incorporation of IK in the NS classroom
3. Teachers’ community of practice
The following section discusses the themes that emerged when the transcriptions of the interviews were analysed.

**Theme 1: Perceptions of teachers regarding IK: although an intervention programme provided teachers with a more nuanced understanding of IK, continued support is needed.**

That data showed that teachers have some understanding of the meaning of IK. The participants explained their understanding of the meaning, its importance and relevance to teaching Natural Sciences.

**Category 1.1: Knowledge of IK**

The data indicated that the participants understood the meaning of IK even though they expressed this in different ways.

**Category 1.2: Differences between IK and Western Science**

According to the findings, teachers understand that there are differences between IK and Western Science (WS). Most participants reckoned that IK is learned at home while WS is acquired from school. IK is gathered from the communities in different cultures while WS is normally scientifically proven unlike IK. Though some participants had the opinion that IK is not open but conservative and limited in terms of testability and evidence.

**Category 1.3: Reason to include IK: the affective domain**

The majority of the participants agreed that there can be positive changes in the NS classroom by the inclusion of IK, as it may develop the learners’ interest in learning science and also improve their participation in the classroom.
Theme 2: Teachers’ professional development regarding IK

The data collected indicated that the participants experienced several challenges in relation to the inclusion of IK in teaching Natural Sciences, mostly the lack of PCK.

Theme 2 highlights the teachers’ need for professional development in regard to IK and Category 2 under this theme shows teachers’ lack of PCK as one of the challenges preventing teachers from including IK in their classrooms.

Category 2.1: Lack of training

All the teachers admitted they did not have any former training in school that could serve as a preparation to teach IK in the Natural Sciences classroom. Teacher education institutions are often criticised as being distant from practice and ineffective in preparing student-teachers for the demands of the profession. This is partly due to the political past of our country, and the Eurocentric approach that characterised education in South Africa. Furthermore, the findings reveal that the teachers do not have any understanding of the NOS.

Category 2.2: Lack of PCK

This category reveals that teachers’ lack of PCK deters the effective teaching of IK in the Natural Sciences classrooms. Teachers acknowledged that they have little or no knowledge as regards the contemporary curriculum and inclusion of IK in their teaching of Natural Sciences. In order to infuse IK in the teaching of Natural Sciences, teachers need relevant PCK or the competence of the IK practices of different cultural groups; pedagogical knowledge is how to effectively present learning opportunities for learners when exploring IK and contextual knowledge or knowledge of the learners’ various cultural backgrounds.

Theme 3: Challenges in teaching indigenous knowledge

Category 3.1: Resources to teach indigenous knowledge

Teachers identified lack of IK-related resources as one of the reasons why it is difficult to include it in the NS classroom. Furthermore, they explained that there is little or no information in textbooks to help in the teaching of IK. The fact that IK is orally communicated does not help since there is no documentation and makes including IK
a challenge for the teachers. The SLP did assist the teachers in providing some learning materials that they could use in future.

Category 3.2: Lack of Support

Teachers have not been receiving adequate support from the Department of Education to help them include IK successfully in the Natural Sciences classroom. Likewise, teachers reported that schools do not have any support system for this. The Department needs to organise in-service education training for the teachers to upgrade their skills and the knowledge they impart to learners.

Category 3.3: Learners’ factors

Some of the participants revealed that only a few learners return with information when asked to enquire at home about the practices of IK. Another challenge is that most learners live alone and therefore have no one to pass the local knowledge to them.

Category 3.4: Lack of time

It was indicated by the participants that lack of time and pressure to complete the syllabus within the stipulated time contributes to why it is difficult to include IK in the Natural Sciences classroom.

Category 3.5: Religion and Belief

The information gathered indicates that some participants are bound by their religious beliefs regarding the inclusion of IK. Belief systems discouraged some teachers.

Theme 4: Incorporation of indigenous knowledge in the Natural Science classroom.

Category 4.1: Instructional methods

Few participants explained that they taught learners by questioning them and by encouraging learners to make enquiries about IK at home.

Category 4.2: Addressing diversity

Teachers in this area had little or no experience with learners’ cultural diversity because the majority are from Swathi and Zulu that have almost the same culture and traditions. A problem was of course that a few Swati or Zulu example were included in
this SLP- definitely a design principle for the next cycle of IK short learning programme (which is not within the focus of this M.Ed. study).

Category 4.3: Teachers community of practice

Few participants, especially the foreign nationals, consulted with other teachers to get more knowledge on IK in the community.

Category 4.4: Sources of indigenous knowledge or information

Teachers from the community indicated that they try to get information on IK from the internet, parts of the textbook and by asking learners to make enquiries at home.

4.13 ANALYSIS OF THE CLASSROOM OBSERVATIONS

In Appendix E, the Reformed Teaching Observation Protocol (RTOP) instrument is provided with notes made during my classroom observations. The RTOP instrument helped to address question one, two and four of the research questions. Question one aimed to find out how the teachers’ pedagogical content knowledge (PCK) inform on their infusion of IK in their teaching of natural sciences (NS). This was determined by the third, fourth and the fifth part of the RTOP instrument mostly. The fourth part consists of the Propositional Knowledge and Procedural Knowledge which refers to understanding of the subject matter, and how connections are made with other disciplines. Also the third part of the RTOP (Lesson design and implementation) revealed whether teachers tapped into the learners’ prior knowledge, and built the lessons on the knowledge that learners brought to the classroom - this assisted in answering the second research question. Finally, the fifth part of the RTOP (Classroom culture) helped to discover the various teaching methods teachers were using to present their lessons. This was used to address both the first and the second research questions. The instrument was indeed useful to capture aspects of teachers’ PCK regarding IK in their teaching of natural sciences.

In the instrument, each item is rated on a scale ranging from 0 to 4. 0- a 0 indicates that the issue of relevance never occurred during the lesson, whereas a 4 means that
it is characteristic of the lesson. Intermediate ratings do not indicate the frequency an item but rather the degree to which that item is characteristic of the lesson observed. Using a Likert scale in the RTOP instrument does not make it a quantitative instrument. Several other researchers (e.g. Cronje, 2015 and Van Wyk, 2016) have used the RTOP instrument in qualitative studies. The following is a description of emerging themes from these lesson observations.

Table 4.16: The results of the classroom observations before intervention

<table>
<thead>
<tr>
<th></th>
<th>PARTICIPANT 1</th>
<th>PARTICIPANT 2</th>
<th>PARTICIPANT 3</th>
<th>PARTICIPANT 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson design and</td>
<td>1.8 ≈ 2</td>
<td>1.4 ≈ 1</td>
<td>1.6 ≈ 2</td>
<td>2.2 ≈ 2</td>
</tr>
<tr>
<td>implementation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propositional knowledge</td>
<td>2.6 ≈ 3</td>
<td>2.6 ≈ 3</td>
<td>1.6 ≈ 2</td>
<td>2.0</td>
</tr>
<tr>
<td>Procedural knowledge</td>
<td>1.2 ≈ 1</td>
<td>1.4 ≈ 1</td>
<td>0.6 ≈ 1</td>
<td>0.4 ≈ 0</td>
</tr>
<tr>
<td>Communicative interactions</td>
<td>1.6 ≈ 2</td>
<td>1.4 ≈ 1</td>
<td>1.0</td>
<td>1.2 ≈ 1</td>
</tr>
<tr>
<td>Student/teacher</td>
<td>2.4 ≈ 2</td>
<td>2.2 ≈ 2</td>
<td>1.6 ≈ 2</td>
<td>1.0</td>
</tr>
<tr>
<td>relationships</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OVERALL</td>
<td>2.0</td>
<td>1.6 ≈ 2</td>
<td>1.6 ≈ 2</td>
<td>1.2 ≈ 1</td>
</tr>
</tbody>
</table>

The table above indicates that for Participant 1, his rating for lesson design and implementation is 1.8 which is approximately 2. This means that he is average because of the degree at which the item occurred in his lesson. Learners’ prior knowledge was recognised and they were encouraged to participate actively. Participants 1 and 2 had their highest rating of 3 in propositional knowledge items because they had a good grasp of the content knowledge, and models and drawings were used to represent phenomena during the lesson. They all had a low rating in procedural knowledge because learners did not actively engage in thought provoking activities and reflective thinking did not take place during the lessons. Also, communicative interactions were low for all the participants as communication only occurs between learners and teachers on occasion and none among learners as would be expected in a good lesson.
Fig 4.9: Graph showing the classroom observation after using RTOP during pre-intervention

As shown by the graph, Participants 1 and 2 had a good rating of 3 in Propositional knowledge while Participants 3 and 4 had a rating of 2. The lowest rating was 0 by Participant 4 in the item for procedural knowledge.

Table 4.17: Results of the classroom observation after intervention

<table>
<thead>
<tr>
<th></th>
<th>PARTICIPANT 1</th>
<th>PARTICIPANT 2</th>
<th>PARTICIPANT 3</th>
<th>PARTICIPANT 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson design and implementation</td>
<td>0.4 ≈ 0</td>
<td>2.4 ≈ 2</td>
<td>2.2 ≈ 2</td>
<td>2.6 ≈ 3</td>
</tr>
<tr>
<td>Propositional knowledge</td>
<td>1.6 ≈ 2</td>
<td>2.8 ≈ 3</td>
<td>2.6 ≈ 3</td>
<td>2.8 ≈ 3</td>
</tr>
<tr>
<td>Procedural knowledge</td>
<td>0.4 ≈ 0</td>
<td>1.6 ≈ 2</td>
<td>1.4 ≈ 1</td>
<td>0.8 ≈ 1</td>
</tr>
<tr>
<td>Communicative interactions</td>
<td>0.4 ≈ 0</td>
<td>1.8 ≈ 2</td>
<td>1.8 ≈ 2</td>
<td>1.6 ≈ 2</td>
</tr>
<tr>
<td>Student/teacher relationships</td>
<td>0.2 ≈ 0</td>
<td>2.4 ≈ 2</td>
<td>2.2 ≈ 2</td>
<td>2.0</td>
</tr>
<tr>
<td>OVERALL</td>
<td>0.4 ≈ 0</td>
<td>2.2 ≈ 2</td>
<td>2.0</td>
<td>2.2 ≈ 2</td>
</tr>
</tbody>
</table>
From the Table above, Participants 2, 3 and 4 increased from 1 to 2 in the item – Communicative interactions. Active communications were allowed in their lesson to a higher degree than during the pre-intervention classroom observation. A change was also noticeable in the item – procedural knowledge for Participants 2 and 4. It was very encouraging to notice that Participant 4 improved in all the items rated after the intervention.

![Graph](image)

Fig 4.10: Graph showing the classroom observation after using RTOP during post-intervention.

The above graph indicates an improvement by Participants 2 and 4 in lesson design and implementation. In propositional knowledge, there was an improvement from Participants 3 and 4 by one point. Only Participant 2 improved in procedural knowledge from 1 to 2 while Participants 2, 3 and 4 improved their communicative interactions.

The above findings show that Participant 1 dropped in performance even after the intervention. This could be as a result of the topic that was taught before and after intervention. In the pre-intervention, the topic was food chain, here he could include IK more but during post-intervention, the topic was periodic table. Teachers do not have sufficient pedagogical content knowledge to be able to include specialised IK related to particular CAPS themes; neither do they have sufficient self-directed learning skills to do research. To get back to the periodic table: traditional leather tanning could have
been used as an example to show how calcium powder used for leather tanning was obtained by grinding the bones of cattle and adding some potash. There was slight improvement for the other participants in their performances after the intervention which did indicate that the workshop helped to develop their PCK to be able to include IK. For instance, Participant 2 taught adaptation and its features in his lesson. He was able to engage the learners to participate and reveal their cultural knowledge in the classroom.

Fig 4.11: Graph comparing the pre- and post- intervention of the classroom observation after using RTOP

4.14 ANALYSIS OF THE ARTEFACTS
The lesson plans for each lesson observed was collected to see if it shows and cater for learner-centred approaches to the teaching of indigenous knowledge in the Natural Sciences classroom. The lesson plans showed little or no preparation for the inclusion of IK. Generally, the teachers were unable to do micro-curriculum development to effectively introduce IK. Also, there was no indication that teachers could carry out experiments to introduce IK scientifically where necessary in their lessons. It is difficult to change existing practices and teachers function in a system that is assessment and examination-driven at the expense of more inquiry learning approaches.

4.15 LOOKING AT THE DATA FROM A CULTURAL HISTORICAL ACTIVITY THEORY PERSPECTIVE

As earlier explained in Chapter Two, third-generation Cultural – Historical Activity Theory (CHAT) is used as a lens to paint a portrait of teachers’ lived experiences and to act as a barometer for existing problems. CHAT effectively captures tensions in an activity system (in this case, the Natural Sciences classroom, and the challenges and barriers in incorporating IK in Natural Sciences learning). The themes that emerged were used to identify the tensions and the relationships between the subject (Natural Sciences teacher), the rules, the community, division of labour, tools, object and outcome. In this study, the subject is the Natural Sciences teachers and the tools they use in teaching and learning in the classrooms. Tensions could arise within components of an activity system (e.g. among the rules), between components of an activity (e.g. between rules and subject) and it can occur between two activity systems.

4.15.1 Tensions involving the subject

Looking at the Natural Sciences teacher as the subject of this activity system, he/she is part of the community, has a role as a lifelong learner and facilitator of learning in the classroom. He/she is also expected to handle the various tools needed for learning, have a good understanding of the NCS policy and its application, a sound Content Knowledge (CK) and PCK. He/she must also be aware of the rules applicable
in the schools and classrooms. More often, tensions arise as the subject tries to do his/her duty.

The first tension identified is that existing between the subject and the tools. The subject teachers are expected to infuse IK in the teaching of Natural Sciences, but this can only occur when the teacher has an adequate understanding of the NCS policy, its application and the nature of science, and the tenets of the nature of indigenous knowledge. There must be adequate knowledge of IK and availability of IK-related materials to enable teachers to institute learning successfully. Inappropriate or inadequate tools to achieve this could give rise to tension. From the data collected, the teachers indicated lack of knowledge on IK, lack of CK and PCK, lack of IK-related materials in the schools and also inadequate preparatory training in schools as reasons for them not including IK in the Natural Sciences classrooms. The lack of some of these tools creates problems for the subject (teacher) and resulted in the object (development of teachers’ PCK) not being satisfactory and ultimately the outcome (inclusion of IK in the Natural Sciences in a scientific rigorous way) not being fully achieved (paragraph 4.12). One of the larger problems identified is that teachers, despite their enthusiasm directly after the SLP, quickly return to old practices (transmission-mode teaching), and very little evidence was visible of inquiry teaching during the post-intervention school visits.

Another major tension identified was between the subject (teacher) and the community. Some of the teachers experienced tensions in the relationship with the community, resulting in not teaching indigenous knowledge due to a fear of clashing with the beliefs, religion or culture of learners or parents. Some teachers indicated that they do not include IK in the teaching of Natural Sciences because of their own beliefs and religion and that of the learners as indicated in Category 3.3 of Theme 3 on the challenges preventing the inclusion of IK in the classroom of the interview coding. For instance, some Christians view IK as being in conflict with Christian dogmas, due to the fact some traditional leaders communicate with the ancestors.

Another tension that emerged was the diverse indigenous learner community that had to be accommodated, as this resulted in confusion on which indigenous knowledge to teach. The teachers also experience tension due to lack of adequate support from the community from parents, school and Department of Education. This actually highlights
the claim that such SLP’s should address Self-Directed Learning (SDL) among teachers. It is impossible to cover all aspects related to the teaching of IK in this limited time and it is hoped that the SLP would increase the interest of the teachers and that they would set learning goals for themselves.

It was also discovered that tension arose between the subject and the rules. The rules in this activity system include the guidelines of the NCS, the rules of the school in which these teachers are operating and the norms, values and social interactions around the school and in the classroom. Lack of proper awareness of these rules causes tension which brought about an uninformed or partial view on indigenous knowledge and also the fear of teaching pseudoscience.

The division of labour also brought about tension in the activity system. The teachers revealed that only few learners produce information when asked to go and make enquiries at home regarding IK, causing tension for the subject. Another challenge is that most learners live alone and, therefore, no one passes IK to them. In addition, various roles expected of science teachers could lead to tensions or contradictions. The division of labour required of the science teachers to act a scientists, teacher and student (a lifelong learner) which led to tensions in the activity system as the teachers did not have the time to carry out all these roles.

### 4.15.2 Tensions between the object and the community

Many teachers are of the opinion that generic CAPS training as arranged by the Department of Education does not adequately assist them in their own PCK development. Although CAPS expect from teachers to include IK in their teaching, the DoE does not sufficiently assist teachers by providing training opportunities, or providing sufficient resources.

### 4.15.3 Tensions between the tools and the rules

The inquiry-based learning expected to enhance effective teaching and learning is difficult to achieve due to the school rules in terms of the time table which limits time allocation. This poses a challenge for the teachers when they have to ensure they
finish the syllabus within the specified period before the examinations. Furthermore, there is tension between the tools and the community. Some parents are not supportive when it comes to providing materials or guidance to their children when they are asked for information from home on indigenous knowledge. The Department of Education is not also forthcoming in providing required tools and materials to enhance the inclusion of IK in the Natural Sciences classroom.

The third-generation CHAT is a very useful framework to discover the various tensions or conflicts that exist within an activity system. In the real sense, tensions are not sign of weakness and should not be seen as part of failure, rather they are obstacles to be overcome in order to achieve goals. Tensions reveal richness in the activity system. They identify opportunities for creative innovations and for new ways of structuring the activity. From this study, it was discovered that tensions present within the activity system provided an opportunity to create awareness about IK and for expansive learning to take place during the interventions on how to include it in a scientifically rigorous way in the Natural Sciences classroom.

![Model of Activity System by Engeström](image)

Figure 4.12: Model of Activity System by Engeström (Engeström 1987: 78)
4.16 CONCLUSION

This chapter has highlighted the findings from the data collected during this research. The data collected before and after the interventions was analysed using the design-based research method. The last chapter will focus on the recommendations and conclusions while also highlighting the challenges encountered in the course of the research.
CHAPTER FIVE

DISCUSSION OF THE FINDINGS, RECOMMENDATIONS AND CONCLUSIONS: CROSSING BOUNDARISED EPISTEMOLOGIES IN SCIENCE EDUCATION – THE AFFORDANCES OF INDIGENOUS KNOWLEDGE

5.1 INTRODUCTION

This study aimed to investigate teachers’ perceptions and experiences of the inclusion of IK in the Natural Sciences classroom. It focussed on the views of teachers on IK and the challenges they experience with its inclusion in the classroom. A qualitative design-based research was employed with a phenomenological flavour. The element of phenomenology assisted me to describe the lived experiences of the teachers in the inclusion of IK in the classroom.

Data for this study were collected by means of questionnaires, artefacts such as lesson notes, individual interviews and classroom observations. The data were coded and categorised into themes. These were analysed and interpreted into findings. The Classroom observations were analysed using the RTOP instrument as this observational instrument can be used to assess the degree to which science instruction is reformed (Sawada, Piburn, Falconer, Turley, Benford, Bloom & Judson, 2000). The findings were integrated with literature and third-generation CHAT was used as a lens to paint a portrait of teachers’ lived experiences. CHAT provided a useful tool to capture teachers’ lived experiences and the challenges (tensions) that they experienced. CHAT effectively captures tensions in the activity system (in this case, the Natural Sciences classroom, and the challenges and barriers that teachers experience in incorporating IK in Natural Sciences learning). This chapter contains the major findings of this research, recommendations that will help to address the problems, the limitations of the study, suggestions for the future research and conclusion.
5.2 IDENTIFIED DESIGN PRINCIPLES FOR THE SHORT LEARNING PROGRAMME

In true DBR fashion, a number of design principles were distilled from this study to help future planners and facilitators of short learning programmes on the inclusion of indigenous knowledge in the natural sciences classroom. These design principles are highlighted below:

5.2.1 Design principles based on content and theory

When planning a short learning programme on indigenous knowledge in the Natural Sciences classroom, good content is desirable to ensure that correct and relevant knowledge is obtained.

i. Due to teachers’ limited understanding of the tenets of the nature of science, these tenets should receive proper attention, and teachers should be shown how they relate to the teaching of natural sciences.

ii. Attention should be given to both the natural sciences and indigenous content knowledge for appropriate effective learning. Where possible, indigenous knowledge should be linked with CAPS curriculum themes, so that teachers know how IK could be infused in the operational curriculum.

iii. Connect local indigenous knowledge to global science (NOS) and global innovations and describe how indigenous knowledge has prompted scientific discoveries (e.g. many commercial drugs are developed from ethnobotanical leads, e.g. aspirin, atropine, camphor, morphine and quinine (Balick & Cox, 1996).

iv. Content related to specific topics in the Natural Sciences curriculum should be included in the short learning programme.

v. Content that is useful in everyday life as well in line with scientific literacy, nature of science and indigenous knowledge tenets should be included. A Science-Technology-Society approach should be adopted.

vi. Make the content of programme relevant to teachers with different educational and cultural backgrounds. In other words, the course should encompass the cultural diversity in the country.
vii. Provide ‘shoestring’ science as alternatives for teachers who do not have the necessary equipment in their classrooms. One of the aims of such a SLP should be to develop teacher agency in improvising teaching and learning resources. For example, chemicals/ active ingredients in muthi plants can be extracted even in an under-resourced classroom, using simple chromatography techniques.

viii. Make use of topics from the curriculum to help the teachers in their PCK -and professional development.

5.2.2 Design principles based on practical inquiry learning

i. Teachers should be provided with an introductory lesson on microbiology terminology and techniques, necessary for the adapted Kirby-Bauer technique. During the first intervention, we were surprised by the lack of knowledge and skills that teachers showed.

ii. There should be proper profiling of teachers to investigate whether they understand the nature of science and mastery of the basic laboratory techniques required to teach the CAPS curriculum. Teachers with a better developed PCK could do a more advanced short learning programme, whereas teachers with under-developed PCK should first do an elementary SLP, where basic terminology is addressed.

iii. A pre-questionnaire should be sent to teachers before the short learning programme, to get an idea of the teacher’s pedagogical knowledge and knowledge of laboratory techniques.

5.2.3 Design principles based on practical considerations

i. Plan for sufficient time for the short learning programme to ensure success of the programme. Not less than three days should be allocated for the intervention.

ii. The package for the short learning programme should include learner and teacher resources on indigenous knowledge useful for the participants both during the intervention and afterwards. Teachers indicated that they do not have access to information on indigenous knowledge.
iii. Certification should be given to the participants after the completion of the short learning programme as motivation.

5.2.4 Design principles based on pedagogy

i. Provide a scheduled session in which teachers are exposed to techniques that would facilitate reflection and meta-cognition. This study has shown that many teachers are not critical reflective practitioners.

ii. Provide a more comprehensive discussion on how De Bono’s Hats could be utilised as a pedagogy- for many teachers this was their first encounter with this teaching strategy.

iii. Use local resources and indigenous knowledge as much as possible. Teachers should be encouraged to approach local indigenous knowledge experts in their local communities.

iv. Allow teachers to work in groups and do group presentations. Emphasise the criteria for true cooperative learning, as identified by Johnson & Johnson (2009), namely positive interdependence, individual accountability and personal responsibility, promote interaction, appropriate use of social skills and group processing. To many teachers, cooperative learning is seen as synonymous to group work, and teachers do not necessarily understand the nuances of true cooperative learning.

v. Those with knowledge of IK from the community should be invited to share their understanding with the participants.

vi. Support teachers in an on-line community of practice. In general, such short interventions have limited impact on teacher professional development. Continued support after the intervention is needed, and this can be provided using the social media, or Blackboard on-line platforms.

vii. Acknowledge local indigenous ways of doing things and appreciate diversity.

viii. Introduce teachers to how they can incorporate indigenous knowledge into their classroom in a scientifically correct manner by making use of high tech science labs.
5.3 SUMMARY OF FINDINGS

One of the aims of the questionnaire was to examine the views of the Natural Sciences teachers on IK and NOS. Findings from the questionnaire revealed that none of the teachers were knowledgeable about the nature of science and the majority had a partial view of NOIK. Therefore, it is difficult to implement the integration of indigenous knowledge and the nature of science in their classrooms. Lesson observations before the intervention revealed that teachers only pay lip service to IK in their classrooms with little or no involvement from the learners. The fourth research question aimed at finding out how a short learning programme could change the pedagogy of the teachers and the third objective was to determine how many of the proposed integration principles of indigenous knowledge, addressed in the professional development intervention, actually were transferred to the science classroom. Three of the lessons observed showed a slight improvement in their teaching strategies. Unfortunately, some of the teachers only mentioned examples of indigenous plants and dealt very superficially with indigenous knowledge.

During the lesson observations evidence of transfer of this knowledge was evident though very slightly. This emphasises the importance of supporting teachers in an online community of practice.

The lack of significant changes, especially for the first interventions on the nature of indigenous knowledge and only slight change in pedagogy after the intervention, could be attributed to lack of assimilation of the new knowledge due to the teachers’ background and prior knowledge. The teachers’ prior knowledge, beliefs and experiences play a very vital role when absorbing new information. The existing knowledge and laboratory skills of the teachers in both interventions were very weak, as many of them did not have any background in Natural Sciences. According to Vygotsky, mediation through social interaction drives learning and development (Donald, Lazarus & Lolwana, 1997). Mediation is the process of facilitating learning and involves helping a person to form links in the process of understanding. When mediating, the facilitator is able to help the individual to connect the familiar with the unfamiliar. And if there is no familiar knowledge (prior knowledge), it becomes difficult
for learning to take place. Like learners, teachers also bring prior knowledge with them to professional development interventions. Warford (2011) asserts that to make such an intervention programme successful, the facilitator should begin by providing tools for the teachers enabling them to reflect on their previous experiences. In this intervention, the pre-questionnaires on the nature of science, indigenous knowledge and how they implement it into their classroom were used as a tool to reflect on their assumptions.

Effective learning occurs if mediation is carried out in zone of proximal development. This is the gap between what the learner knows already and what can be learned with the assistance of a mediator. The learner must actively interact with the lesson in the zone of proximal development to construct his own learning. Though the participants were eager and excited to learn more about indigenous knowledge, but hindered by their lack of prior knowledge, basic experimental design and laboratory skills. The intervention did however help the participants by creating more sensitivity, awareness and appreciation of IK. Though the Natural Sciences teachers are not yet experts on IK, the views of the majority of the participants on the nature of IK changed and their interest increased. Also, it is hoped that the intervention assisted them to become more self-directed as learners, and that they will, in Knowles (1975:18) words, ‘... take the initiative, with or without the assistance of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes’.

Below are the findings from the study that indicated teachers’ experiences in incorporating IK into their NS classrooms.

5.3.1 Teachers’ views on NOS and NOIK

It was gathered from this study that teachers lack understanding of the tenets of the NOS which impacts greatly on the inclusion of IK in the Natural Sciences classroom. This is evident during the second intervention when the VNOS questionnaire was administered to the participants.
Table 5.1: Summary of Teachers’ views on NOS during the second intervention

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From the above table, two of the participants were uninformed, 12 were partially informed and none had an informed view on NOS. Though the questionnaire was only administered before the intervention due to time constraints, the teachers were asked about their views the nature of science during the post-intervention interviews. These results showed that most teachers lack understanding of the VNOS which is alarming. Many teachers view science as static with a step by step mode of enquiry that must always be followed. However, scientific ideas are subjected to change and in making enquiries, there are no fixed methods or procedures to be followed to discover scientific knowledge – the ‘scientific method’ in the minds of many teachers does not make provision for creativity. The teachers’ view of the nature of science is a crucial aspect in the development of their pedagogical content knowledge (PCK) (Yezierski & Herrington, 2011). The VNOS requires inquiry-based approaches in the classroom where teachers are expected to engage in authentic activities in laboratories. But with the lack of correct VNOS, teachers find it difficult to undertake the inquiry-based approach. Teachers are unable to facilitate open-ended inquiry as a result of lack of understanding of scientific concepts and processes. This is not surprising since they do not understand. The research also reveals that majority of the teachers have partially informed views on the nature of indigenous knowledge.

The views of participants on some of the aspects of indigenous knowledge did change. Although it seemed that there were only slight changes in the views of the participants after the intervention, there were none that were uninformed both before and after both interventions. After the intervention, the teachers now had a more educated view on IK.
5.3.2 Learners’ cultural background

South Africa is rich in cultural diversity, and this in a way can pose a challenge in the Natural Sciences classroom. It is possible for a teacher to be knowledgeable in terms of indigenous knowledge in his/her own culture but does not necessarily know much about indigenous knowledge of other cultures. This is a very great challenge for teachers in multicultural classrooms in South African schools, but for this study it was fortunate that all the learners were from a similar cultural background. The study reveals that they are either from Zulu or Swathi backgrounds according to Participant 1 during the interview. This has helped greatly in solving the problem of whose IK to teach in the classroom. The only issue arising here is the teachers’ cultural background. Most teachers are not from the locality due to lack of qualified teachers in the community.

5.3.3 Teacher training

The most common reason given for joining the teaching profession is to make a difference in the lives of learners. To have a chance of achieving this, teachers must be given adequate preparation in the training school that will equip them with the skills required to be a change agent (Fullan, 1993). Teacher education institutions are often seen as distant from real practice and ineffective in preparing student-teachers for the demands of the profession (De Beer, Lautenbach & Batchelor, 2013). Teacher education programmes must help to prepare teaching candidates to effectively include IK in the Natural Sciences classroom and provide the necessary content knowledge. According to Pascale (1990), mastery is necessary for effectiveness, it is also a means of achieving deeper understanding. To have mastery as a teacher in the subject area involves teacher’s education, training and career and professional development. The study reveals that teachers were not adequately prepared to teach IK in the NS classrooms during their pre-service teacher education programmes. All the teachers confessed they did not have any former training in school that could prepare them to teach IK in the Natural Sciences classroom. This was evident during the individual interviews when participants were asked if they were prepared from teacher training school to teach IK. A response from one of the participants - ‘I won’t really say they do’. McDermott (2006) emphasised that teachers need to understand the topics they
teach at a deeper level. Many teachers were trained in the former colleges of education and have limited content knowledge to do justice to the subjects when teaching in the classroom (Rollnick et al, 2008). They were not taught in such a way that they have a deeper understanding of what they were to going to teach. Without any doubt, teachers need relevant and adequate content knowledge for effective teaching in the classroom. It is important to note that strong and useful PCK depend on strong knowledge of the content (Rohaan, Taconis & Jochems, 2010; Smith, 1999). Mastery of a subject involves initial teacher’s education, training and career long staff development.

5.3.4 Lack of professionally qualified teachers to teach natural sciences

The lack of professionally qualified teachers in the NS classroom was also discovered to be a reason for not introducing IK in the classrooms. This was not much of a surprise because of the shortage of qualified experts to teach NS in the country (Ball, Hill & Bass, 2005). Unlike in developed countries, most teachers teaching NS did not even study or major in NS or NS education during their tertiary education level. From the findings of this research, many of the teachers are graduates of other disciplines that opted (or were co-opted) to teach NS in the wake of the shortage of qualified NS teachers. This was evident from the profile of the teachers both for the first and second intervention. Therefore, it is likely that such teachers may not have acquired much NS knowledge to handle the introduction of IK to their teaching in NS classrooms. This is of great concern as it could lead to decreasing proportion in the numbers of learners undertaking science-related studies which will have a ripple effect and cause a crisis in Science education. Eventually, it will further lead to the shortage of skilled Science professionals in the workplace and an even higher scarcity of qualified teachers in our schools. The inclusion of IK in the NS classroom will help to alleviate this problem by making more learners to be interested in studying science. According to Aikenhead (2006), indigenous learners will learn to appreciate science when they see it as meaningful to them. It is very urgent that we increase the number of qualified science teachers in the country.
5.3.5 Teachers’ lack of pedagogical content knowledge and lack of reflection

The first research question for this study was to find out how the teachers’ PCK inform on their infusion of IK in their teaching of NS. The researcher discovered the answer to this during the classroom observations and individual interviews with the participants. The research indicated that most of the teachers lack adequate academic approaches for including IK into their teaching of NS. When teachers lack the approach to teach a particular content, it will be difficult for them to transform content knowledge into a form that can be understood by the learners (Shulman, 1986). On the other hand, when teachers have sound pedagogical approach to teaching a topic they will likely offer quality instructions that would promote learners’ conceptual understanding. Scholars like Shulman (1986) believes that content knowledge and pedagogical knowledge are needed for effective teaching and that they are inseparable rather they interact together as pedagogical content knowledge (PCK). It was revealed during the interviews with teacher and the classroom observations that teachers do not reflect on their own teaching practice. This also resulted in teachers’ lack of capacity to build necessary pedagogical content knowledge needed to effectively include indigenous knowledge in the Natural Sciences classroom. Teaching supersedes merely transferring of knowledge and implementing the methods and techniques acquired through teacher training at colleges or universities. The profession goes with a great challenge that requires teachers to think and reflect (Gravett & De Beer, 2010). A participant during the interview confessed that he uses question and answer methodology - ‘… the methodology I use is question and answer

Table 5.2: Summary of the responses to the Questionnaire before intervention

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Table 5.3: Summary of the responses to the Questionnaire after intervention

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From the data collected, it is clear that some teachers find it difficult to incorporate IK based on their lack of PCK, support from DoE and adequate knowledge of IK, as well as religious views.

5.3.6 Lack of support from the department of education

The second research question of this study was to find out how do NS teachers experience teaching IK systems in the NS classroom, and what are the challenges the teachers face in incorporation of IK in their Natural Sciences classroom. This also correlates with the second objective which was to identify the problems that teachers
experience in the inclusion of IK in the Natural Sciences classroom. In response to this, the teachers pointed out the lack of support from the Department of Education as a major challenge. The NCS and the refined CAPS for Natural Sciences expects teachers to include IK in their teaching. The question arises whether all Natural Sciences teachers are equipped to do this and if there is sufficient support provided by the DoE to comply with these requirements. Curriculum developers and policy formulators place more emphasis on the what of the curriculum and not the how. And this is a great challenge for the teachers who are the implementers of this curriculum in the classrooms (Ogunniyi, 2007). Hope (2002:40-44) explains that it is not easy to transform educational policy into practice, regardless of the level from which it emanates, as many hindrances can arise when attempting to implement policy. These include lack of resources, lack of time, implementers’ indifference or incapacity. Various research on policy implementation around the world indicate that many educational reforms aimed at improving the quality of learning have been more challenging than supportive in their impact on education (Morris & Scott, 2003:71-84). This research shows that these teachers lack adequate support from the Department of Education. Subject advisers should assist in identifying special areas that can help teachers to cope with these challenges in the inclusion of IK. The Department needs to organise in-service education training for the teachers to upgrade their skills and the knowledge they impart to learners. It is important to emphasise the social process by which teachers as curriculum policy implementers are trained, equipped and supported on how to implement policies in the classroom (Maluleke, 2013).

5.3.7 Lack of resources

Another reason for the difficulties in incorporating IK into teaching is the lack of resources in the schools. The teachers indicated a lack of availability of IK-related materials in their schools and they encounter problems in finding materials to use in class and some materials cannot be easily brought to the Natural Sciences classroom. The teachers do not have the awareness of the use of ‘shoestring approaches’ to make their own apparatus and teaching aids using everyday objects. Furthermore, the textbooks used in the classrooms give little or no proper information on IK and many who were trained in the old ways depend solely on the textbooks content for teaching. Those few textbooks providing information on IK do so in the form of examples with
no attention given to teaching strategies and practical work that can be introduced in the classroom, or to the true foundations of both the nature of science, and the nature of indigenous knowledge. Since the textbooks lack adequate information, most teachers are forced to turn to the learners, parents and community to seek information on IK. Unfortunately, many learners fail to produce any useful information, either because they live alone with no elderly figure at home for information or their parents do not show interest in their studies. A major problem is also that most IK is transmitted verbally from one generation to the other without any proper documentation. Unlike Western knowledge, IK is not in archives or in the laboratories, it is active in the indigenous people’s culture. This is why it is so essential for researchers to record it, before it is lost for future generations.

5.3.8 Religious beliefs

It was revealed from the interviews that some participants are constrained by their religious beliefs concerning IK. Their belief systems therefore discourage them as they felt their religion is compromised if they include it in their teaching.

Some participants also felt that teaching of IK amounts to teaching pseudoscience since the knowledge is not documented. This is further compounded by the teachers’ lack of adequate understanding of NOS as this subject should be introduced in a scientific manner in the NS classroom, but this becomes difficult when they had uninformed or partially informed views on the nature of science and the nature of indigenous knowledge. The teachers’ prior knowledge, beliefs and experiences have a large influence in shaping their understanding of the curriculum (Spillane, Reiser & Reimer, 2002:387-431).

5.4 RECOMMENDATIONS

Below are some recommendations that might be useful in better incorporating indigenous knowledge in the science classroom.
5.4.1 Development of teachers’ pedagogical content knowledge

Inclusion of IK in the classrooms requires high pedagogical expectations and demands that educators at all academic levels are also researchers. Therefore, there is need to develop teachers’ PCK by providing the opportunity for them to spend time in research laboratories to improve their understanding of the nature of science. (The value of such an approach has been shown by Pretorius (2015), where teachers in her study learned DNA biotechnology procedures during an ‘internship’ at the African Centre for DNA Barcoding in Johannesburg). It was observed during this research that many teachers do not have the skills to conduct research activities in the laboratory. Teachers need support in teaching IK in terms of education and content. Once-off approaches such as a single workshop are not enough to develop effective teaching strategies for inclusion of IK in their classrooms. As explained by Steyn (2010) there is little that a short workshop can achieve in teachers’ professional development when compared to long-term programmes offering on-going support which are more effective and have lasting results. In the researcher’s opinion, teachers’ PCK could be developed through:

a) Communities of Practice: Barriers to inquiry-based learning such as lack of resources and inadequate in-service education should be addressed by developing teaching strategies and improving the PCK of teacher’s within a functional community of practice as the latter should not be underplayed. Teachers learn best through interactions with other teachers and more competent peers can encourage and assist their colleagues on how to improve their knowledge. Communities of practice will also expose novice teachers to good and more experienced teachers and this could make up for the inadequacies of pre-service teacher education as the neophyte teachers capitalise on the strengths of those with experience. When teachers share best practices among themselves, it enhances their PCK and develop confidence. Though some teachers do react negatively to communities of practice, and this can be due to influence by the old school methods where teachers used to work individually and were solely responsible for their methods of teaching unlike the new curriculum policy which encourages teachers to work together as a team.
b) Teachers’ critical reflection on their own practice: Teacher’s reflection on his/her own teaching provides good insight into how to regard science. It will assist in re-examining the events that happen in the classroom, solve problems that arise during teaching and look for ways of improving the learning and teaching processes. This can be achieved when the teacher is consciously aware and notes what happens in the classroom. The process of reflection includes reviewing, reconstructing and critically analysing one’s teaching practices and then categorising these into evidence for changes to be made to improve teaching skills. Daily reflection on each lesson is important to develop the teachers’ PCK and professional practice. This study provides tools for such a self-reflection exercise. The intervention during the short learning programme made the pre-questionnaires on the nature of science and indigenous knowledge available, and how to implement it into their classroom - these were used as a tool to reflect the teachers’ assumptions regarding the nature of science, indigenous knowledge and how to include indigenous knowledge in a natural sciences classroom in a scientific rigorous way. Reflection is an important part of professional development.

5.4.2 Empowering teachers to follow shoestring approaches in the under-resourced classroom

Many schools in South Africa are under-resourced especially in rural areas and many schools do not have equipment to make learning easy and effective. Funding is tight, grants are not forthcoming and equipment is expensive. These are the common complaints from the schools’ authorities and science teachers and yet science must be taught and learning must take place. To solve this problem of a lack of resources in our schools, it is important to think out of the box and create possible solutions. There are inspiring scientists who use simple materials and resources from the community to develop equipment and apparatus making science learning easy and interesting. These are known as shoestring approaches. Science-on-a-shoestring is very useful especially for those learners or schools with few supplies, limited budgets and no access to laboratory equipment. Science-on-a-shoestring consists of a series of relatively inexpensive, hands-on laboratory exercises or practicals that incorporate
inquiry-based learning to teach concepts and techniques of modern science. It helps teachers to bring exciting and significant hands-on science to their learners. Learners are able to take ownership of their experiments during practicals, are more independent and have fun. It promotes great interaction among learners when working in groups and improves their performance in their laboratory report.

The hands-on nature of science-on-a-shoestrings provides the materials needed to build upon the learners understanding of the world. What they have read in textbooks which they may not have understood and are abstract are made real by these hands-on activities.

The issue of the lack of resources or under resources can also be addressed by teachers by collaborating with neighbouring schools and borrowing resources that are lacking from another nearby school that may have such resources. The use of mind experiments (practicals done only in theoretically) is also known as an alternative to practicals and can be used by teachers to make up for lack of resources. Teachers should source materials from the neighbourhood and local industries to make IK more interesting in the Natural Sciences classroom. Micro-kits could also help to perform various experiments in the laboratory to make IK more meaningful in the classroom. Developing resource material with information on indigenous knowledge for use by science teachers is important and should be practically linked to scientific topics in the curriculum, as well as scientific investigations and hands-on techniques. Above all, shoestring approach should be developed by teachers to solve the problems in under-resourced schools. This approach improvises, using low-cost materials and apparatus to solve the problem of lack of resources. Teachers could use everyday objects to improvise if apparatus is not available and make use of the school environment or local community to illustrate concepts to learners.

5.4.3 Providing indigenous knowledge resources in schools

Very little resources exist in schools for the teaching of indigenous knowledge. Efforts should be intensified to make IK-related materials available to help in the effective incorporation of IK in the Natural Sciences classroom. The Indigenous Knowledge for Self-Directed Learning Programme at the North-West University (Potchefstroom Campus) is busy with a research programme funded by the National Research
Foundation (NRF) and the Fuchs Foundation to develop resources for teachers, to include IK in their teaching. One of the exciting developments, is the development of puppets and scripts, to teach Foundation Phase learners about indigenous knowledge. Since indigenous knowledge is an oral tradition, story-telling is an excellent pedagogy for incorporating indigenous knowledge in science (or, in the case of FP learners, Life Skills). In Figure 5.1 the puppets that were developed for this purpose by the NWU and UL consortium is shown.

![Image](foundation.png)

Figure 5.1: Puppets can be used with great success to teach primary school children about indigenous knowledge

### 5.4.4 Promotion of inclusive education

Inclusivity should become a central part of the organisation, planning and teaching at each school. This can only happen if all teachers have a sound understanding of how to recognise and address barriers to learning and how to plan for diversity. The key to managing inclusivity is ensuring barriers are identified and learners' backgrounds are considered when planning lessons (CAPS, 2012). Teachers need to have contextual knowledge of the learners in their classrooms. Learners must be made to understand the uses of Natural Sciences and IK in their environment. Science learned at school produce learners who understand that school science is relevant to everyday life. The
use of pedagogies and practices aimed specifically at improving learning will help to promote inclusivity. Furthermore, curricula must be formulated to accommodate all learners irrespective of their background so that learning content will not be decontextualized and will be reflective of the life experience of learners. Learners’ cultural and traditional background must be considered and there should be tolerance of different cultures. This will ensure that every learner is accommodated during the teaching and learning process.

5.4.5 Training of pre-service science teachers in contextualised science teaching

The literature states that teacher education institutions are often distant from the real practice and ineffective in preparing student-teachers for the demands of the profession (De Beer, Lautenbach & Batchelor, 2013). Tertiary institutions training science teachers should offer a specific module on indigenous knowledge to their students to improve their understanding and also to help them to develop PCK for their duties in the classrooms. By highlighting indigenous knowledge, student teachers will develop a more nuanced understanding of the importance of contextualising science better for learners. Gibbons (2000:161) remind us that “… society can ‘speak back’ to science. Reverse communication is generating a new kind of science, let us call it context-sensitive. In epistemological terms, context-sensitive science is new in the sense that it produces socially robust knowledge, that is, knowledge likely to be reliable not only inside but also outside the laboratory”.

5.4.6 Support from the department of education

The Department of Education should offer workshops and/or short courses to teachers, including professional development programmes to enable teachers to include IK successfully in their classrooms. PCK should be addressed to include content knowledge, contextual knowledge, best learner-centred approaches and hands-on workshops on the introduction of IK. The Department of Education should provide centres where teachers can find the resources they need to make their work easier. On-going support should be offered to science teachers on integrating IK and
the NOS. Furthermore, providing information addressing integration of IK on different topics in the curriculum will also be beneficial.

5.4.7 A stronger focus on self-directed learning

During this intervention there was a strong focus on developing self-directed learning skills in teachers. Problem-based learning and cooperative learning approaches were followed in the lab activities, with the hope that teachers would realise what affordances these hold for the school classroom. In this discussion of self-directed learning, I am guided by the work of Knowles (1975:19) who describes self-directed learning as “…a process by which individuals take the initiative, with or without the assistance of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating outcomes”.

This indigenous knowledge research is anchored in the above principles of self-directed learning. The assumption is that the short learning programmes stimulate self-directed learning since reflection and metacognition are emphasized, and teachers engage in problem-based learning that challenge them to formulate learning goals for themselves. During the short learning programme teachers are provided with limited knowledge and skills (due to a lack of time), and teachers will have to do individual research on the indigenous knowledge of the various cultural groups in their regions. They will have to identify appropriate learning opportunities and resources. Also, teachers are challenged during the programme to utilise inquiry-learning approaches in their classrooms, based on the tenets of science, and this also sparks a cycle of individual goal setting and professional learning in teachers. Unfortunately, most teachers make use of transmission-mode pedagogies, and in this short learning programme they are exposed to problem-based approaches. In the process teachers often realise that they have very limited understanding of the tenets of the nature of science.

5.5 CONTRIBUTIONS OF THIS STUDY
In this study, these are theoretical, methodological and practical contributions to the body of knowledge

5.5.1 Methodological contribution: the VNOIK questionnaire

The Views of the Nature of Indigenous Knowledge (VNOIK) questionnaire developed by Cronje et al (2015) was confirmed and validated as a very useful instrument for determining the views of science teachers on the nature of indigenous knowledge and also a good instrument to measure the effect of a short learning programme on the views of science teachers. Since Cronje et al developed this instrument, several other researchers have embarked on research using the instrument, notably the SDL research group at NWU. My study broadened the pool of teachers who completed the VNOIK questionnaire. The goal is to eventually use Rasch modelling to determine construct validity (Bond & Fox, 2007). This psychometric model is used to analyse categorical data and should be useful to identify items that do not fit and so improve the instrument. However, Rasch modelling asks for large numbers of completed questionnaires, and I argue that my study made a contribution in this regard.

Also, the graphical representation of findings from RTOP could serve to help other researchers to make their findings more meaningful and explanatory and make findings easily understandable.

5.5.2 Practical contribution: teacher education (distilling design principles for SLP’s)

In addition to various previous studies by Mothwa (2011), De Beer and Ramnarain (2012) and Cronje (2015), this study revealed that many teachers teaching Natural Sciences are either not qualified to teach or have little or no background in science. There is a shortage of qualified experts to teach NS in the country, especially in the rural areas where this research was conducted. Most teachers teaching NS did not even study or major in the subject at a tertiary education level. From the findings of this research, many of the teachers were graduates of other disciplines that opted (or were co-opted) to teach NS in the wake of the shortage of qualified NS teachers. This was evident from the profile of the teachers, both for the first and second intervention.
This is a great call for concern in our education system. A practical contribution of this study was to develop design principles for a short learning programme, and during this design-based research, this SLP was offered twice to teachers. This research also assisted a team of researchers at NWU, who is continuing to provide teacher training in the field of indigenous knowledge.

5.5.3 The theoretical contribution: importance of the inclusion of indigenous knowledge in the natural sciences classroom

This research has been able to expatiate the various advantages and importance of including IK in the NS classroom. This will contribute to the body of theoretical knowledge and also boost the morale of teachers to include IK in their classrooms. This comes at a time when the decolonization of the curriculum is receiving a lot of attention in South Africa. I have also contextualised the argument for the inclusion of IK from Gibbons’ (2000) construct of mode 2 knowledge production, namely contextualised science.

5.6 LIMITATIONS OF THIS STUDY

Several challenges were experienced while doing this research and may have impacted on the outcomes of the research and its quality. However, before these limitations are discussed, I would first like to provide a demarcation of the study.

5.6.1 Demarcation of the study

This study forms part of a larger project on indigenous knowledge in the STEM classroom, and it enjoys funding from the NRF and the Fuchs Foundation. My study follows the research of Cronje (2015) who also developed the VNOIK instrument. Gaps that my study revealed, is currently being investigated by the IKS group of the Self-directed Learning Focus Area of the NWU.
5.6.2 Time

Without any doubt, time was a major constraint in this research. The second intervention that was planned as a three-day intervention had to be reduced to one day for logistical reasons. Also the researcher is a full time lecturer and the study is carried out on a part-time basis which did effect on the quality of the study. For instance, having a third intervention would have been desirable due to the demand for this SLP in Mpumalanga. Furthermore, due to time constraints, only two lessons were observed for each teacher: one lesson was observed before and one after the intervention. Availability of additional time would have helped to organise and follow up more on community of practice to help the teachers’ professional development.

5.6.3 Physical access to my supervisor

During my studies my supervisor accepted a position at the NWU, leaving UJ. This made it even more difficult for me, residing in Mpumalanga, to have face-to-face meetings with my supervisor.

5.6.4 VNOS questionnaire during intervention one

The VNOS questionnaire was not administered during the first intervention, however, teachers’ views were ascertained during the individual interviews with the participants, and during the classroom observations. The questionnaire was only administered during the second intervention before the intervention and not after the intervention although it was discussed during the individual interviews after the intervention. It would have been beneficial if the questionnaire could have been administered to determine teachers’ view on NOS both before and after both interventions. As highlighted in Chapter Four, the reasons for this were twofold:

(a) The focus of the study is on teachers’ views of the nature of indigenous knowledge systems, and not primarily on their views of the nature of science.
(b) The second reason is the lack of sufficient time to complete the questionnaire. The SLP was a demanding programme, as the laboratory activities are time consuming.

5.6.5 Topics for classroom lesson observations

It should be noted that not all topics in Natural Sciences actually have much IK embedded in them. When conducting this study, some of the topics the teachers used during their lessons did not necessarily lend itself to the infusion of indigenous knowledge. For example, a topic on Atoms, Electrons and Neutrons was used in one of the cases, and it was difficult to observe how the teacher would have infused IK into a lesson on these subjects.

5.7 SUGGESTIONS FOR FUTURE RESEARCH

During this specific SLP, a lot of emphasis was placed on medicinal plants, and teachers were shown how this links with CAPS themes. However, Indigenous Knowledge is also relevant in other disciplines such as agriculture, medicine, technology (engineering), etc. There is however a lack of resources that teachers can use, and more research should be done to address this challenge. A proper and sound understanding of IK will lead to improved development processes for local communities where it is produced and could also lead to knowledge that will be useful internationally. Therefore, it is suggested that further studies be done to look at IK in other fields such as agriculture, e.g. issues such as improving water quality, growing food without damaging the land, food preservation, climate and building energy-efficient houses. An appreciation of the history of scientific discoveries and their relationship to IK and different world views will enrich our understanding of the connections between science and society. It could be suggested that the intervention be developed into a series of themes to help in teachers’ professional development and encourage learning within communities of practice.
As mentioned earlier, future research should also include using Rasch modelling to determine the construct validity of the VNOIK instrument. This asks for a richer data base and the use of the instrument on more participants.

To most South African scholars, the rich African indigenous knowledge comes to mind, when talking about including of IK in the classroom. However, we often forget that 2.6% of the South African population consists of Indian learners and that we should also consider the rich Indian IK (e.g. Ayurveda) in future research. The inclusion of IK should be done in an inclusive fashion.

De Beer & Mentz (2017) have shown by means of a number of examples how the holders of indigenous knowledge were and are self-directed learners. In an era where we need to prepare learners for a very complex 21st century, this is important research that should be continued. Our research on indigenous knowledge holders could assist us in addressing some of the perennial issues that plague science education, as these two authors show.

5.8 CONCLUSION

Chapter One of this study introduced the reader to the research, background and also the research questions and objectives. Chapter Two provided the literature review, focusing on the need to incorporate IK in the STEM curriculum, and exploring relevant conceptual and theoretical frameworks. In particular, Cultural-Historical Activity Theory (CHAT) was explained. The chapter also included definitions of various terms like nature of science, Indigenous knowledge, Pedagogical Content Knowledge, etc.

Chapter Three focussed on the research design and methodology.

In Chapter Four, analysis of the data collected was undertaken. The chapter provided the reader with the ‘lived experiences’ of the participants, and identified emerging themes from the data.

Lastly, Chapter Five discusses the findings, conclusion and recommendations to help NS teachers to incorporate IK in their classroom in a scientifically rigorous way. The researcher believes that the developments and findings emanating from this study will
contribute to empower science teachers and ensure IK has its rightful place in science classrooms.

The science of 'old knowledge' (IK) needs to be examined scientifically. This is not a matter of ideology as much as it is a matter of the archaeologies of knowledge. It is proposed that IKS be seen as investigating the knowledge systems that have worked for enduring communities. Conceptual change and the nurturing of a scientific worldview, which is the ideal of science education, should include a better understanding of the oral knowledge of cultures and its place in society.
REFERENCES


ETHICS CLEARANCE

Dear J de Beer

Ethical Clearance Number: 2014-035

Re: The influence of intrinsic and extrinsic factors on the implementation of indigenous knowledge in science teaching and learning

Ethical clearance for this study is granted subject to the following conditions:

- If there are major revisions to the research proposal based on recommendations from the Faculty Higher Degrees Committee, a new application for ethical clearance must be submitted.
- If the research question changes significantly so as to alter the nature of the study, it remains the duty of the student to submit a new application.
- It remains the student’s responsibility to ensure that all ethical forms and documents related to the research are kept in a safe and secure facility and are available on demand.
- Please quote the reference number above in all future communications and documents.

The Faculty of Education Research Ethics Committee has decided to

☒ Grant ethical clearance for the proposed research
☐ Provisionally grant ethical clearance for the proposed research
☐ Recommend revision and resubmission of the ethical clearance documents

Sincerely,

Prof Geoffrey Laurenbach
Chair: FACULTY OF EDUCATION RESEARCH ETHICS COMMITTEE
6 June 2014
APPENDIX B: ETHICS APPROVAL CERTIFICATE OF STUDY
NORTH WEST UNIVERSITY

ETHICS APPROVAL CERTIFICATE OF STUDY

Based on approval by the Ethics Committee of the Faculty of Education Sciences (ESREC) at the meeting held on 23/06/2016, the North-West University Institutional Research Ethics Regulatory Committee (NWU-IERERC) hereby approves your study as indicated below. This implies that the NWU-IERERC grants its permission that, provided the special conditions specified below are met and pending any other authorization that may be necessary, the study may be initiated, using the ethics number below.

Study title: The affordances of indigenous knowledge for self-directed learning

Project Head: Prof J de Beer
Research Team: Prof Elia Mentz, Prof Martha van der Walt, Dr Neil Petersen, Dr Christo van der Westhuizen, Prof Aubrey Golightly, Ms Loullen White, Prof Marietjie Havenga, Mr Kobus Havenga

Ethics number: NWU-IERERC-2016-092711-15-A2

Application Type: NFA
Commencement date: 2016-06-24
Expiry date: 2018-12-24
Risk: N/A

Special conditions of the approval (if applicable):

- Translation of the informed consent document to the languages applicable to the study participants should be submitted to the ESREC (if applicable).
- Any research at governmental or private institutions: permission must still be obtained from relevant authorities and provided to the ESREC. Ethics approval is required before approval can be obtained from these authorities.

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The study leader (principal investigator) must report in the prescribed format to the NWU-IERERC via ESREC:
  - annually (or as otherwise requested) on the progress of the study, and upon completion of the project;
  - without any delay in case of any adverse event (for any matter that interrupts sound ethical principles) during the course of the project.
- Annually a number of projects may be randomly selected for an external audit.
- The approval applies strictly to the proposal as stipulated in the application form. Would any changes to the proposal be deemed necessary during the course of the study, the study leader must apply for approval of these changes at the ESREC. Would there be deviation from the study proposal without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-IERERC via ESREC and new approval received before or on the expiry date.
- In the interest of ethical responsibility, the NWU-IERERC and ESREC retains the right to:
  - request access to any information or data at any time during the course of the study;
  - to ask further questions, seek additional information, require further modification or terminate the conduct of your research or the informed consent process.
- Withdraw or postpone approval if:
  - any unethical principles or practices of the project are revealed or suspected;
  - it becomes apparent that any relevant information was withheld from the ESREC or that information has been false or misrepresented;
  - the required annual report and reporting of adverse events was not done timely and accurately;
  - new institutional rules, national legislation or international conventions demand it necessary.
- ESREC can be contacted for further information or any report templates via Ethics.Committee@nwu.ac.za or 018 290 4596

The IERERC would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the IERERC or ESREC for any further enquiries or requests for assistance.

Yours sincerely

Prof LA Du Plessis
Chair, NWU Institutional Research Ethics Regulatory Committee (IERERC)

Digitally signed by
Prof LA Du Plessis
Date: 2016.06.30

Prof Linda du Plessis
08:45:53 +02'00'

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APPENDIX C: CONSENT LETTER

Informed Consent/Assent Form

Project Title:

TEACHERS’ PERCEPTIONS AND EXPERIENCES OF THE INCLUSION OF INDIGENOUS KNOWLEDGE IN THE NATURAL SCIENCES CLASSROOM

Investigator

AKERELE FOLUKE VICTORIA

Date:

18 September 2013

Please mark the appropriate checkboxes. I hereby:

__ Agree to be involved in the above research project as a participant.

__ Agree to be involved in the above research project as an observer to protect the rights of:

___ Children younger than 18 years of age

___ Children younger than 18 years of age that might be vulnerable* and/or

___ Children younger than 18 years of age who are part of a child-headed family.

__ Agree that my child, ________________________ may participate in the above research project

__ Agree that my staff may be involved in the above research project as participants.

__ I have read the research information sheet pertaining to this research project (or had it explained to me) and I understand the nature of the research and my role in it. I have had the opportunity to ask questions about my involvement in this study. I understand that my personal details (and any identifying data) will be kept strictly confidential. I understand that I may withdraw my consent and participation in this study at any time with no penalty.
__ Please allow me to review the report prior to publication. I supply my details below for this purpose.

__ Please allow me to review the report after publication. I supply my details below for this purpose.

__ I would like to retain a copy of this signed document as proof of the contractual agreement between myself and the researcher.

Name: ______________________________________________________

Phone or cell number: __________________________________________

e-mail address: ________________________________________________

Signature: ____________________________________________________

If applicable:

__ I willingly provide my consent/asset for using audio recording of my/the participant’s contributions.

__ I willingly provide my consent/asset for using video recording of my/the participant’s contributions.

__ I willingly provide my consent/asset for the use of photographs in this study.

Signature (and date): ________________________________

Signature of person taking the consent (and date):

______________________________________________
To: Physical-, Life-, and Natural Science teachers

Dear Natural-, Physical- and Life Science Teacher

AN EXCITING SHORT LEARNING PROGRAMME: 22-23 NOVEMBER 2013

The Faculty of Education invites all Natural-, Physical- and Life Sciences teachers to attend this very exciting short learning programme.


This one-day course will show you how you can incorporate indigenous knowledge systems in the science classroom, in a scientific rigorous way. We’ll start the course by looking at plant materials bought at the Muthi market. We will then test the medicinal claims – in other words, we’ll establish whether these plant products have anti-microbial activity. We’ll engage in various types of chromatography techniques, and will also then test for anti-microbial activity, by using microbial techniques. All participants will receive a UJ certificate upon completion of the course. (The course facilitator is Prof Josef de Beer). Please bring a lab cot along, as we’ll be doing a lot of laboratory work.

On the both days, the classes run from 09:00 in the morning, until 16.00 in the afternoon on Friday, and 13:00 on Saturday. Lunch will be provided. Such a short learning programme would normally cost between R2000 and R3000. However, UJ is offering this free of charge to teachers in Mpumalanga. Space is limited though – we can only accommodate 15 teachers. You are therefore advised to book immediately.
Hope to see you there!

Regards

Prof Josef de Beer

SHORT LEARNING PROGRAMME 22 – 23 November 2013

Name: ........................................................................................................................................

(as it should appear on the UJ certificate)

School: ....................................................................................................................................... 

I am teaching: (subjects and grades

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ID number (required by UJ for issuing a certificate): .................................................................

Tel: ................................................................................................................................................

Email: ............................................................................................................................................... 

Please note: We offer this course free of charge to teachers. We can only accommodate 15 teachers. If you book, and do not show up, your school will be billed for these courses, as you have prevented another keen teacher from being able to participate.

Dietary requirements (for lunch): .......................................................... ................................................

Would you be willing to participate in a short survey (part of Ms Akerele M.Ed. research)?
Yes

No

Signature

Fax your form to (011) 559-2048, or e-mail it to: josefdb@uj.ac.za, or give the hard copy to Ms Victoria Akerele.

Closing date for applications: 19 March 2015
To: Physical-, Life-, and Natural Science teachers

Dear Natural-, Physical- and Life Science Teacher

AN EXCITING SHORT LEARNING PROGRAMME – 26 MARCH 2015

The Faculty of Education invites all Natural-, Physical- and Life Sciences teachers to attend this very exciting short learning programme.

Thursday 26 March: Incorporating Indigenous Knowledge Systems in the science classroom

This one-day course will show you how you can incorporate indigenous knowledge systems in the science classroom, in a scientific rigorous way. We’ll start the course by looking at plant materials bought at the Muthi market. We will then test the medicinal claims – in other words, we’ll establish whether these plant products have antimicrobial activity. We’ll engage in various types of chromatography techniques, and will also then test for anti-microbial activity, by using microbial techniques. All participants will receive a UJ certificate upon completion of the course. (The course facilitator is Prof Josef de Beer). Please bring a lab cot along, as we’ll be doing a lot of laboratory work.

On the day, the classes run from 08.30 in the morning, until 16.00 in the afternoon. Lunch will be provided. Such a short learning programmer would normally cost between R2000 and R3000. However, UJ is offering this free of charge to teachers in Mpumalanga. Space is limited though – we can only accommodate 15 teachers. You are therefore advised to book immediately.

Hope to see you there!

Regards

Prof Josef de Beer
SHORT LEARNING PROGRAMME 26 MARCH 2015

Name: ..............................................................................................................................................

(as it should appear on the UJ certificate)

School: ..............................................................................................................................................
 .......................................................................................................................................................

I am teaching: (subjects and grades
 ...........................................................................................................................................................
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ID number (required by UJ for issuing a certificate): .................................................................

Tel: ......................................................................................................................................................

E-mail: ..................................................................................................................................................

Please note: We offer this course free of charge to teachers. We can only accommodate 15 teachers. If you book, and do not show up, your school will be billed for these courses, as you have prevented another keen teacher from being able to participate.

Dietary requirements (for lunch): ...................................................................................................
Would you be willing to participate in a short survey (part of Ms Akerele M.Ed. research)?

☐ Yes
☐ No

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

Signature

Fax your form to (011) 559-2048, or e-mail it to: josefdb@uj.ac.za, or give the hard copy to Ms Victoria Akerele.

Closing date for applications: 19 March 2015

PROGRAMME: IKS SHORT LEARNING PROGRAMME
22 – 23 NOVEMBER 2013
MAYFLOWER - MPUMALANGA

Friday 22 November 2013

8.30 Registration

09.00 – 10.15 Welcome and overview (Prof J de Beer)

09.30 – 12.30 IK in the science classroom: Science, pseudo-science, or missing link?

12.30 – 13.15 LUNCH BREAK

13.15 – 16.00 Testing medicinal claims of plants. Extracting active ingredients, chromatography, anti-microbial activity test, and incubation (overnight)
Saturday 23 November 2013

9:00 – 11:00  Herbarium vouchers, and identification of plants
11:00 – 12:30 IKS in the science classrooms; using the jigsaw method
12:30 – 13:00 Questionnaires
13.00 – 13.15 Conclusion; handing out of certificates.

SHORT LEARNING PROGRAMME IN PIET - RETIEF

8.30  Registration
09.00 – 10.15 Welcome and overview (Prof J de Beer)
09.30 – 12.30 IK in the science classroom: Science, pseudo-science, or missing link?
12.30 – 13.00 LUNCH BREAK
13.00 – 16.00 Testing medicinal claims of plants. Extracting active ingredients, chromatography, anti-microbial activity test, and incubation (overnight)
16.00 – 16.30 Conclusion; questionnaires and handing out of certificates.
APPENDIX D: TRANSCRIPTION OF INTERVIEW

TRANSCRIPTION PARTICIPANT 1 –INTERVIEWEE (R1)

INTERVIEWER: Em, thanks for your assistance, what is your view about IK?

INTERVIEWEE: IK, I think it is quite important for us to have this. IK I believe is the knowledge that are passed from ancestors, from the past. I will say for the learners to know and have understanding of our culture errh, there are a lots of topics I can have that require the IK of different rocks in NS, it is part of science itself that is important for the learners to know because we can relate it to the knowledge they must know them so that they can be able to differentiate so there are lot of things I can think of.

INTERVIEWER: Okay, from what you have said now IK is the knowledge from their ancestors that the learners bring from home which are passed on to them from their ancestors –hmm. Now the Department of Education through the new curriculum – the CAPS say that IK must be introduced into science classroom but do you think you have resources to be able to introduce this IK in your lessons – materials?

INTERVIEWEE: I don't think there is now

INTERVIEWER: Is there any support from the department, from the school, for you to be able to introduce IK into the classroom like in form of training or workshop?

INTERVIEWEE: I think it is possible to have

INTERVIEWER: But for now there is nothing like that?

INTERVIEWEE: No

INTERVIEWER: Okay, what are the challenges you usually face to introduce IK, what are the challenges?

INTERVIEWEE: The first challenge is the materials, the inavailability of these materials is a problem because you can’t teach that which is not there.

INTERVIEWER: Did you do science in your Diploma or Degree?

INTERVIEWEE: Yes I have Science
INTERVIEWER: Natural Science?

INTERVIEWEE: Yes

INTERVIEWER: Were you prepared to teach IK from school with the type of training, types of courses you did in school, did it prepare you to be able to teach IK?

INTERVIEWEE: Not really.

INTERVIEWER: Not really, Okay, now if you want to get information about IK to teach in your classroom, what do you do? How do you get information?

INTERVIEWEE: Arrh, at the current moment, I haven’t, I only have a year teaching so I haven’t had any.

INTERVIEWER: What I mean is if you want to teach IK in the classroom how will you be able to get the information that you need to teach topics that require IK, to prepare, do you get them from the textbook, from the internet or ..................?

INTERVIEWEE: Yea, I do have access to internet

INTERVIEWER: Do you get such information from the internet, does the textbook has something to do with IK at all?

INTERVIEWEE: In some part of it

INTERVIEWER: The textbook you use in class, you get information?

INTERVIEWEE: Part of it

INTERVIEWER: Are there, there what methods do you use to teach IK, what are the instructional methods that you use if you want to teach IK in the class, what form?

INTERVIEWEE: Uhmm, I think errh, errh making it in form of a presentation. I will have those resources that relates to IK and linking it to the IK

INTERVIEWER: Can you explain further?

INTERVIEWEE: May be I will, may be if I found something on the internet, then may be there are some pictures, I draw on a big chart that I can give to the learners in class then explain or in that picture.
INTERVIEWER: Now how do you encourage the learners to bring their IK as in, how do you like now, you talk about the knowledge the learners have brought which were passed on to them by the ancestors, how do you involve the learners to bring their IK, what methods do you use or approach?

INTERVIEWEE: Errhh, because some of the things which do have different plants that are being used for different things that have been used by our ancestors.

INTERVIEWER: Okay

INTERVIEWEE: Errrh for this plants may be they can look for them because we are living in rural area and have some of them for the learners to bring them, it is a way forward.

INTERVIEWER: Do you know if they know the usefulness of these plants may be they have been told by their parents, that this one can be used for this one, do you think the learners know?

INTERVIEWEE: I believe they do, they can have the understanding of the IK. I believe their parents they also tell them about them, I will make an example – I was once coughing, I had a flu actually, they told me about what a plant they are having at home, they bring it for me

INTERVIEWER: Okay

INTERVIEWEE: I was, I can say from that that they do have knowledge

INTERVIEWER: So we can just encourage them to bring the knowledge to the classroom to make the science classroom to make the science classroom interesting and so that they can also get this idea that their knowledge is relevant.

INTERVIEWEE: Uhmm

INTERVIEWER: Okay, what in your opinion do you think is the difference Western knowledge and IK?

INTERVIEWEE: Okay, what....... I believe there is no much of a difference because some of the plants that are used, they are also from plants. I believe that even the similarities, the Western they do heal and so also the indigenous plants. I think they
are both important, the only difference might be people nowadays are no longer doing or believing our Africa way they believe much on or.........

INTERVIEWER: .... the Western, why do you think is like that, people no longer follow.........?

INTERVIEWEE: Arrrh, they no longer trust much on the IK. The generation we are having now because may be the workshop coming can provoke that interest again for generation of nowadays or I think may be we can learn a lot from it.

INTERVIEWER: What is your view about NOS, like what are the Nature of Science, you know science knowledge is not static neh, it keep on changing as people are getting more information and getting research, what is your own view about NOS?

INTERVIEWEE: The NOS ehhhn ehnn for me errrh because it is good to find something that have been researched before. I believe that if people learn NOS and keep on associating ourselves with it, there is a lot that we gain from it. The knowledge that we gain...... acquire a lot, you know there is a world and so are problem that we might have

INTERVIEWER: Some people they see what we called IK as false science they think mostly the people that use these plants may be for healing, you don't have measurements unlike Western Science. Some of these things also they don't go straight like it's not like you take a useful leaf to cure yourself, some of them have to still go through some processes may be the ancestors, you have to call on the ancestors, how do you balance that one because that is why many people they don't want to introduce IK into their classrooms because they think oh it has to involve like throwing bones or whatever before but you know Western, they will tell you take two spoonful in the morning, in the afternoon, yea.

INTERVIEWEE: Yea, I don't, that is not all

INTERVIEWER: Okay

INTERVIEWEE: We do have some plants that do heal from diseases without even calling on ancestors. I don't think that. That is not always the case
INTERVIEWER: So we can still make use of IK in the classroom and it will still help the learners. Like the topic you did today in the class, what ways can you bring IK of the learners?

INTERVIEWEE: I believe in the environment, we do have plants that we have talked of which act as our producers and the learners know the indigenous food. I bring them to class to show the learners these types of plants

INTERVIEWER: Apart from eating these plants, they can be useful, apart knowing these plants too they might know that apart from eating these plants, they can also be useful for other things.

INTERVIEWEE: Yes

INTERVIEWER: And some other plants that can be harmful if the goat or cow eat this one it can be harmful, you know they can know them. That one could have been gotten from their ancestors.

INTERVIEWEE: Yea

INTERVIEWER: Okay, what other examples of IK can be used in the lesson, do you have any other examples?

INTERVIEWEE: An example?

INTERVIEWER: Yea of a lesson or a topic in which you can make the learners to bring their IK

INTERVIEWEE: IK, errh, it could be even some types of rock because we use them for different things. We also use some of these rocks for cleaning ourselves

INTERVIEWER: Yea, yea

INTERVIEWEE: We do use them, we can as well...................

INTERVIEWER: That’s very important because if you create interest in them to make them have interest when they see that oh this is the same plant they are talking about, it will make them interested, then may be their failure rate will be less because some of them they think science is for extra ordinary people, yea
INTERVIEWEE: Yea

INTERVIEWER: Yea, yea but by the time they see that these things are important, this thing you mentioned it and they know it in their home you also know some of these plants, you as a South African, you also know some of these plants that they use neh, you’re from Zulu?

INTERVIEWEE: Yea

INTERVIEWER: So teaching them it’s not difficult. Now do you manage diversity in your classroom? That’s another reason why some people might not want to teach IK because whose IK do you take especially where you have Zulu, you have some people from Limpopo, some Suthu etc? How do you manage, do you have such experience here?

INTERVIEWEE: Arrh, [here most of the learners we have they are Zulu and Swathi, they are common actually.

INTERVIEWER: The culture are common?

INTERVIEWEE: Yea, they are in a way common

INTERVIEWER: Okay, actually if you as a teacher you know some of these things, it will be easy for you to also bring to the classroom but if you don’t know the whatever it is difficult

INTERVIEWEE: It is difficult

INTERVIEWER: Only you have to make research, you have to make ehmm enquiries. What ways do you think you can teach it better in the classroom, what methods can you use to teach IK better?

INTERVIEWEE: Uhmnn, uhmnnmm, the method to teach?

INTERVIEWER: To involve the learner

INTERVIEWEE: To involve the learner?

INTERVIEWER: Yea
INTERVIEWEE: May be asking them to do some experiments and practical. We use the plants together with them, we do everything together.

INTERVIEWER: You ask them to bring the plants themselves and ask them what is useful for?

INTERVIEWEE: Yea

INTERVIEWER: That’s a better way. Thanks so much sir, I so much appreciate you.
INTERVIEWER: I appreciate you for your support and agreeing to be a participant in my research. What do you understand by Indigenous knowledge?

R2: It is the use of … students knowledge about ………… Whatever concept I teach, I make sure I include things they are familiar with starting from what where they know like, whatever concept I teach I try to use that idea of saying……. because when talking about IK, they are something that are found locally because it opposite of exotic. What they know then we can go to what they don’t know. IK really I will say that kind of information they know.

FV: How do you think they get to know/acquire this knowledge, the learners where do they get the knowledge from?

R2: I think some of the knowledge they get it from home, or like through observation when they are moving up and down they will see some of them like from home just by observing.

FV: From home like?

R2: Like parents told them some of the things, they might learn not directly being told but through observation I will ask them questions that………. 

FV: Okay, how do you incorporate this IK into your teaching?

R2: hmmm, normally I try to when I’m teaching them a concept I try to may be even tell them like a or even before I teach them may be I’m talking the use of element instead of giving them that information, ……………

Let them tell so that I will know they have got an idea and some of the uses of those elements. Let me start with what they know I will ask so the way I incorporate it by asking them. Then I will know that they have got that knowledge. Actually in a correct way, I will say I will incorporate it by asking them.

FV: Can you give me example of like IK you think they brought from home, from their parents, the examples of such as you have been teaching?
R2: Okay emmmm may be let say I am may be teaching the uses of like I will go back to the one I have already used, the uses of elements right, some of them they would they know the items they are using at home right, some of them so far have seen them. The moment I mentioned that what’s the use of Aluminium, they know Aluminium pot. If you have got element called Aluminium so that kind of information I will say it’s coming out from parents.

FV: What problems do you normally encounter when you are teaching IK in NS?

R2: Normally their errr, we normally don’t get the equipments

FV: May be laboratory equipment?

R2: Yea, normally we don’t get expose to some of the materials that they need for example if I am teaching electricity things like that if I want to show them cells

FV: How does IK differ from Western Science? How does IK, the knowledge the learners bring from their home, how does it differ from Western Science?

R2: Arrh, I will say may be, the reason IK it’s not been confirmed but may be the only difference I will say it’s the words that are used. The understanding of the concept will be differ so that’s the main difference. Otherwise generally, I will say they almost one of the same thing because IK like I have already said, it’s something that they know but Western knowledge is ............... in other words the difference will be made on the scale, IK is lower but on Western knowledge there can be addition that will make them understand better.

FV: You also mentioned some concept which might not be there from their IK like some names, terms?

R2: Yes

FV: Why do you think IK should receive consideration in NS classroom?

R2: Should be included

FV: Yea, why should it be included?

R2: Or put into consideration like……
R2: I will say because when you are looking at the subject NS it deals with Nature around so I will say the reason for including because it will make students to understand the subject much easier like because when you teach like concept something they are not familiar with, they might find the subject boring, you don’t even see them. But when you start with what they know, what capture their mind, if you talk of something they have seen so it will make it easy to understand, it’s easy for them to participate. It’s easy for them to arrh come with IK so like making a platform like making a step so that they can move towards achieving a higher course. Without them understanding the concept, it might affect them. Starting from the known to the unknown.

FV: Thank you sir. What are the methodologies or skills that you used to incorporate IK in your lesson? What are the various methodologies?

R2: Like I have already highlighted, I try by all means……. the methodology I use is question and answer! I’m trying to release information that they know. I use what they could see around.

FV: And I also saw that you gave them assignment to go and find out more, that is they should still make enquiry from home

R2: Yea

FV: What are your experiences in the inclusion of IK in your lessons from the way you want them to bring IK, are they cooperating? What are your experiences? Are you getting the desired outcome?

R2: In most cases, I think may be it’s lack of…….. that kind of laziness, they don’t go and make inquiry and find information.

FV: But in the classroom are they actually giving you needed information you needed, may be you expect them to do something from home, are they coming up?
R2: Yea

FV: To what level?

R2: Mostly they……………..

FV: What level?

R2: Mostly…………..

FV: You said you are looking at plants, some of these plants are useful, do they know some of the usefulness of these plants. May be you’re asking them what could they be useful for, may be this one is used for this one, different plants. Do they have the knowledge?

R2: They do have such knowledge like for example, there was a time when I gave them some kind of a task on the plant that I teach. They did brought some of medicinal plants. There are some plants that are not been used for firewood around, I actually explained to them that that is the way people are trying to **conserve the plants**, so that’s IK, of course they didn’t know what was the purpose that why is this plant not used as firewood.

FV: That is where you now bring the WS now to strike the balance

R2: Yea

FV: Where do you get information and relevant materials when you want to incorporate IK in your class? Where do you get the information and the materials?

R2: Mostly I get it from the **students**, I also used my field of knowledge, mostly I used mine, of course may be one or two **things I might ask other people**, mostly I also use knowledge that I have but some I **get from the textbook**.

FV: How do you see the training that you have received from University or College, did it prepare you, you the CAPS have just been introduced and in CAPS, it’s mandatory that we incorporate IK into NS classroom from the DoE. Now the training you received from University or College, did they actually prepare you in any way?

R2: Arrh, I will say yes somehow somehow they were encouraging us to use IK of course.
FV: What is your discipline, what did you study in the University?

R2: I specialize in Geography

FV: Okay

R2: They say when you’re teaching them, start with what they know

FV: Actually is part of training, when you begin to teach as a teacher, you must make sure you allow the learners to bring their knowledge into the classroom. But in the area of IK specifically, were you taught some things?

R2: No not at all

FV: How are the learners and colleagues experiencing IK, let’s start with the learners. How do you think they experience IK, what’s their opinion about IK?

R2: Errrhh how do the learners experience IK

FV: Yea, how do they experience it?

R2: Most cases most of the students you find out they have the information but they don’t want to apply it

FV: What about teachers, colleagues, other colleagues? Do they have any experience about IK or not?

R2: I will say most of these teachers, they don’t concentrate on that like they tend to concentrate on let me finish the syllabus. If you try to incorporate IK some people will try to follow the book literally. (lack of PCK)

FV: And also time?

R2: And also time to finish up so they don’t want to spend time to incorporate.

FV: What support structures are available to help in incorporation of IK, any support from the government, DoE, from the colleagues, even your Circuit, is there any support they are giving you?

R2: I will say........ attending workshop

FV: Okay, do they normally organize workshops for you?
They organize

FV: Does the workshop talk about IK and how?

R2: They always encourage us to incorporate it of course they don’t say it directly like you’re saying it, I will say, they say let’s start with the known to the unknown after that……. (not much support)

FV: Now in most classrooms you have different people that are from different culture, like you know, you’re from another culture and you’re here. How do you now incorporate IK in a multicultural classrooms like you have the Zulus, they might have their own belief about a particular thing, like the Venda might have their own belief, how do you go about such?

R2: Em, like I will say yes that can be a problem but with this current school that I am with most of them there’s not much of a difference. I will try to strike a balance that there’s this and this belief, this and this belief in this generally. At the same time they understand. I will try to accommodate all of them, how do different people understand that particular concept.

FV: Okay, what’s your view about NOS?

R2: My view of NS?

FV: Of NOS

R2: NOS?

FV: NOS not NS what is the characteristics of Science?

R2: Of Science?

FV: Nature

R2: NOS?

FV: Yea

R2: My view of NOS is all using this kind of concept, so NOS try to explain the difference that are taking place together that only are they like that, so it tries to explain why are we in different forces and why are they about may be understanding the world.
like function that are taking place why are we happening the way they happen. So Science really try to explain how the world function.

FV: Do you think in your own opinion that NOS has to do with IK? Do they have anything in common?

R2: NOS and IK?

FV: The NOS, do they have anything in common?

R2: With the ..........

FV: IK

R2: Yea, the NOS because arrh, the IK is explaining what is happening right, eerrh , using the knowledge we are having right around us but at the same time, NOS is the same thing which is explaining the process that are taking place. Yes there is a link but the link…….Yes the link is a bit different some of the things may be right......... With Science there’s some proof and studies that have been done. Our beliefs and of some of this things have no proof.

FV: One of the tenets of NOS is that knowledge is not static they review the knowledge like some people have worked on something before and now scientists taking up to work on them, IK is passed from generation to generation from forefathers, these learners will not just know something, it is because their forefathers pass it on to them. Is there any relation, this knowledge that is passed from generation to generation, is it also static?

R2: I will say it is more static, I will say that but the improvements are not much, there is no much changes.

FV: Thanks so much for your assistance. I am grateful
PARTICIPANT 3 – R3

FV: Sir, I appreciate you for accepting to participate in my research. What do you understand by the word IK?

R3: IK is, I think is the information that has come from the history of our people that can be applied in our classroom or can be transmitted to our kids.

FV: Okay, the knowledge we have gotten from our forefathers?

R3: Yea

FV: Passed from one generation to the other?

R3: From one generation to the other

FV: And the present Curriculum, CAPS they encourage teachers to infuse IK to the NS classroom. How do you incorporate IK into your teaching?

R3: Yea, honestly, you find out where some lessons for examples some topics in NS, mining, there were methods used by our forefathers. If you give them homework which they will discuss in class, some kids will come out with information but sometimes some won’t but most of them will.

FV: What kind of barriers do you think will not allow them to bring such information?

R3: Some barriers especially you find out, some of the kids are staying with grandmothers, grandparents, it serves as a barrier to them.

FV: Do you have other examples whereby one can introduce, you talk about mining now, in what other topics

R3: There was a girl she having goiter I couldn’t believe what she was telling me about a stone that could remove it just by rubbing. So that’s IK.

FV: In curing their diseases?

R3: I don’t understand but they are applying it

FV: What problems do you normally encounter in teaching of IK in NS?

R3: English is a major one (language barrier)
FV: What?

R3: English and secondly the problems of our kids they don’t practice what they learn at school. They don’t take it on a daily basis. They only take it as academic, they leave it at school.

FV: And that is part of what we have to let them know and really emphasize that. Because when you make NS as like part of their daily living, it makes them much interested in science and that is what the curriculum is also telling us, we should make them to understand that it is part of their daily lives. If it’s what they see everyday it will make them to be much interested. It should. Do you have enough resources to teach IK in the classroom?

R3: Yea, well no

FV: Yea part of what this workshop will do is to let you know how you can you can make use of shoestring- improvise some of the experiment in the laboratory. How does IK differ from WS?

R3: IK has its limitation, WS has more evidence of information and the terms

FV: The terms use in WS are different?

R3: Yes, WS has a wealth of information does not from the aspect of understanding.

FV: Why do you think IK should receive consideration in the NS classroom, why should it be entertained?

R3: I will rather put it that we cannot run away from where we are coming from, it makes learners to understand better.

FV: What are the methods or tools you use to incorporate IK in your classroom?

R3: As long as you are teaching IK in Western language now, I will support the idea whereby they are saying teachers should use indigenous language so that they can understand better. If I were to explain the stone they are using in English, this person will understand it better if it was explained in his/her language

FV: Okay, like you want to bring a topic how and you want to include IK into it, how do you go about it?
R3: You know in my case, I'm a Zim guy, I will explain in English

FV: Yes of course, you will explain in English, how do you encourage them to bring m, this IK to the classroom, how do you get the knowledge they have?

R3: I can ask them to be in group to discuss

FV: Okay, you can ask them to work in groups to discuss together, so that everybody will get the idea

R3: The idea

FV: You also said the other time that you can ask them to go and find out from home?

R3: From home, I will ask them to bring the knowledge from home so we can discuss it in the class

FV: Okay, what are your experiences when you are including IK in your lesson, what are your experiences so far?

R3: They are forthcoming. Yea, but from learners who are staying alone you can hardly get any information but the ones who stay with their parents do bring information.

FV: Where do you get information and relevant materials, how do you get the information you need, how do you get the materials you need?

R3: I consult other teachers who are local and from the learners

FV: How do you view the training that you receive from the College or University, did it prepare you to teach IK, so is there any aspect of the training or teaching that equipped you to teach IK?

R3: I won't really say they do

FV: These textbooks, do they have information about IK?

R3: Hai! They don't talk much about IK (partially)

FV: How do learners and colleagues, how do they experience IK?

R3: These learners, I think they like it (acceptance from students)
FV: What support structures are available to help you in the teaching of IK, in the incorporation of IK what support system is it from the government, may be they organize workshop for you or from the school itself, do you have any support system or anything that is really helping you to be able to deliver the job?

R3: I will rather say there is no support system

FV: No training or workshop that has to do with IK?

R3: Yea

FV: How do you manage to infuse IK in a multicultural classroom, may be you are having from different background. Do you have such experience here, are they all from the same cultural background or may be you have people from Venda, people from Khosa because you know South Africa is multicultural nation and each learner has gotten their own IK that they have brought with them. Do you have such experience?

R3: If you ask them do you know this, they tell you we know but we call it this name, we call it that name but there is no such difference even if there is, you find out such information is common generally or cut across all the culture.

FV: They are the same, but the way they view it might be different?

R3: They understand each other

FV: What is you view of NOS?

R3: Natural Science?

FV: I mean NOS itself, what is your view about the NOS?

R3: Uhhmmmm, I …………..

FV: NOS, you know people have different views about NOS like of the characteristics of the NOS is that knowledge is not static. It’s changing may be when some people have done some research long time ago while some people do recent research they get new information so day by day science keeps improving. The knowledge is not static. What is your view about NOS and IK?
R3: Unlike IK, WK can be questioned, you can be critical, not like IK, you have to take like that without question.

FV: The reason why some people don’t want to introduce IK into their classroom is that they think it is false knowledge, how come, like what you have said the other time like the stone, how do you explain that the stone what type of experiment will you perform to prove that?

R3: Most of the time IK is conservative, people don’t want to share the idea with others. IK is not opened.

FV: Does that mean in such cases you might have difficulty in introducing IK in your classroom?

R3: Yes of course. My religion also comes in because there is no hypothesis.

FV: Thanks for your time.
APPENDIX E: RTOP INSTRUMENT

POST-INTERVENTION OBSERVATION
Reformed Teaching Observation Protocol (RTOP)

Dayo Savada
External Evaluator

Michael Phiburn
Internal Evaluator

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom
Evaluation Facilitation Group (EFG)

Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

Technical Report No. [N00-1]

1. BACKGROUND INFORMATION

Name of teacher: M
Announced Observation? Yes

Location of class: School [Student name(s)]

Years of Teaching: 1
Teaching Certification: 7-12

Subject observed: Natural Science
Grade level: 9

Observer: Victor IA
Date of observation: March 2014

Start time: 11:30 am
End time: 12:10 pm

2. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

The seating arrangement was typical of the old single desk. It did not allow for students’ interaction with one another. The students were mostly Zulu and Swazi. There were 39 learners in the classroom - 15 boys and 24 girls.
Reformed Teaching Observation Protocol (RTOP)

Daiyo Sernada  
External Evaluator

Michael Piturn
Internal Evaluator

and

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom
Evaluation Facilitation Group (EFG)

Technical Report No IN00-1
Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher: M

Announced Observation? YES

(yes, no, or explain)

Location of class: School

StartDate, subject, room)

Years of Teaching 1

Teaching Certification 7-12

Grade level 8

Subject observed: Natural Science

Date of observation: NOV 2012

Observer: Victoria

Start time: 9:20 am

End time: 10:00 am

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. The diagrams if they seem appropriate.

The classroom looks a bit overcrowded with 46 learners. 31 were boys, 25 were girls. They were from Swati and Zulu speaking culture.
Reformed Teaching Observation Protocol (RTOP)

Daiyo Sawada  
External Evaluator

Michael Pilburn  
Internal Evaluator

and

Kathleen Falconer, Jeff Torley, Russell Benford and Irene Bloom  
Evaluation Facilitation Group (EFG)

Technical Report No. IN00-1  
Arizona Collaborative for Excellence in the Preparation of Teachers  
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher  
5

Announced Observation?  
Yes

Location of class  
School  
(please, school, room)

Years of Teaching  
7

Teaching Certification  
7-12  
(6-8 or 7-12)

Subject observed  
Natural Science

Grade level  
9

Observer  
Aterele Fadila

Date of observation  
March 2014

Start time  
9:50am

End time  
10:30am

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

The learners are majority Swati speaking. The seating arrangement was typical of the old usual setting. Three desks were meant for 2 learners. There are 37 learners in the classroom - 18 boys, 19 girls. They are from different socio-economic background.
Reformed Teaching Observation Protocol (RTOP)

Daiye Sereeda  
External Evaluator

Michael Piturn  
Internal Evaluator

and

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom
Evaluation Facilitation Group (EFG)

Technical Report No. IN00-1
Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher:  
Announced Observation: YES
(yes, no, or explain)

Location of class: School  
(District, school, room)

Years of Teaching:  
Teaching Certification: 7-12
(6-8 or 7-12)

Subject observed: Natural Science  
Grade level: 8

Observer: Victoria  
Date of observation: NOV 2012

Start time: 9:20am  
End time: 10:00am

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. The diagrams if they seem appropriate.

The classroom was a bit overcrowded with 46 learners - 31 were boys, 25 were girls. They were from Swati and Zulu speaking culture.
### APPENDIX F: ARTEFACTS

**Periodic Table of Elements and Chemical Periods**

<table>
<thead>
<tr>
<th>Concept to be learned</th>
<th>Topic: Names of Compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-knowledge:</td>
<td>Periodic Table of Elements and Chemical Periods</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Skills/Competences

- Interpreting information
- Recreating information
- Planning investigations
- Collecting/observing
- Data handling
- Communication
- Developing questioning
- Identifying problems and issues
- Interpreting and communicating

#### Specific Aim 1:

- Plant Earth and Beyond
- Energy and Change
- Matter and Materials
- Life and Living
- Natural Sciences: Stands:

#### Specific Aim 2:

- Understanding and connecting ideas
- Doing Science and Technology

**Date:** 15-02-2014

**Time:** 1

**Grade:** 9

Example lesson plan:
### Teachers' Reflections

**Plan B:**
- A three-step approach to teaching the Reception of the Pilgrimage.

**Planned Activity:**
- Write the names of the Pilgrimage Elements.

**Resource/Textbook Page nos:**
- Page 28 of the 'Plan B' Resource.

<table>
<thead>
<tr>
<th>Teaching and Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodates learners with barriers to learning</td>
</tr>
</tbody>
</table>

**Techniques of new words:**
- Use visuals (International Union of Pure and Applied Chemistry).

<table>
<thead>
<tr>
<th>Resources</th>
<th>Other</th>
<th>Newspapers</th>
<th>Other</th>
<th>Maps/Atlases/DVDs</th>
</tr>
</thead>
</table>
| Posters/Pictures | Resource Books | Textbooks | Microscopes | Science M.

**Assessment:**
- Maji N.A.
- Pls. Q. 40.
<table>
<thead>
<tr>
<th>Concepts to be learned</th>
<th>Pre knowledge</th>
<th>Knowledge to build on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpreting information</td>
<td>Solving and classifying</td>
<td>Observing and recalling information</td>
</tr>
<tr>
<td>Scientific investigations</td>
<td>Computing</td>
<td>Developing language skills: Reading and Writing</td>
</tr>
<tr>
<td>Predicting and hypothesizing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicating</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Skills/Competencies:**
- Science, Technology, and Society
- Energy and Change
- Matter and Materials
- Life and Living

**Specific Aim:**
- Introduce the 2nd year requirements

**General Science Standards:**
- Domain: 50 min
- Grading: 8

**Example Lesson Plan:**

Mr. Scott
### Teachers Reflections

<table>
<thead>
<tr>
<th>Date</th>
<th>Notes</th>
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<tbody>
<tr>
<td>15/10</td>
<td>Instruct the process of knowledge and learning achievement.</td>
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<tr>
<td>16/10</td>
<td>During the process of production.</td>
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### Planned Activity

<table>
<thead>
<tr>
<th>Pupil Name</th>
<th>Activity</th>
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<tbody>
<tr>
<td>Student 1</td>
<td>Activity 1</td>
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<tr>
<td>Student 2</td>
<td>Activity 2</td>
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</table>

### Resource/Textbook Page no.

<table>
<thead>
<tr>
<th>Resource/Textbook</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook 1</td>
<td>12</td>
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<tr>
<td>Textbook 2</td>
<td>18</td>
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</table>

### Teaching and Learning Activities

- **Unit:** Accommodating learners with certain barriers to learning.
- **Technologies/Tools:** Map/Atlas/Global

<table>
<thead>
<tr>
<th>Materials/Tools</th>
<th>Uses</th>
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<tbody>
<tr>
<td>Projectors</td>
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<tr>
<td>Resource Books</td>
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<tr>
<td>Microscope</td>
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<td>Textbooks</td>
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<tr>
<td>Other</td>
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</table>

<table>
<thead>
<tr>
<th>Materials/Tools</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
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<td>Other</td>
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</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
<tr>
<td>CD/DVDs</td>
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<td>Periodic Table</td>
<td>Concepts to be learned: Symbols of the Periodic</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Topic</td>
<td>Pre-knowledge:</td>
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<tr>
<td></td>
<td>Interpretation information</td>
</tr>
<tr>
<td></td>
<td>Recording information</td>
</tr>
<tr>
<td></td>
<td>Observation</td>
</tr>
<tr>
<td></td>
<td>Planning investigations</td>
</tr>
<tr>
<td></td>
<td>Predicting/Infotmation</td>
</tr>
<tr>
<td></td>
<td>Researching questions</td>
</tr>
<tr>
<td></td>
<td>Developing/enhancing skills: Reading and Writing</td>
</tr>
<tr>
<td>Skills/Competences</td>
<td>Planet Earth and Beyond</td>
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<tr>
<td></td>
<td>Energy and Change</td>
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<tr>
<td></td>
<td>Matter and Materials</td>
</tr>
<tr>
<td></td>
<td>Life and Living</td>
</tr>
<tr>
<td></td>
<td>Natural Science: Standards</td>
</tr>
<tr>
<td>Date: 10/11/2013</td>
<td>Time: 1:00 PM</td>
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<tr>
<td>Grade: 8B</td>
<td>Mr. Sirtupa</td>
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<td>Example lesson plan:</td>
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<tr>
<td>Concept to be Learnt</td>
<td>Topic: 4.A Protection</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Pre Knowledge: THE ECOLOGY</td>
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<tr>
<td>Interpreting Information</td>
<td>Sorting and classifying</td>
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<tr>
<td>Recounting Information</td>
<td>Theories</td>
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<td>Decision-making</td>
<td>Experimenting</td>
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<tr>
<td>Planning Investigations</td>
<td>The Learning Process</td>
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<tr>
<td>Observing</td>
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<tr>
<td>Making Questions</td>
<td>Developing Language Skills: Reading and Writing</td>
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<tr>
<td>Communicating</td>
<td>Identifying Problems and Issues</td>
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<tr>
<td>Skills Competence</td>
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<tr>
<td>Science, Technology and Society</td>
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<td>Specific Aim:</td>
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</tr>
<tr>
<td>Understanding and Constructing Ideas</td>
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<tr>
<td>Specific Aim:</td>
<td></td>
</tr>
<tr>
<td>Doing Science and Technology</td>
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<tr>
<td>Specific Aim:</td>
<td></td>
</tr>
<tr>
<td>Natural Sciences Standards</td>
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| Date: 2.04.14 | Grade: A |
| Term: MA 513.6A | |

Example: Expression Plan
<table>
<thead>
<tr>
<th>Date</th>
<th>Planned Activity</th>
<th>Resource/Textbook Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Assessment:**

- Adapt to fit the curriculum
- Teacher to explain the parts of other animals
- In an ecosystem, describe the living tissues
- In a group, pupils to describe the living tissues
- Teacher to ask questions on how the animals adapt

**Teaching and Learning Activities:**

- Industry (accommodating learners with certain barriers to learning)

<table>
<thead>
<tr>
<th>Resource/Textbook Page</th>
<th>Topics/Outcomes</th>
<th>Other</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Maps/Alas/Globe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CD/DVD'S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Microscope</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Models</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Photos</td>
</tr>
<tr>
<td></td>
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<td>Posters/Charts</td>
</tr>
<tr>
<td></td>
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<td>Pocket</td>
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<td></td>
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<td>Activity Book</td>
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<tr>
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<td>Research Books</td>
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<td>Newspapers</td>
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<tr>
<td></td>
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<td>Other</td>
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</table>

**Terminology of New Words:**

- photos and P2P
### Resources:

<table>
<thead>
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<th>Notes:</th>
<th>✓</th>
<th>Microscope</th>
<th>✓</th>
<th>Maps/Atlas/ Globe</th>
<th>✓</th>
<th>CD’s/DVD’s</th>
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<td>Sketches</td>
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<tr>
<td>Laboratory Equipment</td>
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<td>Chalkboard</td>
<td>✓</td>
<td>Plants</td>
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<tr>
<td>Resource Books</td>
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<td>Projector</td>
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<td>Animals</td>
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<td>Posters/Charts</td>
<td>✓</td>
<td>Magazines</td>
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<td>Trips/Outings</td>
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</table>

### Terminology or new words:
- enzynas, pepsins

### Inclusivity (accommodating learners with certain barriers to learning):

### Teaching and Learning Activities:

<table>
<thead>
<tr>
<th>Date/Activity</th>
<th>Planned Activity</th>
<th>Resource/Textbook page no</th>
</tr>
</thead>
<tbody>
<tr>
<td>16/09/2003</td>
<td>Picture meaning of words used</td>
<td>Platinum Natural Science, p 68 - 69</td>
</tr>
<tr>
<td>17/09/2003</td>
<td>Identify structure and function of the digestive system</td>
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</tr>
<tr>
<td>18/09/2003</td>
<td>Using a model to name the parts of the digestive system</td>
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</tbody>
</table>

### Assessment:

<table>
<thead>
<tr>
<th>Date/Activity</th>
<th>Planned Activity</th>
<th>Resource/Textbook page no</th>
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<tbody>
<tr>
<td>16/09/2003</td>
<td>Observers</td>
<td>Platinum Natural Science, p 68 - 69</td>
</tr>
<tr>
<td>17/09/2003</td>
<td>Observers</td>
<td></td>
</tr>
<tr>
<td>18/09/2003</td>
<td>Homework</td>
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</tr>
</tbody>
</table>

### Teachers Reflections:

Pupils did fairly well in naming the parts. Some had trouble in explaining differences between chemical and mechanical digestion.