TEACHERS' EXPERIENCES OF INDIGENOUS KNOWLEDGE SYSTEMS (IKS) FOUND IN THE LIFE SCIENCES CURRICULUM: A CASE STUDY OF LIFE SCIENCES TEACHERS AT A HIGH SCHOOL IN THE PINETOWN DISTRICT

by

Marcell Mc Knight

971162797

Submitted in fulfilment of the requirement for the Degree of

Masters of Education

Curriculum Studies

Humanities and Curriculum Studies

School of Education

University of KwaZulu-Natal

Supervisor: Dr S. B. Khoza

2015

DEDICATION

This study is dedicated to my wife, son and parents who during the course of my study, have given me unwavering support, belief and inspiration.

ACKNOWLEDGEMENTS

DECLARATION

I, Marcell Mc Knight, declare that this study is my own work and has not been submitted in any form for any degree or diploma to any other tertiary institution. Where use has been made of the work of others, it is duly acknowledged in the text.

_____

(Signature of candidate)

_____

(Date)

_____

(Signature of supervisor)

_____

(Date)

ABSTRACT

A number of curriculum reforms which attracted much criticism in post apartheid South Africa have resulted in the curriculum currently adopted. Curriculum changes bring forward issues concerned with the achievement in the attained curriculum of the vision of the intended curriculum through its implementation as forms of curriculum are experienced differently at various levels, largely making teachers responsible for the implementation of the intended curriculum. This qualitative case study of three Life Sciences teachers within the interpretive paradigm aims to explore teachers' experiences of Indigenous Knowledge Systems (IKS) found in the Life Sciences curriculum at a high school in South Africa. This exploration of these experiences is done with the utilisation of a conceptual framework namely, the curricular spider web which identifies what these experiences are, which incorporates the classroom practice of the teachers. In exploring teachers' experiences the study identifies the attitudes of the teachers' towards IKS and the influence of these experiences which involves their attitudes on their classroom practice. Purposive and convienance sampling was used in selecting the three teachers who participated in this study. Data was generated from the participants using questionnaires, semi-structured interviews and document analysis in the form of the analysis of teacher lesson plans which were analysed using guided analysis. Findings show that the teachers have above adequate understandings of relevant concepts related to the teaching of Life Sciences, these being the Nature of Science (NOS) and Indigenous Knowledge Systems (IKS), which manifests in them having positive attitudes towards IKS which however, does not translate well in their classroom practice. As further findings show that there is a misalignment between the intended curriculum and attained curriculum. A misalignment which is a result of poor implementation of the curriculum by the teachers due to various reasons which includes a lack of understanding of components found within the curricular spider web.

TABLE OF CONTENTS

CHAPTER TWO: Literature review and Conceptual framework 8

CHAPTER THREE: Research Methodology

ABBREVIATIONS AND ACRONYMS

Abbreviations and Acronyms	Description
ACE	Advanced Certificate in Education
B. Ed.	Bachelor of Education
B. Paed.	Bachelor of Paedagogics
CAPS	Curriculum and Assessment Policy Statement
CNE	Christian National Education
DoE	Department of Education
FET	Further Education and Training
IKS	Indigenous Knowledge Systems
LTSM	Learning and Teaching Support Materials
M. Ed	Masters of Education
MIAN	My Idea About Nature
NCS	National Curriculum Statement
NOS	Nature of Science
OBE	Outcomes Based Education
PAC	Practical Argumentation Course
PCK	Pedagogic Content Knowledge
PISME	Psycho – socio – cultural Issues in Science and Mathematics Education
SAARMSTE	Southern African Association for Research in Mathematics, Science and Technology Education

LIST OF FIGURES

LIST OF TABLES

Table Number	Description	Page
2.1	Comparisons of the competence model and performance model.	17
2.2	Ten questions relevant to each component of the curricular spider web.	37
2.3	Components of the curricular spider with relevant proposition/s for each and a summary of the literature covered pertaining to each component.	38 - 40
2.4	The three broad subject specific objectives referred to as specific aims in Life Sciences.	46
2.5	Content explored in each knowledge strand in the three-year phase	51
2.6	Sequencing of a strand and topics for the first term of grade 10.	52
2.7	IKS topics explored through grades 10 – 12.	52 - 53
2.8	Weighting of cognitive demands for assessment of content in grades 10, 11 and 12.	72
3.1	Profiles of participants of study.	81
3.2	How the generation of data was conducted.	89 - 90
4.1	Responses to statements related to the Nature of Science.	101
4.2	Responses to assumptions underlying IKS.	104 - 105
4.3	Components, questions and teachers' experiences categories guided by the curricular spider web.	109 - 110

LIST OF APPENDICES

Appendix Number	Description	Page
Appendix 1	University Ethical Clearance	154
Appendix 2	Principal Consent Letter	155 -156
Appendix 3	Teacher Consent Letter	157 - 158
Appendix 4	Questionnaire	159 - 163
Appendix 5	Lesson Plan Template	164 -165
Appendix 6	Teacher semi-structured interview schedule	166

CHAPTER ONE
BACKGROUND AND ORIENTATION TO THE STUDY

1.1 Introduction

According to Van den Akker, de Boer, Folmer, Kuiper, Letschert, Nieveen, and Thijs (2009) there are three forms of curriculum which are namely; the intended, the implemented and the attained curriculums which are experienced at various levels. These levels are the macro (national) for the intended curriculum, the micro (classroom) for the implemented curriculum and the nano (learner) for the attained curriculum. The experiences of curriculum differ at various levels. This largely leaves teachers who operate at the micro level entrusted with implementing the intended curriculum, which is concerned with the macro level (Carl, 2012) which involves the designers and developers of the curriculum. This study aims to explore the experiences of teachers of Indigenous Knowledge Systems (IKS) which are found within the Life Sciences curriculum at a high school in South Africa. It explores what these experiences are, the ratonale behind their occurance and why these experiences are taking place. Such an exploration will engender a better understanding of these experiences.

The context and overview of the study are provided in this chapter. It also discusses the background to this study which provides insight into how South Africa's current Further Education and Training (FET) curriculum was adopted. The chapter also provides the rationale and objectives of the study.

1.2 Curriculum reform and Indigenous Knowledge Systems in South Africa

The political change in the country brought with it the founding of a new democratically elected government in 1994 which ushered in major education reforms in South Africa. Evidence of this reform can be seen in the move away from Christian National Education (CNE) which was used to ensure cultural and political control (Abrahams, 2000) during the apartheid era. This status quo was changed after the implementation of an outcomes based approach to education post 1994. The apartheid era education system was considered irrelevant and monocultural (Msila, 2007). It divided races through the adoption of separate education departments that were assigned different curricula. Areas of educational system reform included the abolishment of separate education departments, and the designing and adoption of one national curriculum policy document.

1

The new South African Constitution formed the basis for this one national curriculum policy document called Curriculum 2005 which was introduced in 1997. This document was predicated "on the notion of 'science for all', and was in keeping with the transforming socio – political environment" (Mudaly & Ismail, 2013, p. 179), where equal access to science education by all learners was envisaged.

Curriculum 2005, an outcomes based curriculum for the General Education and Training (GET) band (up to Grade 9) and the Further Education and Training (FET) band (from Grade 10 up to Grade 12), was seen as a catalyst through which the aims of the Constitution of South Africa would be realised. This move to Outcomes Based Education involved using the values that inspired the Constitution of the Republic of South Africa as a basis to design it. This is the Constitution which aims to 'heal the divisions of the past and establish a society based on democratic values, social justice and fundamental human rights' (DoE, 2011, p. 1). Subsequent curriculum reforms included the Revised National Curriculum Statement, Grades R – 9; the National Curriculum Statement, Grades 10 – 12; and in recent times, the combining of these two National Curriculum Statements to produce a single policy document known as the National Curriculum Statement (NCS) Grades R – 12. The NCS which includes the Curriculum and Assessment Policy Statement (CAPS) remains relevant to each subject. All subjects used the constitution as basis for their design.

The Constitution, in an endeavour to heal the divides of the past, acknowledges the diversity of the people of South Africa. This recognition of diversity manifests itself in the curriculum with the inclusion of IKS into it. Understanding what indigenous knowledge systems are, places one in a position to contextualise it with regard to the recognition of diversity as proposed by the constitution. There is a need to recognise and include IKS into the educational system in order to address the division created by the past within the South African context which in the past did not recognise and include African thinking within the curriculum.

Evidence of the above stated point can be found in both the National Curriculum Statement for Life Sciences (DoE, 2003) and the currently implemented Curriculum and Assessment

Policy Statement for Life Sciences (DoE, 2011). It states that one of the principles it is based upon is concerned with valuing IKS which concerns the acknowledgment of the rich history and heritage of this country (South Africa) as fundamental contributors in nurturing the values contained in the Constitution.

The enactment schedule of Curriculum 2005 was based on a progressive phasing in of the curriculum, where eventually by 2005, all phases of schooling would be included. However, Curriculum 2005 garnered much criticism which included for example as Jansen and Taylor (2003) identified, the highly inaccessible and complex nature of the language used in the Curriculum 2005. Embedded in the criticism was the notion that teachers were underprepared to engage with the complexities of the curriculum. One such complexity may have been the inclusion of IKS. Added to this is the fact that there is much complexity in defining IKS. This type of criticism resulted in the curriculum being reviewed which ultimately led to a Revised National Curriculum Statement Grades R – 9 as well as the National Curriculum Statement Grades 10 – 12. The review was completed in 2002 and the new curriculum was implemented in 2004. The curriculum reform brought about many changes. These changes included the terms used for Subjects and the Goals of the curriculum. The new term which was introduced to describe *Subjects* was *Learning Areas* and the term which described *Goals* of the curriculum was *Outcomes*. A discussion on the goals of the curriculum that involves the various types of goals takes place in chapter two which explores the conceptual framework used for this study. Regarding *subjects* changing to *learning areas*, there were even further changes to the naming of these learning areas. For example, (and relevant to this study) the subject of Biology was renamed the learning area of Life Sciences.

1.3 Purpose of the study

This study aims to explore the experiences of teachers of IKS which are found within the Life Sciences curriculum at a high school in South Africa. Exploring teachers' experiences may also aid in ascertaining whether the intended curriculum is in fact implemented. Such an exploration might shed light on this matter due to the teachers' interpretations of the intended curriculum influencing their experiences in the classroom.

1.4 Rationale for the study

The rationale for conducting this study is primarily informed by personal interest in the teaching and learning of Life Sciences. Secondly, seeks to acquire to acquire an understanding of the teaching of the topic of IKS within Life Sciences which is not superficial in nature. In addition to the personal interest mentioned above, is the result of a ten – year teaching experience. Learners often ask why they must learn about IKS. As a result of my experience in this field, I am able to give a profound response that encompasses even an explanation of the importance of IKS in relation to the curriculum. This interaction with learners ignited curiosity as to how other teachers might handle such a question of this nature if posed by a learner.

A teachers' response to the above – mentioned question may be informed by his or her experiences of relevant issues with regard to the subject. These relevant issues with regard to Life Sciences include the understanding of concepts which include the Nature of Science (NOS), IKS and pedagogies that are involved in the teaching and learning of science in general. In a study which was conducted by Dziva, Mpofu, and Kusure (2011) in Zimbabwe, which explored teachers' conceptions of indigenous knowledge, it was found that participants demonstrated shortcomings in their understandings. Participants in the study spoke of indigenous knowledge in terms of spirits of vengeance and ancestral spirits. These types of shortcomings would consequently therefore impact on their ability to explain to learners what IKS entails. This claim is further corroborate by Onwu and Mosimege (2004) who point out that simply defining IKS could prove problematic due to the many definitions which prevail concerning this topic. My erstwhile concern of how other teachers might explain IKS then led me to consider (in light of their deficiencies in defining IKS) the influence of their attitudes which emanate from their experiences on their classroom practice.

Another reason for undertaking a study of this nature is underpinned by recent research conducted in relation to teacher education in the field of Mathematics and Science (see Adler, Pourana, Taylor, Thorne, & Moletsane, 2009). They concluded that in recent times the trend of research in teacher education in Science has been on the Nature of Science (NOS) as well as IKS. However, Adler et al. (2009) also indicate through their review that although much research has been conducted in Mathematics and Science education (Physical Science aspect), there are gaps in teacher education for Life Sciences. This research may thus initiate

or contribute to a discussion related to teachers and IKS which may influence areas of teacher education in Life Sciences.

1.5 Objectives of the study

In light of the purpose and rationale of the study, it intends to achieve the following objectives:

- Explore teachers' experiences of IKS.
- Explore IKS teachers' experiences with reference to their classroom practice.

1.6 Research questions

There are two research questions in this study. The main question is stated first with the second question being viewed as a sub question that is derived from the main question in order to make this study applicable to teaching and learning. They are:

1. What are the teachers' experiences of IKS?
2. How do the teachers' experiences of IKS influence their classroom practice?

In an effort to answer the two research questions three data generating methods namely, a questionnaire, semi – structured interviews and document analysis of lesson plans, are utilised.

1.7 Significance of study

The significance of this study is that it may firstly make other Life Sciences teachers' aware of the strengths of their understanding of issues around Life Sciences and IKS through the exploration of the participants' experiences. It may also help identify limitations in their own understanding which may be used to improve teaching and learning in the classroom. The study also has a potential to inform policy makers/ reformers about teachers' understandings of the relevance of IKS. This may assist policy makers/ reformers in identifying teacher misconceptions if any and design interventions where such issues could be addressed. Largely, it is hoped that this study will enhance the standard and quality of education in the country.

1.8 Outline of study

1.8.1 Chapter 1 Background and Orientation to the Study

This chapter sets the scene for the study by providing the reader with the historical background on educational reform in South Africa which leads to the inclusion of IKS in Life Sciences. The chapter also provides the reader with the significance of the study, the purpose and the rationale behind the study.

1.8.2 Chapter 2 Literature Review and Conceptual Framework

In this chapter, literature that is relevant to issues of curriculum development in general and those that relate to curriculum development in Life Sciences in particular is presented. The NOS and IKS as fields of study are also discussed. The chapter involves the review of literature which is concerned with the components that are found in the curricular spider web which is adopted as the conceptual framework of the study. This exploration of the curricular spider web is necessary as it informs the experiences of the participants.

1.8.3 Chapter 3 Research Methodology

Discussion on how the objectives of this study are going to be achieved take place in this chapter where various elements relevant to the research strategy of this study are explored. These elements include the research paradigm (interpretive), research methodology (case study), research approach (qualitative), sampling (purposive and convenience), data generation methods (questionnaire, semi – structured interviews and document analysis of lesson plans), ethical issues, trustworthiness (credibility, dependability, transferability, conformability), data analysis (guided analysis) and study limitations.

1.8.4 Chapter 4 Research Findings and Discussion
Findings of the study are discussed through the analysis of the data generated from the data generation methods. The findings are based on the interpretations of data generated from the research participants (three Life Sciences teachers). The data from the questionnaire are first analysed in order to ascertain both past and present experiences which may impact on teacher

attitudes. Then, the semi-structured interview data and the lesson plans are analysed in an attempt to reveal the participant's experiences in relation to the influence of their attitudes on their classroom practice. The data are presented with the use of verbatim quotations and use the concepts found within the curricular spider web to inform the discussion around the participants' experiences.

1.8.5 Chapter 5 Conclusion and Recommendations

This chapter presents a discussion of the findings and the conclusions derived from the findings that are relevant to the objectives of this study. These findings and conclusions state what the Life Sciences teachers' experiences of IKS are. They also state the teachers what are their experiences' of IKS are in relation to their influence on their classroom practice. Furthermore, a number of recommendations are made based on the findings of the study.

1.9 Chapter Summary

This chapter describes the historical background of the South African educational reforms which led to the inclusion of IKS in the new curriculum policy. It provides the reader with the purpose, rationale, objectives and the significance of this study where the research questions, which the study intends to answer, are given. The next chapter explores the literature and the conceptual framework relevant to the study that will help in my research methodology, analysis, findings and recommendations.

CHAPTER TWO
LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter reviews literature that is relevant to this study. The literature reviewed includes research conducted both nationally and internationally. According to Cohen, Manion, and Morrison (2011) a literature review must provide broad themes on issues around the topic of a study and must show how the study could contribute towards the enhancement of the existing literature around the said topic. This section reviews the literature that is relevant to study and its objectives which are related to the experiences of Life Sciences teachers with reference to IKS. The chapter starts with the description of the phenomenon that is being studied which is teachers' experiences of IKS. It then discusses concepts that are relevant to this study in terms of the curriculum in general. The broad themes suggested by Cohen et al. (2011) which are namely; vision, rationale, content, materials and resources, location, teacher role, learning activities, assessment, time and grouping will be explored as these broad themes form the conceptual framework that is adopted by the study, which is the curricular spider web (Van den Akker et al., 2009).

Included in the conceptual framework of this study, is the concept of constructivism as a learning theory. Although this concept is concerned with learners when they construct knowledge, the adoption of this theory in their construction of knowledge will inform teacher classroom practice (experiences). Therefore, where relevant, an the exploration of this learning theory will also be presented in this chapter. The rationale for the inclusion of this learning theory as a concept is in accordance with the definition provided by Jansen and Vithal (1997) who state that a conceptual framework might link two or three key concepts. This knowledge influenced the decision to include this concept as the study attempts to identify the influence of the teachers' experiences. It is these experiences that inform understanding and in turn inform attitudes held by the teachers with regard to IKS and their teaching practice in the classroom.

2.2 Teacher experiences

The study aims to explore the teachers' experiences that are related to IKS which are part of in the Life Sciences Curriculum at a high school in the Pinetown District. The researcher decided to identify and explore concepts which are relevant to a teachers' experiences.

In a broad sense the term *experience* is defined as one having direct personal participation of something (Collins, 2006). The relevance of this definition to the study can be explained by the understanding that the teachers do in fact personally participate in the Life Sciences curriculum which includes IKS. In an educational sense Van Manen (1977) defines educational experiences as being grounds on which an individual's knowledge is constructed. These educational experiences constructing an individual's knowledge can be further explored in a comprehensive interpretive study that was conducted by Naidoo (2010) which involved the exploration of indigenous knowledge in terms of the interpretation and implementation of policy by teachers. This case study, firstly aimed to find out what informs the way teachers conceptualise, interpret and envisage implementing IKS. This was done with the participation of twenty-three teachers who completed a University module 'Issues in Science Education'. Secondly, the study also aimed to find out how the implementation of indigenous knowledge systems was done by teachers and why they interpret and implement it in the way they do. To fulfil this aim three of the teachers who were involved in the fulfilment of the first aim were further utilised. The comprehensiveness of the study can be attributed to the variety of data generation methods that were used. The study employed largely qualitative methods which included written assignments, telephonic interviews, classroom observations, reflective and face to face interviews. Findings included that a variety of experiences (university modules, parents, grandparents and elders) informed the teachers' conceptualisation or knowledge of IKS for the classroom.

The impact of experiences is not only limited to the construction teachers' knowledge of a concept as stated above. Kardos and Johnson (2010) conducted a study that was concerned with the assessment of novice teachers' experiences of formal coaching during their first year. The study involving randomly selected second-year student teachers found that conflict existed internally by teachers with regard to the teaching strategies to be adopted, content to be taught and the resources to use in their classroom practice which suggests that their

experiences have influenced their decisions on teaching strategies, content and resources. The evaluation of experiences by a teacher in terms of reflecting on them could help in improving their classroom practice as it would identify areas where changes could be made to bring about such improvement.

Thus, experiences have been identified as contributing to the construction of knowledge. Through their evaluation, they can also be used as a tool to bring about improvement in the classroom practice of the teacher. In line with the work of Kardos and Johnson (2010) regarding the conflict within teachers are the challenges experienced by teachers which are identified by Spooner, Flowers, Lambert, and Algozzine (2008). The challenges identified include the time that is available to cover subject content is insufficient and which is the correct teaching method is suitable for the learners. The issue of the suitable teaching method to be used is relevant to CAPS as it does not stipulate the envisaged role of the teacher as did the previous curriculum (NCS) which would assist the teacher in some way in determining the teaching method to be adopted.

2.2.1 Linking teacher experiences to attitudes and classroom practice

In light of the above discussion regarding defining experiences from a broad sense and then to an educational one which involved the identification of experiences being concerned with teacher classroom practice, this study will be informed and framed by the relevant concepts which are concerned with the curriculum. As it has already been stated in the introduction of this chapter, this study adopts the curricular spider web by Van den Akker et al. (2009) as its conceptual framework. The Spider Web is appropriate as the study deals with concepts that are concerned with the curriculum in order to explore Life Sciences teachers' experiences which are informed by the ten components of the curricular spider web. In exploring experiences, a link can be identified between experiences and attitudes held by an individual towards a topic or concept using the work of de Souza Barros and Elia (1998) who define an attitude as a subjective or mental conception for the preparation of action, where experience determines what an individual will do in terms of reacting to sight, sound and thought. The definition is further divided into two types of attitudes; those that are positive or negative towards an object. A possible summary of the above definition that could be used in an attempt to clarify and contextualise it to a teaching and learning sense is that, an attitude can

be viewed as personal, shaped by experiences which impact on the behaviour (positive or negative) of the teacher in the classroom which is viewed as the teacher's classroom practice.

A practical example of the above definition can be seen in the work of Naidoo (2010). Her study found that a variety of sources which can be viewed as experiences informed teachers' conceptualisation of IKS for the classroom and that the different approaches used by teachers involved in the study in the implementation of IKS were informed by individual teacher's biographies, values, cultural backgrounds and world views (experiences). These findings resonate with the definition discussed concerning attitudes, based on experiences, having an influence on classroom practice. Further evidence of attitudes having an influence on classroom practice can be seen in Brickhouse (1989) who through her work found that after observing and interviewing three science teachers, their attitudes concerning the NOS did in fact impact on teacher classroom practice. The impact of these attitudes could be observed in their conducting of laboratory work which involved the way they implemented demonstrations in their classroom practice. These demonstrations can be viewed as resources which facilitate the teaching and learning process.

It is also important to mention that the understanding of a concept of a teacher has an impact on that particular teacher's attitude towards the concept. According to de Souza Barros and Elia (1998) a lack of confidence about subject content could result in a negative attitude towards the subject which would lead to it affecting the learning process negatively.

The figure below illustrates the link between experiences, conceptual understanding, teacher attitudes and their influence on classroom practice. The arrows in the figure represent the influence that one of the aspects has on the other/s in this relationship.
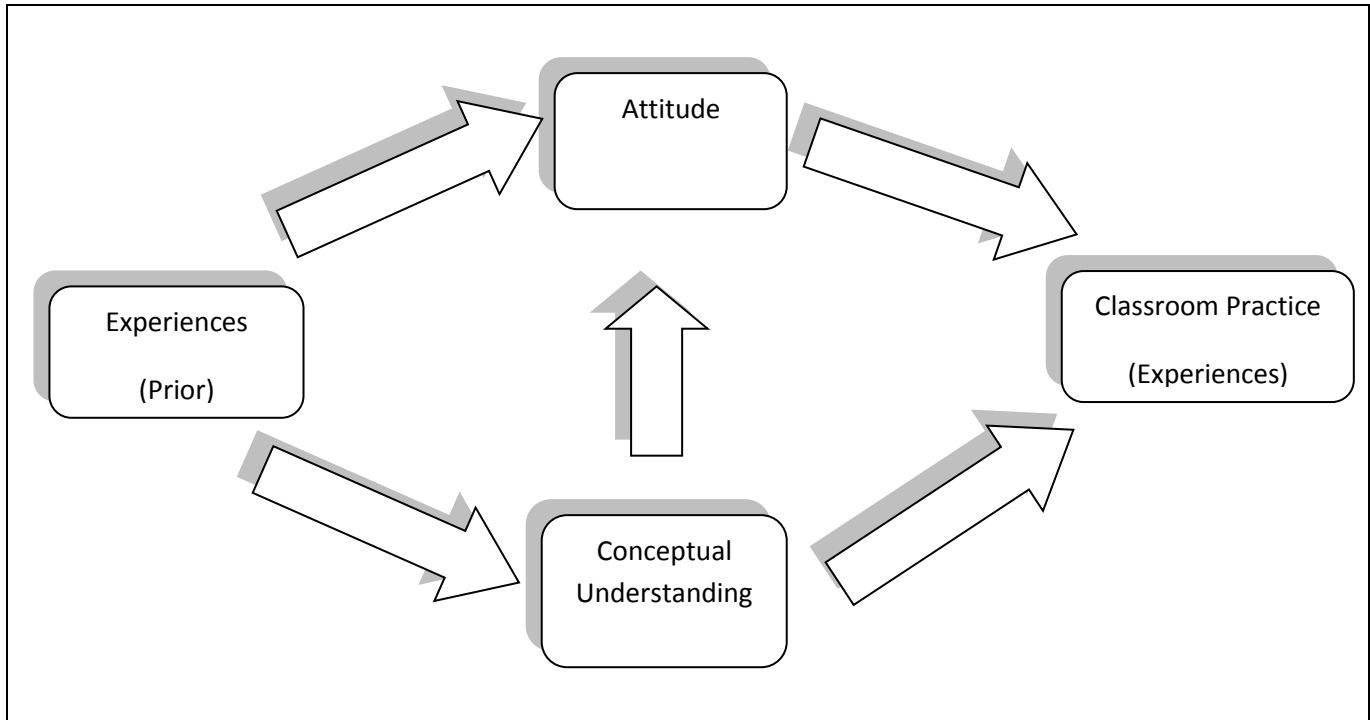
Figure 2.1 Link between prior experiences, conceptual understanding, teacher attitudes and classroom practice.

2.3 Study filling gaps in the existing literature on IKS

A report compiled by Adler et al. (2009) which is concerned with the education of teachers in South Africa in terms of the Mathematics and Science discipline, involved the reviewing of research in times of change with respect to policy and practice. It concluded that the recent trend of research in teacher education that pertains to the Sciences has been in the NOS and IKS. The method used for this review was a survey which used criteria as its framework to identify which research related to teacher education. The criteria used for the review included studies of, or reflections on teacher education policy and practice relating to Mathematics and Science, and interventions related to teachers' practice.

The criteria used as a basis for the study mentioned above is relevant to this study, in light of this study aiming to research teacher practice. The sample for survey involved a total of seventeen Mathematics and/or Science education journals both local and international, and seven well – known educational journals where it was known that South Africans had published research on Mathematics and Science. From these journals only a total of twenty-five articles on Mathematics teacher education and seventeen on science teacher education met the criteria explained above. The survey was extended to the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE) proceedings. The SAARMSTE proceedings yielded forty-four conference papers (twenty-five mathematics and nineteen science) which met the criteria previously outlined. Therefore, to focus these quantitative results to Science education of which this study is concerned with a component of, namely Life Sciences, only thirty-six out of a total of eighty-six pieces of research relevant to science education were identified using the criteria previously outlined.

Closer inspection of the research concerned with Science education indicated that the studies conducted at first, predominately involved teachers who were participating in formal in-service programmes (such as ACE or honours programmes), secondly it involved teachers who worked in urban settings and thirdly, it established that these studies were carried out by presenters of courses in the programmes stated above. These above mentioned factors are pertinent in illustrating this study's worthiness. This study does not involve teachers who are participating in a formal in – service programme, who work in an urban setting and the researcher is not presenting a course in a formal in-service programme. The point of the researcher not presenting a course will eliminate any bias, which speaks to the point of trustworthiness of the findings.

Adler et al. (2009) also indicate through their review that although much research has been conducted in Mathematics and Science education (Physical Science aspect), there are gaps in the research that concerns teacher education for Life Sciences which includes new foci such as evolution, cloning, genetically modified products and relevant-to-the study environmental education which involves IKS. This study may therefore initiate or contribute to a discussion that relates to teachers and IKS, which may influence areas of teacher education in the Life Sciences.

The need for this study can be further emphasised by the assertion made by Mudaly and Ismail (2013) in their qualitative study located in the interpretive paradigm which explored the value of incorporating practices and knowledge entrenched in IKS. The participants of the study included thirty pre-service teachers who had engaged with the pedagogic content knowledge (PCK) module. Data generation methods included lesson plans and written reflections on the activities of participants. It was found through the study that pre-service teachers have the ability to refer to a variety of sources for information, that through collaborative work their confidence in drawing on different knowledge systems increased and that they recommend that IKS be included in modules taught at tertiary institutions. After critical analysis of relevant research pertaining to issues around the incorporation practices and knowledge entrenched in IKS, Mudaly and Ismail (2013) recommend that more research should be conducted with reference to IKS which is concerned with both school and university levels of curricula due to the belief that it is still in its formative stages of development.

2.4 What is curriculum?

Van den Akker et al. (2009) acknowledge that many definitions exist for the term 'curriculum', where the many definitions supplied only serve to confuse the understanding of the term as some are expansive while others demonstrate a narrow view. Such definitions include that curriculum is a body of knowledge which consists of content or subjects where education is viewed as the means by which the transmission of this body of knowledge to learners with the use of methods that are most effective (Rao, 2010). This definition could be viewed as a rather narrow view of curriculum because it only relates to the transmission of a body of knowledge. According to Van den Akker et al. (2009) the concept of 'curriculum' has its origins from the Latin verb currere, which means to run and that the Latin noun curriculum refers to a 'course' and a 'vehicle'. A logical interpretation of curriulum within an educational context is that it is a course for 'learning', which is in line with Taba's (1962) definition which refers to it as a 'plan for learning'. This short definition does not demonstrate a narrow view of curriculum but rather allows for the elaboration of curricular levels, contexts and representations.

In further defining the term curriculum Van den Akker et al. (2009) identifies firstly, the five levels in which a curriculum can operate and secondly the forms of curriculum. The five

levels in which curriculum operates are namely; the supra (*the international*), the macro (*the system*), the meso (*the school*), the micro (*the classroom and teacher*) and the nano (*the learner*). Respective examples of these five levels are common European framework for references for languages (supra), core objectives (macro), school programmes (meso), teaching plan (micro) and personal plan for learning (nano).

The different forms of curriculum are firstly, the intended (formal) which clearly states the common core standards of the curriculum (Porter, Mc Maken, Hwang, & Yang, 2011). Hoadley and Jansen (2013) further describe it as aiding to direct teachers in terms of the information, principles and competencies the learners need to learn, and it provides a statement of what the curriculum developers think is important for the human being and the world. The second form is the implemented (perceived) which according to Van den Akker et al. (2009, p. 10) is the "actual process of teaching and learning" where the interpretation of the intended curriculum is carried out by teachers. The third one is the learned or attained curriculum which can be divided into (Hoadley & Jansen, 2013) the explicit and hidden curriculum where explicit refers to what is planned and official with a more teacher centred approach while hidden refers to elements learned out of the teachers' consciousness.

These forms can be further unpacked into representations which Van den Akker et al. (2009) identify as feeding into one another. The intended curriculum representations are concerned with the ideal (rationale) of the curriculum which is stipulated in formal writings found in official documents. The representation of the implemented curriculum is concerned with the curriculum which is operated and is informed by the interpretations by the teachers of the intended curriculum as stated above. The representation of the attained curriculum is concerned with the achieved curriculum where the learning experiences perceived by the learners are measured by the attainment of learning outcomes. To contextualise the above levels and forms of curriculum to this study, the Life Sciences curriculum of South Africa is generated nationally (macro) guided by some international standards (supra) which informs the intended curriculum, is disseminated to schools to implement (meso) where the teacher practises it in the classroom (micro) which speaks to the implemented curriculum. Lastly, the implemented curriculum is measured in terms of the attained curriculum which is concerned with the student's (nano) achieved outcomes. Considering the various forms of curriculum, the definition supplied by Talla (2012) on curriculum sums it up by identifying it as a

document (intended) that includes strategies (implemented) for achieving educational goals (attained).

However, there are areas of concern with reference curriculum in terms of its different forms. Definitions supplied for the intended and implemented curriculum suggest there needs to be a consultative process between policy makers and teachers when designing a new curriculum which involves teacher training interventions before the implementation of a new curriculum. The intended curriculum providing core standards which need to be adopted by the teachers in order for them to interpret the intended curriculum so that there is successful implementation of it. This consultative process was not done with the implementation of CAPS.

2.5 Types of Curriculum

Bernstein (1975) identifies two distinct types of approaches to curriculum. He terms these types the 'competence' model and the 'performance' model. The competence model is concerned with the integration between subjects and making the connection between real life and school learning. What remains noteworthy about the performance model is the separation of subject disciplines where there is not an extensive drawing from real life in order to teach in school.

According to Hoadley and Jansen (2009) the learner's competencies which they already possess are fundamental to a competence model. The envisaged motivation for this type of model is for learners to apply newly acquired knowledge in their lives where the emphasis is on them drawing upon everyday knowledge and own experiences in the teaching and learning process. Due to the importance being placed on the own experiences of the learner the line between school learning and everyday experiences is blurred which results in the non-traditional perspective on locations of learning. In this non-traditional perspective on locations of learning the classroom is not regarded as very important as it is assumed that learning can take place anywhere. Learning is organised around themes which are based on experiences of the learners where learners are entrusted with a large degree of control over the selection (what content they learn), sequencing (when do they learn it) and (pacing) how they move through the levels of learning. On the contrary, the performance model is characterised by the development of high levels of understanding. There is a focus on formal

school knowledge as opposed to everyday knowledge and experiences. Learning is organised around specific subjects where the teacher has a large control over selection, sequencing and pacing. The table on the page which follows serves to summarise the comparison of the two curriculum models in terms of other areas relevant to curriculum models.

	Competence Model	Performance Model
Learner	• All learners will achieve the envisaged outcome in their own way and at their own pace. • Overt role	• Some learners do not achieve outcomes. • Covert role
Teacher	• Acts as a guide and facilitator • Covert	• Directly transmits knowledge • Overt
Pedagogy	• Learner centred	• Teacher centred
Knowledge	• Integrated subjects • Unrelated in terms of complexity	• Specific subject disciplines • Complexity of knowledge
Assessment	• Evaluated on what the learners know	• Evaluated on what the learners don't know
Learning site	• Anywhere	• Clearly defined

Table 2.1 Comparisons of the competence model and performance model. Adapted from Hoadley and Jansen (2009, p. 179)

To contextualise the above to the South African setting in engaging with the above factors which characterise the two models of curriculum, one can identify that the current South African curriculum is in line with the performance model. Evidence of this can be seen in the fact that there is separation of subject disciplines (Life Sciences, Business Studies). Each subject discipline through its Curriculum and Assessment Policy Statement (CAPS) is very

specific regarding the content to be learnt and in the sequencing of the content as there is a complexity in the knowledge as one moves to the next level. A consequence of the CAPS (DoE, 2011) being performance in nature in terms of it being teacher centred and driven more by content, is that learning experiences for learners tend to take place in specific learning places. CAPS for the Life Sciences (DoE, 2011) supplies evidence that is relevant to specific learning places as it identifies which resources are needed to teach the subject of Life Sciences. Resources identified include secure storage space for textbooks, sufficient workspace and laboratory equipment as well as DVD's and a DVD player. This suggests that indeed a specific learning place such as a classroom or laboratory is required. The teacher's role in the curriculum delivery is definitely overt where there is much control by the teacher in terms of the selection, sequencing and pacing of learning. It is therefore incumbent of the teacher to direct teaching (selection, sequencing and pacing) in terms of syllabus coverage. The learner's role is covert and learners are assessed in terms of what they do not know (marking rubrics).

In identifying that the curriculum utilised by South Africa is strongly aligned to being a performance curriculum one needs to address the comments of Hoadley and Jansen (2009) who suggest that in many instances a curriculum is most often a hybrid of the two types of curriculums discussed above. In the South African context, an element of the competence model can be seen in the general aims of the curriculum, where one of them is to ensure that children acquire and apply knowledge in a meaningful manner to their own lives which promotes knowledge in local contexts. This point is closely related to one of the tenets of a competence model where there is an emphasis on children drawing on everyday knowledge and own experiences in the process of teaching and learning.

2.6 Ideological nature of a curriculum

Commenting on the relationship between ideology and curriculum Apple (2004) writes that a purpose of institutions involved in education is to disseminate knowledge and ideological values, knowledge which is necessary to maintain the status quo in terms of economic, political and cultural conditions. The history of curriculum points out that maintaining the status quo can be viewed as a form of controlling society, where

education in general, and the everyday meanings of curriculum in schools in particular, were seen as essential elements in the preservation of existing social privilege, interests, and knowledge, which were the prerogatives of one element of the population, maintained at the expense of the less powerful group.

(Apple, 2004, p. 45)

Applying the above to explore the curriculum which was implemented pre 1994, Jansen (1999, p. 4) describes the education system implemented during apartheid as "racist, Euro - centred, sexist, authoritarian, prescriptive, unchanging, context blind and discriminatory". Fundamental to the apartheid education system was to divide races and to prepare various groups of people for different roles in society. This was done by having separate education departments for races using different curricula. Grooming various groups of people for different roles in society was done through the adoption of Christian National Education which was based on Christian values. According to Pillay (2006) it was used to protect white privilege by implementing the principle of divide and control. The above suggests that no curriculum is neutral. The ills of the apartheid educational system supply evidence of curriculum not being neutral. The question then is to ask about the ideology of the present curriculum being implemented and its endeavour to establish and maintain social control.

The type of knowledge which is included in the curriculum is an area which can be identified as being fundamental in establishing and maintaining social control. A manifestation of colonialism in South Africa was the adoption and implementation of Christian National Education which did not incorporate IKS. In reviewing the literature concerned with the link between colonialism and the type of knowledge which this study is concerned with namely IKS, one can conclude that colonisers implemented various measures overtly as well as covertly which stripped the indigenous people of various aspects. Aspects which contributed to their identities, which included the knowledge they generated. According to Durie (2004), colonisation was not only carried out by Great Britain in relation to South Africa. Other western countries also became colonisers such as America, France and Germany in other parts of the world, which resulted in a loss of identity of the indigenous peoples through a loss of various components which constituted their identities. These components included the

loss of culture, land, voice, dignity and traditional methodologies due to the colonisers arrogantly claiming to have a divine right to oppress, exploit and plunder.

This resulted in a view of the status of the knowledge which IKS encompasses that was considered as being inferior to that of the status of the knowledge of the colonisers. Durie (2004) suggests that one of the consequences of the colonisation of indigenous people includes the marginalisation of IKS as a form of knowledge. This marginalisation of IKS as a form of knowledge is in relation to western knowledge and is termed by Semali and Kincheloe (1999) and Maurial (1999) as being 'subjugated knowledge'. This is happening at a time when western knowledge as a knowledge system has become dominant with the disqualification of IKS on the grounds of it being inadequate as a result of factors suggested by Maurial (1999) of power which are embedded in knowledge.

Ogunniyi (2004) concurs that colonisation brought with it the erosion of certain cultural values and practices of African people. His study aimed to assess the worldviews held by the teachers who participated in a module called the Psycho-socio-cultural Issues in Science and Mathematics Education (PISME). The PISME module formed part of a Masters in Science and Mathematics Education programme. This module focussed on exposing the teachers to a series of discussions and debates which places science and indigenous knowledge systems on the same footing. His study involved ten practising teachers enrolled in the Masters programme. The instrument used to assess the effect of the PISME was the 'My Idea About Nature' (MIAN) questionnaire. This questionnaire consisted of eight fictitious stories dealing with various natural phenomena. Each fictitious story was followed by five shorter explanatory statements about what may have caused the phenomenon. The questionnaire was administered before and after the PISME module. Teachers were also afforded the opportunity to express themselves with more personal comments regarding their views. It was found that the PISME module seemed to have increased the teachers' awareness of alternative worldviews which includes indigenous knowledge systems. Bishop (1990) adds that it is a well-attested historical fact that the use of western knowledge through facilitating agents of trade, administration and education colonisation was an instrument of exploitation, cultural subjugation and the denigration of local people.

2.7 Defining Indigenous Knowledge Systems

Literature reviewed in this section is categorised as that which explores issues that contribute to the complexity of defining IKS which is divided into two sub categories. The first sub category is concerned with understanding the terms that contribute to the concept of IKS which could contribute to the complexity of defining it. These terms are; 'indigenous', the understanding of what knowledge is and what a system is. The second sub category explores other issues which academics in the field of defining IKS view as contributing factors which make defining IKS a complex task. Secondly, it explores the various definitions used for IKS.

In reviewing the literature which is concerned with defining IKS, researchers in the field of IKS agree that defining it is complex. Evidence of this complexity can be identified in the work of Onwu and Mosimege (2004) which involved a discussion with regard to issues relevant to IKS, who suggest that although various definitions exist there is difficulty in agreeing upon a legally and scientifically acceptable definition for indigenous knowledge due to the fact that the term or concept of IKS consists of diverse knowledge which involves different peoples with many layers.

2.7.1 Understanding 'indigenous', 'knowledge', 'systems'

Being cognisant of the complexity of defining IKS as stated above, as a point of departure in defining the IKS, definitions of the terms that contribute to the concept will be explored. These terms being 'indigenous', 'knowledge' and 'systems'. Nnadozie (2009) and Naidoo (2010) contribute to the defining of these terms by suggesting that in defining the concept of IKS, critical questions with regard to the concept need to be asked. These questions include what is meant by the term 'indigenous'? what type of knowledge is the concept referring to? and what is understood by the term 'system'?

Nnadozie (2009) contributes to the defining of these terms through her study, whose purpose was to explore educators' understanding of the integration of IKS in science education and to investigate how they mediate and reconcile indigenous knowledge in their teaching of conservation. The research approach of this study was a qualitative one that involved a case study. The research design of the study was in two parts. Part one involved nineteen educators. This was meant to explore educators' understandings and integration of indigenous knowledge. It would also establish the extent to which educators integrate indigenous

knowledge systems in their teaching. Data were generated with the use of an open ended questionnaire. Part two of the study involved two of the educators from the group of nineteen who had participated in part one. This part aimed to identify how educators integrate indigenous knowledge in their teaching as well as to ascertain what informs the way in which the educators integrate indigenous knowledge. Data in this part were generated by conducting a pre-observation interview, a lesson observation and a post-observation interview. Findings included that there was no evidence of proper understanding and integration by the educators of indigenous knowledge in their teaching.

In defining the term 'indigenous' Nnadozie (2009) writes that it is complicated to define 'indigenous' due to fact that various groups of people have been displaced as a result of events such as slavery, colonisation and migration. This displacement makes it difficult to establish who in fact the indigenes are. She argues this complication by pointing out that due to the movement of people various laws have been passed in order to protect and promote the interests of all, where as a consequence a national communality manifests itself. This national communality leads to a loss of identity for various indigenous groups.

Loubser (2004) writes that 'indigenous' is often understood as the opposite to 'European'. This definition of it being opposite to 'European' inextricably according to Naidoo (2010) links 'indigenous' to colonialism, which influenced the definition given to the type of knowledge the concept of IKS is referring to. Both researchers mention colonialism as having an influence in defining the term 'indigenous' which ultimately influences defining IKS. The influence of colonialism can be further identified in defining the second term, 'knowledge' which contributes to the concept of IKS. To further unpack this term one needs to consider what type of knowledge the concept is referring to.

In defining the type of knowledge that the concept is referring to, a logical assumption can be made that it is indeed a knowledge base. As already stated, defining IKS is a complex task. This complexity can also be attributed to a counter perspective, which is concerned with the legitimacy of "indigenous knowledge" being referred to as a knowledge base. Horsthemke (2004) further explores this definition and relates it to the term "indigenous knowledge" in order to argue her point. In order to put forward her argument, she first identifies three main kinds of knowledge. These are identified as being factual knowledge (propositional

knowledge), practical knowledge (how to) and knowledge by acquaintance. Knowledge by acquaintance is concerned with knowledge of persons, places or things. She acknowledges that there in inherent controversy concerning the relationship between indigenous knowledge and the third kind of knowledge, which is knowledge by acquaintance. An example of knowledge by acquaintance can be identified in Afghan soldiers' knowing their own surroundings, which is not seen among the American soldiers (Horsthemke, 2004).

Her argument concentrates on the first two types of knowledge; the factual knowledge and the practical knowledge. She argues that the problem related to indigenous knowledge is when these two types of knowledge are viewed as having no clear distinction. An example where she illustrates the idea of these two types of knowledge having no clear distinction relates to a traditional healer who knows how to (practical knowledge) cure people. The traditional healer knowing how to implies that the traditional healer knows the factual knowledge that certain roots have disease curing properties. However, there is no clear distinction in the traditional healer of the factual knowledge and practical knowledge.

She is of the opinion that in order for there to be factual knowledge, three components must be apparent in the knowledge. These components are belief, justification and truth. "In order for a person to know something (propositional knowledge), he/she has to believe that propositional knowledge, she has to be justified in believing that propositional knowledge, and that propositional knowledge has to be true" (Horsthemke, 2004, p. 3).

Taking the three components of factual knowledge into consideration, Horsthemke (2004) states that, "indigenous knowledge" in some instances is not considered to encompass beliefs of all types, where there is little or no consideration of truth or justification. Therefore, this type of "indigenous knowledge" does not meet the criteria for it to be classified as indigenous knowledge. However, a more suitable term proposed would be "indigenous beliefs", which does not equate knowledge.

Naidoo (2010) in defining the third term 'system' which contributes to the concept IKS, writes that a system involves separate components working together. This definition can be used to interrogate the work of Onwu and Mosimege (2004). In an attempt to illustrate the complexity of defining IKS they identified a misconception in peoples' understanding of IKS

with reference to the term 'system.' This misconception is concerned with many people believing that IKS only involves traditional healing. They suggest that traditional healing is but one component of IKS and that IKS involves and relates to a host of issues like biological resources and management thereof. Indigenous institutions, languages, mathematical knowledge, environmental resources and governance matters are some of them. Therefore, believing that it only involves traditional healing, the point of IKS consisting of many components working together within a system is lost.

2.7.2 Other issues which contribute to the complexity of defining IKS

Battiste and Henderson (2000) expand on the difficulty experienced in defining IKS by commenting that IKS is part of a particular clan, band or community, or an individual, that cannot be dissociated from the bearer and be placed in a definition that is universally accepted. To illustrate the point that IKS is part of a particular clan, band or community, or an individual, one can use the example of IKS of different communities being used to store maize. Two different communities' IKS of storing maize can be used to substantiate the above mentioned point. According to Ayerst, Langley, Majozi, Metherell, and Smith (2005) the people of Southern Africa store their maize by firstly, hanging dried maize on cobs in a kitchen hut in order for the maize to be exposed to the cooking smoke. This cooking smoke would form a film around the seed which serves as a preservative agent as well as an insect repellent, thus ensuring that there would be seed for the next planting season.

Secondly, they would dig a pit in the middle of a cattle kraal, where maize would be placed. Owing to the location of the pit it is believed that the cattle would serve as an alarm if someone attempted to steal the maize as cattle bellow loudly if disturbed. The maize needs to stay dry in order to be preserved as moisture would result in fungus which would destroy it. This point also influenced the decision to make a pit in the cattle kraal. The threat of the maize becoming wet is diminished by the fact that the cattle through their movement compact the kraal surface. Other measures implemented which facilitate the dry storage of the maize include, the cow dung absorbing most of the water and the burning of the pit which serves to kill off red ants and to reduce the moisture content of the pit.

Prasad (2009) whose study aimed to identify and document the indigenous practices followed by maize farmers in the Karimnagar district of Andhra Pradesh of India involving a total of

12 villages concurs that communities do hang maize cobs above the fire place which is similar practice of the people of Southern Africa, however their IKS differs in terms of how they store their maize. The communities store their maize in storage bins made of bamboo sticks pasted with clay which are used to prevent insects attacking the seed from outside. In these storage bins neem leaves or dried chillies are placed. It is believed that the neem leaves or the pungency of dried red chillies keep away pests.

Adding to the discussion regarding the difficulty in defining IKS, Semali and Kincheloe (1999) in examining the social, cultural and political issues related to indigenous knowledge argue that the debate around indigenous knowledge is rooted in issues such as, its origins, production, archived retrievement and the manner in which it is distributed. Shortcomings in teachers' understanding of IKS could be used as an identification tool of the difficulties surrounding defining indigenous knowledge. In a qualitative study which was conducted in Zimbabwe by Dziva, Mpofu, and Kusure (2011) teachers' conceptions of IKS in the science curriculum were explored. Data production methods included preliminary and in depth interviews, sampled homework and test exercise books as well as teachers' schemes of work. The study found that teachers have a limited conception of IKS. These limitations included a lack of understanding on how indigenous knowledge is generated (production) and how it is transferred (archived and retrieved) from one generation to the next.

As mentioned before, the second part of this section of the literature review offers various definitions of IKS. Researchers who acknowledge the complexity in defining IKS do however supply definitions. The respective definitions which are proposed are used as a point of departure for their particular academic work. A common feature that these definitions point out is that IKS is concerned with a variety of activities that are (knowledge and skills) relevant to a host of issues of a certain people that are used in their everyday lives. These have been modified and added upon in order to adjust to varying conditions due to their interaction with their environment which enables them to survive. A manifestation of these modifications is IKS being dynamic in nature as it evolves due to circumstances and by interaction with other knowledge systems. These activities have been used both in the past and at present. Fundamental to its evolution is the manner in which it moves from generation to generation which is done orally.

A definition which encapsulates the above is supplied by the *Indigenous Knowledge and Development Monitor* editorial. It states:

> Indigenous Knowledge is the sum total of knowledge and skills which people in a particular geographic possess, and which enable them to get the most out of their natural environment. Most of this knowledge and these skills have been passed down from earlier generations, but individual men and women in each new generation adapt and add to this body of knowledge in a constant adjustment to changing circumstances and environmental conditions. They in turn pass on the body of knowledge intact to the next generation, in an effort to provide them with survival strategies.
>
> <div align="right">(as cited in Hagar, 2003, p. 338)</div>

The application of the above definition can be seen in the work of Maurial (1999) who proposes that one views indigenous knowledge as *local, holistic and agrapha*. Firstly, *local* refers to IKS being the result of indigenous peoples' interactions in their territories. Secondly *holistic* is concerned with IKS being concerned with a variety of disciplines of knowledge where there is a union of these disciplines of knowledge which manifests in a wholeness of a worldview and thirdly, *agrapha* speaks to the view that it is not written down, but is rather passed on from one generation to the next through the indigenous peoples' mythical narrations in some instances which is in keeping with the complex oral traditions which prevail in the indigenous peoples' culture.

Both Maurial (1999) and George (1999) comment on the oral connection which is concerned with indigenous knowledge. Added to this oral connection is Hager's (2003) suggestion that the definition of IKS should include that an abundance of practical indigenous knowledge is stored and accessed by doing, watching and living a particular way of life. This suggestion is in line with the definition supplied by George (1999) who emphasizes that indigenous knowledge is "not generated by a set of pre – specified procedures" (p.40), but rather it is knowledge that is generated in a specific social context which is used by ordinary people in their daily lives.

In discussing a definition for IKS what is apparent are the characteristics of which it is comprised. These characteristics include that firstly, it is as Battiste and Henderson (2000)

elaborate, part of a particular clan, band or community, or an individual. secondly, it is comprised of knowledge and skills that are used by people in their everyday lives and it is moved orally from one generation to the next. Being cognisant of these characteristics leads to the identification of IKS as what Hoadley and Jansen (2009) term everyday knowledge. Where the type of everyday knowledge is randomly acquired from conversations overheard and is dependent on family, community, context and culture, it is unsystematic as it is picked up in bits and pieces with a strong emphasis of it being practical. Bernstein (1999) identified this everyday knowledge as a horizontal form of knowledge and adds to this discourse of it being segmentally differentiated as not all the segments of this form of knowledge have equal importance.

Evaluating the characteristics of IKS and everyday knowledge highlights that, similarities between the two are identified which suggests that in fact IKS could also be also referred to as everyday knowledge as defined by Hoadley and Jansen (2009) and Bernstein (1999). Identifying IKS as everyday knowledge as done above would not be fully explored with no mention of the other type of knowledge, school knowledge, as proposed by Hoadley and Jansen (2009). School knowledge by its nature is different to everyday knowledge. It is dependent on the national curriculum that is the same for all children, is grouped into particular subject disciplines and is taught systematically where it is written. Bernstein (1999) identified this school knowledge as a vertical form of knowledge where, as in the sciences, it is hierarchically organised where circulation is accomplished by the way of strong distributive rules that are concerned with regulating access, regulating transmission and regulating evaluation. These regulation measures concerned with the circulation of the vertical form of knowledge can be identified in school knowledge with reference to school knowledge being accessed by individuals who officially register for it. In such cases, transmission and evaluation of this type of knowledge is regulated respectively by the curriculum and assessments found within the curriculum.

Linking the exploration of everyday (horizontal) knowledge and school (vertical) knowledge with a previous section of this chapter that is concerned with the ideological nature of curriculum, Bernstein (1999) comments that one form of knowledge can be imposed by a dominant group on a dominated group and is used as a mechanism to silence and exclude the form of knowledge which the dominated group possesses. This point can be seen in South

Africa's educational history where a strong emphasis of school (vertical) knowledge before 1994, without the inclusion of everyday (horizontal) knowledge excluded the voice of the people who generated and valued such knowledge.

The defining of everyday knowledge and school knowledge leads to the next section of this chapter which is concerned with western/scientific knowledge and indigenous/traditional knowledge. The definitions suggest that school knowledge is rooted in western/scientific knowledge.

2.8 Western/Scientific Knowledge and Indigenous/Traditional Knowledge

This is a progression from a previous discussion which involved the ideological nature of a curriculum which was primarily concerned with IKS being categorised as an inferior knowledge where the term 'subjugated knowledge' was proposed to describe it. It also includes defining of IKS which acknowledged the complexities in defining it. A discussion which concerns the relationship between western/scientific knowledge and indigenous/traditional knowledge is provided. In the discussion that follows, emphasis has been placed on the status or conflict between them, their differences and the proposal of their complementary relationship that exists between them.

The views of Durie (2004) and Ogunniyi (2004) concerning the consequences of colonisation on the indigenous people as explored in the previous section forms the basis for the views held by many regarding the discourse of the status of indigenous/traditional knowledge in relation to western/scientific knowledge.

Durie (2004) indicates that both western and indigenous people value their respective knowledge bases. Both western and indigenous knowledges accrue high status amongst the people who produce or generate the knowledge, where there exists amongst their people a rejection of the alternative knowledge base. For example, in the case of western people, knowledge which does not subscribe to scientific principles which involve scientific method is given lesser status if it is given any acknowledgement at all. On the other hand, indigenous people often dismiss scientific knowledge as a legitimate knowledge base on the grounds of it being unable to explain spiritual phenomena.

The aspect relevant to the status concerning the relationship between the two knowledge bases in question that has garnered much attention is the belief of the producers of western knowledge that western knowledge is superior to indigenous knowledge, which ultimately led to the oppression of the indigenous people and their knowledge. One could attribute this view to the belief of the colonisers that it was a right bestowed by the authority of God to colonise.

As previously discussed indigenous knowledge has been termed 'subjugated knowledge' and therefore is not regarded as a scientific knowledge to many people. However, there is a growing perspective that indigenous knowledge as a knowledge base is not one of inferior status but rather a knowledge base that must be viewed as another type of science. Proponents of this view include Snively and Corsiglia (2001) who argue that every culture has its own science where this culture has its own unique thinking processes and worldview. The issue of each culture having its own worldview can be further interrogated through the work of Ogawa (1995) who claim that people have different ways of perceiving reality. It is this difference in perceiving reality that leads to the conclusion that there are in fact many sciences. This view is supported by Cobern (1996) who claims that if the studying of nature is a defining point in determining whether a knowledge base is a science then all cultures have their own science as at any time all cultures study nature. A manifestation of the above could result in IKS being referred to as Indigenous Scientific Knowledge or, in order to contextualise it even further it could be known as African Scientific Knowledge.

Differences between the two knowledge bases are identified in the work of Jegede (1999) who suggests that western/scientific knowledge is firstly, mechanistic in nature which involves reductionist, rigid, product-orientated and consumerist western ways, while indigenous/traditional knowledge is holistic and anthropomorphic, where there is an emphasis on the blending with, or conserving the environment through the practice of taboos, elastic systems of measurements, classification and counting. Secondly, western/scientific knowledge seeks empirical laws and principles that are informed by the assumption that the universe is orderly and predictable, while indigenous/traditional knowledge is based on the philosophy that the universe is monistic-metaphysical, where the universe can be viewed as abstract, partly predictable and partly unpredictable, where everything could be explained in terms of one principle.

According to Jedege (1999) indigenous/traditional knowledge is dominated by its oral nature while on the other hand western/scientific knowledge is documented. Indigenous/traditional knowledge involves communal learning whereas western/scientific knowledge learning is taken individually. This point resonates with the definition offered by George (1999) of indigenous/traditional knowledge being knowledge which is orally cascaded from one generation to the next. This point would impact on the teaching and learning in the classroom because IKS being oral in nature and involving communal learning would implore the teacher to create opportunities for learners to debate and discuss. The view of communal learning is explored by Snively (1995) in a section that follows which involves teaching strategies that create an environment for the integration of indigenous/traditional knowledge.

The discourse of western/scientific knowledge and indigenous/traditional knowledge can be further explored with literature which calls for a relationship between the knowledge bases that are complimentary in nature rather than antagonistic. Agrawal (1995) suggests that there exist certain contradictions and conceptual weaknesses in most writings that are concerned with indigenous knowledge. His argues that a prevailing theme is to categorise western/scientific knowledge and indigenous/traditional knowledge by identifying differences between them. He suggests that attempting to categorise them is ridiculous where according to Agrawal (1995) they are categorised according to substantive, methodological and epistemological and contextual differences. In his interrogation of these differences it becomes apparent that in fact these differences do not hold water. For example, in terms of substantive differences which are concerned with the view that indigenous knowledge is relevant to people's daily lives while on the other hand western knowledge is removed from the daily lives of people, he points out that if one looks at life in the west there is definitely an imprint of science. He suggests that we move away from the view of labelling the two knowledge forms and rather engage in meaningful dialogue which focuses on the disadvantaged.

le Grange (2004) in acknowledging the differences between both knowledge bases also argues that there are also similarities between them. According to le Grange (2004) these two knowledge bases are complimentary. He points out that all knowledges even though they may differ in various ways share a common characteristic which is concerned with all knowledge

being local in terms of that particular knowledge having a place. Another similarity identified is with the generation of knowledge in terms of it having heterogeneous components where differences are evident in viewpoints, local beliefs, local practices and resources. Turnbull (as cited in le Grange, 2004, p.87) states that knowledge assembly "is a process of making connections and negotiating equivalences between the heterogeneous components while simultaneously establishing a social order of trust". Understanding this point leads to the view that western/scientific knowledge and indigenous/traditional knowledge can share a relationship that is complimentary in nature. By bringing these heterogeneous components from western/scientific knowledge and indigenous/traditional knowledge together by establishing social order trust through negotiation between western and indigenous researchers, would create new knowledge spaces (le Grange, 2004).

2.9 The Nature of Science

In light of the discussion concerning western/scientific knowledge and indigenous/traditional knowledge an exploration of the NOS follows. It is deemed necessary in terms of aiding in answering the research question which is concerned with identifying how teachers' experiences influence their classroom practice where a link between experiences understandings and attitudes exist which has been explored in a previous section. Due to the understanding that a teachers' understanding of the NOS determines what their view of science is which influences how it is taught.

Evidence of the above assertion is illustrated by Hammrich (1997) who suggests that the principles which influence teacher understandings of science are the understandings they have concerned with the NOS. Shulman (1986) and Brickhouse (1990) both argue that teachers' classroom practice is significantly influenced by their understanding of the subject matter (which includes the NOS). Singh (1998) found that there is indeed a connection between the way teachers conceptualise the NOS and the way they teach. It was revealed that the way teachers teach is influenced by how their learning was conducted as learners in terms of the resources used, the curriculum used, their teacher education and past philosophies held about science. All of this impacts on their understanding of the NOS. This ultimately results in teachers finding the NOS a challenging endeavour to teach. For example, according to Shah (2009) the majority of teachers' view science as being linear in nature consisting of an unchallenged body of knowledge, manifesting in the view held by teachers that only

scientists have the ability to produce scientific knowledge. As a result of this, science learning experiences are presented as a body of facts where memorisation is emphasised.

In defining the NOS Lederman (1992, p. 331) explains that "The nature of science refers to the epistemology of science as a way of knowing or the values and beliefs inherent to the development of scientific knowledge." What is important about this definition is that in teaching, in this case, the subject of Life Sciences, teachers need to make learners aware of the fact that within a science discipline, the body of knowledge is one of the components and that other components include the dynamic nature of science where scientists are continuously conducting investigations, debating the truth and beliefs of scientific knowledge. With this in mind, Mohanlall (2013) further states that Science learning experiences should include the production of scientific knowledge, the dynamic nature of science and how this dynamism nature of scientific knowledge is attributed to it being changed or modified with the availability of new evidence. Anderson (as cited in Mc Comas, Clough, & Almazroa, 1998) concurs with regard to scientific knowledge that emphasis should be put on the transmission of scientific facts as opposed to aiding learners conceptualise science as a process.

In defining the NOS one needs to be cognisant of the multifaceted nature of the concept. Mc Comas, Clough, and Almazroa (1998) present unanimous views held of the NOS which illustrate this. These unanimous views of the NOS comments that the nature of scientific knowledge, while it being durable is tentative relies heavily on experimental evidence and is affected by social and historical milieu. That there is no one way to do science as it aims to describe and understand natural phenomena which includes contributions from people from all cultures as it being part of social and cultural traditions. Science and technology impact each other and that the people who carry scientific endeavours are creative.

Bell (2008) who commented on aspects of the consensus views held of the NOS is of the opinion that developing scientifically literate learners is the aim of science education. These learners should have an understanding of the NOS enabling them to operate productively in society. The NOS has been divided into seven key ideas that are viewed and agreed upon as the most useful in developing scientific literacy.

The first aspect of the consensus views held of the nature of science that he comments on is concerned with the *tentative* nature of scientific knowledge. Bell (2008) postulates that scientific knowledge is open to change due to new evidence and new ways of thinking, where in the event of change the new knowledge is susceptible to a degree of scepticism especially if the change is different to well established scientific concepts. However, he does acknowledge that many scientific ideas have demonstrated robustness due to the fact that these ideas have survived repeated challenges and have remained predominately unchanged. Therefore, a realisation is that there is confidence in scientific knowledge and an understanding that it has the potential to change.

The second aspect is *empirical evidence*. In this aspect Bell (2008) comments that intrinsic to scientific knowledge is the heavy reliance on empirical evidence obtained from observational or experimental data.

The third aspect is *observations and inferences*. According to Bell (2008) science is not only concerned with the accumulation of countless observations. It is the manifestation of a combination of observation and inference. The five senses are primarily involved in the observation process aided by technology. From such observations the inferences are made. This process involves the development of explanations.

The fourth aspect is *theories* and *laws*. In commenting on theories and laws Bell (2008) differentiates between the two, where a law is a logical description of relationships or patterns in nature which has been consistently observed which are often expressed in mathematical terms. On the other hand, a theory is a well supported explanation of natural phenomena. Therefore, one cannot evolve into the other. However, even though they are different, they do share a similarity which refers to both being supported by substantial evidence where a change in the evidence will result in a change in the theory and law.

The fifth key aspect is the *scientific method*. Farber (2003) defines the scientific method as systematic way of doing science. According to Bell (2008), there are various ways to do science owing to the fact that scientists implement a variety of approaches in the production

of scientific knowledge which include observation, inference, experimentation as well as chance discovery.

The sixth aspect deals with *creativity*. This refers to a source of innovation and inspiration in the discipline of science where creativity and imagination are adopted throughout scientists'/scientific investigations.

The seventh aspect is *objectivity* and *subjectivity*. These two concepts might sound very different, however Bell (2008) points out that there is place for both in science. Firstly, scientists in an effort to secure and improve objectivity apply self checking mechanisms such as peer review. However, the scientists' intuition, societal values and personal beliefs all contribute in the manufacturing of scientific knowledge.

The above discussion on the aspects of the consensus views about the NOS is important to this study. As the consensus views are used to describe the participants' understandings of the NOS.

2.10 Conceptual Framework

According to Christiansen, Bertram, and Land (2010) a conceptual framework consists of key ideas or concepts determined by the particular area of focus of a study or research project which guide it. As it has been already stated in a previous section which explored teacher experiences in relation to attitudes and classroom practice the curricular spider web has been adopted as the conceptual framework to be used for this study.

Adopting the curricular spider web as the conceptual framework for this study highlights the role of this study in the filling of gaps in terms of research that is relevant to IKS. Recent and relevant research studies pertaining to the topic were reviewed in an effort to explore the various themes relevant to the concept of IKS in relation to the components of the curricular spider web. It became apparent that relevant research pertaining to the topic is concerned with issues such as teachers' conceptions, and integration of the IKS from more of a Science specialisation as opposed to a Curriculum one. Therefore, research which exists that is relevant to IKS is not concerned with using the curricular spider web as framework to explore teachers' experiences as this study does. Throughout the discussion around the concepts

found in the curricular spider web an attempt is made to contextualise them by exploring the Curriculum document adopted presently in South Africa.

Van den Akker et al. (2009) explain that the concepts which make up the curricular spider web refer to the ten components of a curriculum, where each component is concerned with an element of learning and the learning programmes of learners. Important to this curricular spider web is the understanding that all of the components found within it need equal attention in order for the successful implementation of a curriculum to occur. Van den Akker et al. (2009) further indicate that the use of a spider web as a metaphor illustrates the flexible yet vulnerable nature of a curriculum, where if one component is not given the necessary attention, the result would be a curriculum which will not be sustainable. An analogy that can be used to illustrate the vulnerable nature of the curricular spider web can be seen in figure 2.2 on the next page where it is represented as a cluster of bubbles which result from children interacting with a simple bubble blower. A result of one of the bubbles not being taken care of with attention from the child will result in the cluster of bubbles being affected.
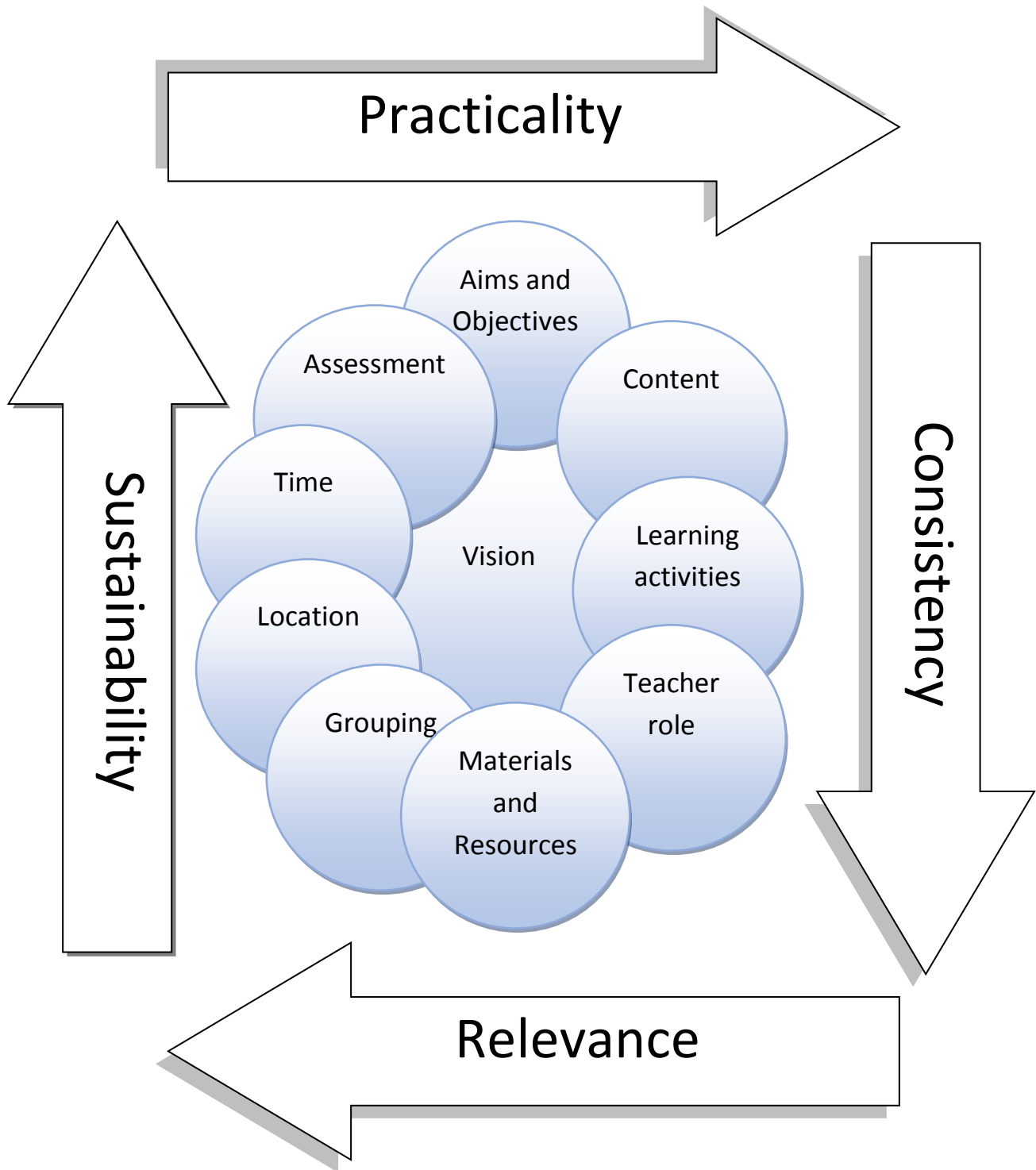
Figure 2.2 The curricular spider web (adapted from Van den Akker et al., 2009, p. 11) and (Berkvens et al., 2014, p. 18).

Berkvens et al. (2014) added four quality criteria indicators where the emphasis is on practicality, consistency, relevance and sustainability as quality education has become a priority. Practicality is concerned with how the decisions, policies and materials can be

utilised by teachers to be suitable to the setting for which they are produced. Consistency is how aligned and sequential the decisions, policies and materials are. Relevance relates to the decisions and plans dependent on state-of-the-art (scientific) knowledge and approval of key stakeholders. Sustainability relates to the construction of decisions, policies and materials with a view to the future, and are likely to remain successful when support and budget fade over time

Each component of the curricular spider web involves asking a complementing question relevant to that particular component. For example, according to the vision, the following question is asked: *why are they teaching*? In engaging with the curricular spider web, the nature of the study which is concerned with teachers, dictates that there is a substitution of the term *learning* with the term *teaching* in order for it to be applicable to the study. Questions pertaining to each component are listed in the table below:

Vision	Why are they teaching IKS?
Goals	Towards which goals are they teaching IKS?
Content	What content are they teaching in IKS?
Materials and Resources	With what are they teaching IKS?
Location	Where are they teaching IKS?
Teacher Role	How do they perceive their role in teaching IKS?
Learning Activities	How are they teaching IKS?
Assessment	How are they assessing IKS?
Time	When are they teaching IKS?
Grouping	Who are they teaching? And with whom are they teaching?

Table 2.2 Ten questions relevant to each component of the curricular spider web.

The ten components of the curricular spider web and the questions that are relevant to each component are represented in the above table. The ten components of the curricular spider web form the basis of this study in terms of them providing themes which will be used to explore literature as well as the teachers' experiences.

Unpacking the curricular spider web even further are the propositions relevant to each component of it. These propositions serve to guide the exploration of literature related to a particular component. They also aid in ascertaining findings from the data generated relevant each component. The table below states the component with its relevant proposition/s and also provides a summary of the literature covered pertaining to that component.

Component	Propositions	Literature related to propositions
Vision	Personal (pedagogical) Societal (beneficial) Professional (content)	Van den Akker et al. (2009) Berkvens et al. (2014) Khoza (2015a), Khoza (2015b) du Preez and Reddy (2014) Schiro (2013) Kilinc and Mahiroglu (2009) WorldBank (1998) Emeagwali (2003) Semali and Kincheloe (1999) Owuor (2007) Corsiglia and Snively (2000) Jegede and Aikenhead (1999) George (1999) Dziva et al. (2011) Wilson (1981)
Goals	Aims Objectives Outcomes	Dash (2012) Kennedy, Hyland and Ryan (2006) Khoza (2013b) Khoza (2015a), Rao (2010)
Content	Traditional technology, e.g., traditional medicines and healers, beer, wine and cheese. Medical biotechnology Loss of Biodiversity Indigenous knowledge systems and the sustainable use of the	CAPS (DoE,2011) Klep, Letschert and Thijs (2004) Tyler (1949) Carl (2012) Hidi and Harachiewicz (2000) Krapp (2002) de Villiers (2011)

	environment	
Materials and Resources	Hard – ware resources Soft – ware resources Ideological – ware resources	Khoza (2012) Khoza (2013a) Criticos, Long, Moletsane and Mthiyane (2005) Roa (2010) Arulsamy (2010) Mudulia (2012) de Souza Barros and Elia (1998) De Villiers and Somerville (2005) Shizha (2007) Ogunniyi (2004) Ogunniyi (2007) Dziva et al. (2011) Adler (2005)
Location	Inside the classroom Outside the classroom	Marx et al. (1999) Michie (1999)
Teacher role	Mediator/Facilitator Interpreter Leader, Manager Scholar Researcher Assessor Specialist Pastoral role.	Government Gazette, No. 20844 (2000) Hoadley and Jansen (2013) Jegede and Aikenhead (1999) Snively (1995) Solomon (1992) Mulholland and Wallace (2003)
Learning activities	Related to the constructivist learning theory Learner centred Teacher centred Inquiry based	Ozer (2004) Huba and Freed (2000) Weinstein, Tomlinson – Clarke and Curran (2003) Matthews (2003)

		Bybee (1989
Assessment	Formative	Kennedy, Hyland and Ryan (2006)
	Summative	Black and Williams (1998)
	Continuous	Brown and Knight (1994)
		Brown (1999)
Time	Hours	Berkvens et al. (2014)
	Weeks	du Plessis and Mbunyuza (2014)
Grouping/Acces - sibility	Physical	Berkvens et al. (2014)
	Financial	Chall (2000)
	Cultural	

Table 2.3 Components of the curricular spider with relevant proposition/s for each and a summary of the literature covered pertaining to each component.

2.10.1 Vision

According to Van den Akker et al. (2009) and Berkvens et al. (2014) the vision for the teaching of a topic, in this case IKS, serves as a central link, connecting and controlling the other components of the curriculum. With reference to IKS the vision is a response to the questions of why are teachers teaching IKS and why it has been made part of the school curriculum.

Berkvens et al. (2014) write that teachers' lack of understanding of teaching visions in teaching a curriculum is becoming a worldwide challenge that needs to be addressed for the promotion of quality teaching and critical thinking to be achieved. The vision is viewed as the central link that connects and controls other aspects that are concerned with curriculum. Khoza (2015b) elaborates that success in teaching is initiated by teachers identifying and understanding their curriculum vision followed by identifying relevant goals from their subject content. Curriculum visions can be divided into the personal vision, societal vision and the professional vision. According to du Preez and Reddy (2014, p. 2), vision is a "cognitive process that requires us to pull aside the curtains of habit, automatism, banality, so that alternative possibilities can be perceived" which implies that reasons for designing and teaching a curriculum are not limited to personal experiences but should include societal and professional visions.

Schiro (2013) uses the term learner centred ideology in describing the attributes of a personal vision that an individual holds for teaching/ of teaching? In this vision schools are viewed as enjoyable places where the development of people occurs naturally according to each individual's innate abilities. Each individual is viewed as a source of information for the curriculum. Learning is believed to occur when there is the interaction between an individual and his or her environment. Teachers who hold this vision attempt to create an environment which is conducive for each individual to construct his/her own unique meaning (personal). This is due to the belief that each individual's experience with their environment is unique and the construction of this meaning according to Schiro (2013), holds personal significance to each person since the particular environmental context in which it is constructed is a result of experiences in a particular teaching/learning environment at a particular time. Knowledge learned in this vision assists in individuals understanding themselves, which culminates in them making decisions responding to society and therefore is fundamental to societal and professional visions.

A study conducted by Kilinc and Mahiroglu (2009) which explored the attractors of teaching Biology, which Life Sciences was previously known as, consisting of thirty-seven pre – service Biology students, where data was generated using an open – ended questions, found that one of the main attractors of why the participants in the study chose teaching Biology was that they enjoyed Biology. Only a few students felt otherwise. This point is in line with the personal vision as one of the characteristics of this vision is concerned with school being viewed as an enjoyable place. This further suggests that teachers who choose to teach a subject, in this case Life Sciences, would have had an enjoyable experience with the subject which consequently shaped their vision for teaching the subject.

Added to the issue of enjoying the subject which a teacher teaches is the issue of the teacher having a passion for the subject. In a recent study conducted by Khoza (2015a) which could be used to contextualise the vision for teaching a particular subject to a South African one it was found that teachers' vision for teaching a particular subject are closely aligned with the vision of the intended curriculum of that particular subject and not with them having a passion for the subject. The participants of the study merely used the elements from vision found within the policy document to explain and describe their vision for teaching their subject which did not convey them having a passion for it.

In the case of the societal vision, the needs of society are at the core of educational process. According to Schiro (2013) who refers to the societal vision as the social efficiency ideology individuals who hold this vision advocate that youth be trained to become mature contributing members of society where the individual as a product has acquired the necessary workplace and home life skills. Learning in this vision is attributed to learners' competencies which will manifest in the learners becoming productive in society. To contextualise this vision to South Africa, there was the enactment of Curriculum 2005, the Revised National Curriculum Statement and the National Curriculum Statement which were competence approaches to curriculum. They were adopted where a competence curriculum adopts a horizontal form of knowledge (Bernstein, 1999). Emphasis was placed on drawing on the learners' own experiences and everyday knowledge in the teaching and learning process where individual subjects were combined to form learning areas. As a result of this practice, achievement was based on the acquiring of stipulated competencies (outcomes) which were observable and were not based on international standards but rather on what was observed. The role of the teacher was one of a guide or facilitator.

The professional vision which Schiro (2013) refers to as the scholar academic ideology is concerned with placing an emphasis on academic disciplines. In this vision the goal of education is for individuals to learn knowledge which is derived from academic disciplines, where the acquirement of such knowledge involves learning its particular content, conceptual frameworks and ways of thinking. This vision is in sync with a performance approach to curriculum where such a curriculum adopts a vertical form of knowledge (Bernstein, 1999). This performance approach to curriculum can be identified in the present curriculum (CAPS) that was implemented in South Africa in 2012. In the interest of curriculum development, in terms of learning from the past, it is noteworthy to mention that the pass rate of the first group of learners who adopted this performance curriculum was lower than the previous groups who adopted a competence curriculum. This may suggest that the learners, teachers and/or the department of education did not fully grasp the nature of a performance curriculum as they may have been accustomed to the competence curriculum. In this curriculum, content is divided into particular subject disciplines for example, Life Sciences and Business Studies. This is in contrast to the principles of a competence approach to curriculum. In a performance curriculum the content is structured in a hierarchical nature (vertical) where there is an

increase in complexity as an individual progress through the various levels found within the curriculum. In terms of assessment, learners are assessed according to what they do not know using, the contributions of international standards. The cognitive abilities/level of the individual are used to determine which individual is successful.

The literature which is relevant to the vision which is concerned with questions regarding why teachers are teaching IKS and why it has been made part of the school curriculum, is predominately concerned with the societal vision as previously discussed. This societal vision where the needs of society are at the core of teaching and learning is identified in the literature in terms of the value ascribed to IKS. It is suggested that there is in fact value in including IKS in a curriculum. The value of IKS is firstly viewed as having the ability to initiate and sustain socio – political transformation (WorldBank, 1998; Semali & Kincheloe, 1999; Emeagwali, 2003; Owuor, 2007), whose prerequisite is sustainable development. Secondly, the value of IKS is viewed in a pedagogical sense in terms of its inclusion in facilitating a teaching and learning theory for the teaching of science (Jegede & Aikenhead, 1999).

In terms of development, the WorldBank (1998) views IKS as being fundamental to local communities' developmental strategy, where IKS is an important part of the lives of the poor. IKS is viewed as their main ingredient in accumulating the basic needs required for survival. These basic needs include food, shelter and independence in controlling their lives. This point is reinforced by Emeagwali (2003), who suggests that its value involves indigenous knowledge enabling sustainable development, environmental responsibility and cultural survival which will result in what Semali and Kincheloe (1999) describe as its value of having transformative power, that can be utilised to establish empowerment and justice. This idea is relevant to the South African context in light of the past colonial and apartheid education systems, where it was envisaged that the implementation of a curriculum that calls for inclusivity would address issues of empowerment and justice.

Owuor (2007) highlights the need for this transformative power of IKS by highlighting important issues around IKS through her work. The purpose of her work was to explore the meaning of Indigenous Knowledge (IK), provide reasons for valuing IK, examine the Kenyan

government's efforts to indigenise curricula and the challenges faced when integrating IK in formal education. She writes that the purpose of colonial education was to erode Kenyan ethnic communities' indigenous knowledge learning structures, which denied individuals their cultural diversity. This was the result of economic exploitation and assimilating Africans into western cultures, values and practices. Similarities are apparent between South Africa and Kenya's formal education system, with reference to colonial education. One can conclude that this transformative power, in light of the purpose of colonial education, is of great value for not only South Africa but also for other countries in Africa.

Corsiglia and Snively (2000) ascribe value to IKS in terms of it enabling people from countries not regarded as modern to survive as opposed to western science not being able to have all the answers on issues relating to the environment. This includes its damaging effects through pollution in the attainment of development. This argument brings in the issue already explored in a previous section which calls for western science and indigenous knowledge systems in enjoying a complimentary relationship (Agrawal, 1995; le Grange, 2004). Where indigenous knowledge can assist in finding solutions to pollution in the western world which would result in development. From the above discussion on the value ascribed to IKS one can conclude that its inclusion can in fact enable the youth to be trained to become mature contributing members of society in which they acquire necessary workplace and home life skills this will safeguard the societal needs on which the societal vision places emphasis.

The other view concerning the value of indigenous knowledge speaks to how indigenous knowledge could be used in a pedagogical sense. According to Jegede and Aikenhead (1999) the inclusion of indigenous knowledge in the teaching of science is in line with a social constructivist teaching and learning theory. This places importance on prior knowledge or indigenous knowledge in the development of meaning in an unfamiliar situation in which a competence curriculum and a horizontal form of knowledge is deeply rooted (Bernstein, 1999). The social constructivist teaching and learning theory is in line with the societal vision as it emphasises drawing on learners' own experiences and everyday knowledge in the teaching and learning process. The benefits of such a teaching and learning theory or practice? can be seen in the following quote: "Recognizing the social context of learning, as well as the effect of learner's socio – cultural background in the teaching and learning of science, is of primary importance if a strong basic foundation is to be established for

successful pupil achievement and successful outcomes" (Jegede & Aikenhead, 1999, p. 46). George (1999) concurs with this view which calls for the use of indigenous knowledge in the classroom as it draws upon children's real life experiences and in doing so serves as a vehicle to promote learning. This is achieved through motivating children to start to see acknowledgement being given to how they behave and speak in their communities.

In advocating for the use of indigenous knowledge in the learning environment, George (1999) does acknowledge that introducing and sustaining the utilisation of indigenous knowledge is inherent with obstacles. Such obstacles include that indigenous knowledge is not "packaged" as school resources and therefore the teacher must start by accessing it before he/she interprets it.

Contrary to the above advocacy for the use of indigenous knowledge in a pedagogical sense is the view held by Driver, Asoko, Leach, Mortimor, and Scott (as cited in Dziva et al., 2011), who found that a consistent finding in science research is that students' everyday common knowledge often inhibits their learning of science through students resisting the re-conceptualization of their prior knowledge. This view is in line with an earlier stance taken by Wilson (1981) who viewed traditional culture as a hindrance to the teaching of science.

2.10.2 Goals

According to Dash (2012) education as a process is meaningless without the presence of goals. Goals according to Kennedy, Hyland, and Ryan (2006) and Khoza (2013b) can be divided into aim, objective and outcome. Although these terms are concerned with the goals that the curriculum (it is envisaged) will achieve, they are in fact different in their definitions. This point of them been different is not understood by teachers (Khoza, 2015a). Differences include that an aim is a broad general statement, a long term goal of teaching intention of a module or programme. The broad aim of the curriculum of the South African curriculum is "to ensure that children acquire and apply knowledge and skills in ways that are meaningful to their lives" (DoE, 2011, p 4).

An objective is rather a short term specific statement of teaching intention which indicates one of the specific areas that the teacher intends to cover. Both aims and objectives are

written from the teacher's point of view in terms of their intentions. The table below states the three subject specific objectives referred to as specific aims in Life Sciences (DoE, 2011).

Specific Aim 1 Knowing Life Sciences	Relates to knowing the subject content which involves the understanding and making meaning of sciences which enables the learners to make connections between the ideas and concepts. Such connections enable the learner to apply their knowledge in new and unfamiliar contexts. The scope of knowledge that learners should acquire is not just knowing a lot of facts but also includes knowledge of process skills related to carrying out investigations.
Specific Aim 2: Investigating Phenomena in Life Sciences	Relates to doing science or practical work and investigations. Learners must be able to plan and carry out investigations as well as solve problems that require some practical ability. This aim is underpinned by an attitude of curiosity and an interest in wanting to find out how the natural world and living things in it work.
Specific Aim: 3 Appreciating and understanding the history, importance and applications of life sciences in society.	Relates to understanding the applications of Life Sciences in everyday life, as well as understanding the history of scientific discoveries and the relationship between indigenous knowledge and science. Learners must be exposed to the history of science and indigenous knowledge systems.

Table 2.4 The three broad subject specific objectives referred to as specific aims in Life Sciences (DoE, 2011, p. 13).

An outcome is what learners should achieve in terms of them acquiring skills at the end of a lesson that is generated from specific observable components which indicate various levels of complexity with the use of Bloom's taxonomy. Evidence of the differences between the various goals can be found in the CAPS (DoE, 2011) for Life Sciences. The objective/specific aim that is relevant to IKS and is found in the Life Sciences curriculum is specific aim 3 which is found in the table above. One can see from this objective/specific aim that it is in fact more specific than the curriculum aim and therefore is an objective. Within

the CAPS (DoE, 2011) for Life Sciences, skills which learners must be able to perform include accessing and analysing information, selecting key ideas, recalling information, describing knowledge, organising and reorganising, writing summaries, developing flow charts, recognising patterns, apply and use knowledge and identify assumptions. As stated in defining an outcome, the use of Bloom's taxonomy is of importance in order to identify the learner's achievement of complexity level in terms of the skills mentioned above. Therefore, keywords are used in order to ascertain their achievement of the complexity level. Figure 2.3 (Bloom's taxonomies) shows how outcomes are constructed according to observable keywords that indicate different levels of complexity as mentioned above. The original concepts of Bloom's taxonomy are indicated on the left hand side of Figure 2.3 which are concerned with a teacher – centred approach while a second version is indicated on the right hand side which is a learner – centred approach of Bloom's taxonomies:
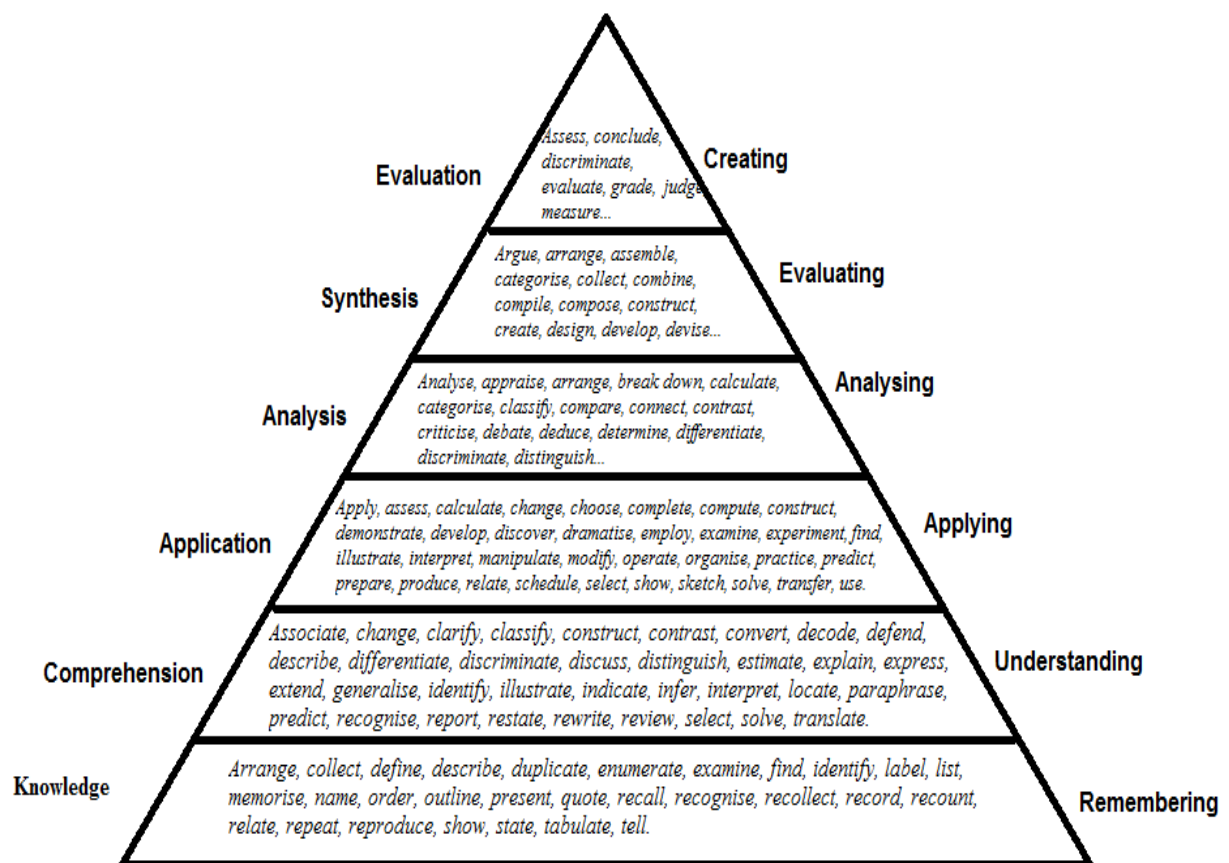
Figure 2.3 Bloom's Cognitive levels of outcomes and keywords (adapted from Khoza, 2015a).

Rao (2010) writes that societal values influence the goals of education. This idea is pertinent to South Africa. Evidence of this can be seen in CAPS for Life Sciences (DoE, 2011) which states that the curriculum is based on the Constitution of the country whose aims include healing the divides of the past, the improvement in the quality of life of all citizens and freedom for each person to fulfil his/her potential. One can see that the value ascribed to IKS in terms of development is well aligned with the curriculum serving as a vehicle to secure the aims of the Constitution.

2.10.3 Life Sciences Content

Van den Akker et al. (2009) posit that a core question in curriculum is: what is going to be taught? This is asked in terms of the content which will equip learners for their role in society. Changes in the societal landscape call for the continuously changing set of knowledge and skills (Klep, Letschert, & Thijs, 2004). These changes according to Van den Akker et al. (2009) result in society becoming more complex as there is greater pressure on education to meet the needs of the variety of social interests. Considering this aspect of content meeting the needs of social interests in terms of changes in society, one can look at the history of South Africa in terms of curriculum reform post 1994. As it has already discussed in a previous section which explored the connection between the current curriculum being used as a vehicle to secure the aims of the Constitution relevant to the social change was the inclusion of IKS in the curriculum.

The needs of society are but one of the aspects identified by Van den Akker et al. (2009) which influence the choice of content. Others include the subject knowledge and the personal development needs of the learner. Both Tyler (1949) and Carl (2012) call for content to be well balanced where the latter further suggests that it should be well sequenced, organised and progression through it should involve the movement from the known to the unknown.

Evidence of this organising, sequencing and progression, which is in line with Taba's (1962) definition of a curriculum as being concerned with a plan for learning, is outlined in the Life Sciences CAPS document (DoE, 2011). The use of one document may be viewed as a positive aspect of CAPS as it outlines the organisation, sequencing, progression and assessment. Teachers could then use it as a work schedule as weeks are indicated which will

support them in keeping up with the curriculum. Further evidence of this positive aspect in having one document will become apparent as the discussion unfolds.

What follows is the identification of this plan of learning in terms of organising, sequencing and progression as documented in CAPS (DoE, 2011). It involves an analysis of the document which culminates in an identification of a link between the rationale for the inclusion of IKS and what content is included. The content which Life Sciences in the Further Education and Training (FET) phase consists of is organised/framed according to four 'knowledge strands' consisting of various topics which are developed progressively over the three years of the phase. The CAPS (DoE, 2011) stipulates that these knowledge strands do not have to be taught in the same order each year, nor do all the strands have to be covered in each year. This may be viewed as a contradiction to the idea that each knowledge strand is developed over the three years of the phase. This opens up CAPS for criticism regarding this point. As in a performance model of curriculum there is a complexity of knowledge through the progression of the various levels. If one of the strands is not included, one needs to ask how the complexity of knowledge is being ensured. Evidence of all four knowledge strands not being compulsory can be seen in the Figure 2.4 which is found on the next page which illustrates the strands to be covered in each year of the FET phase.
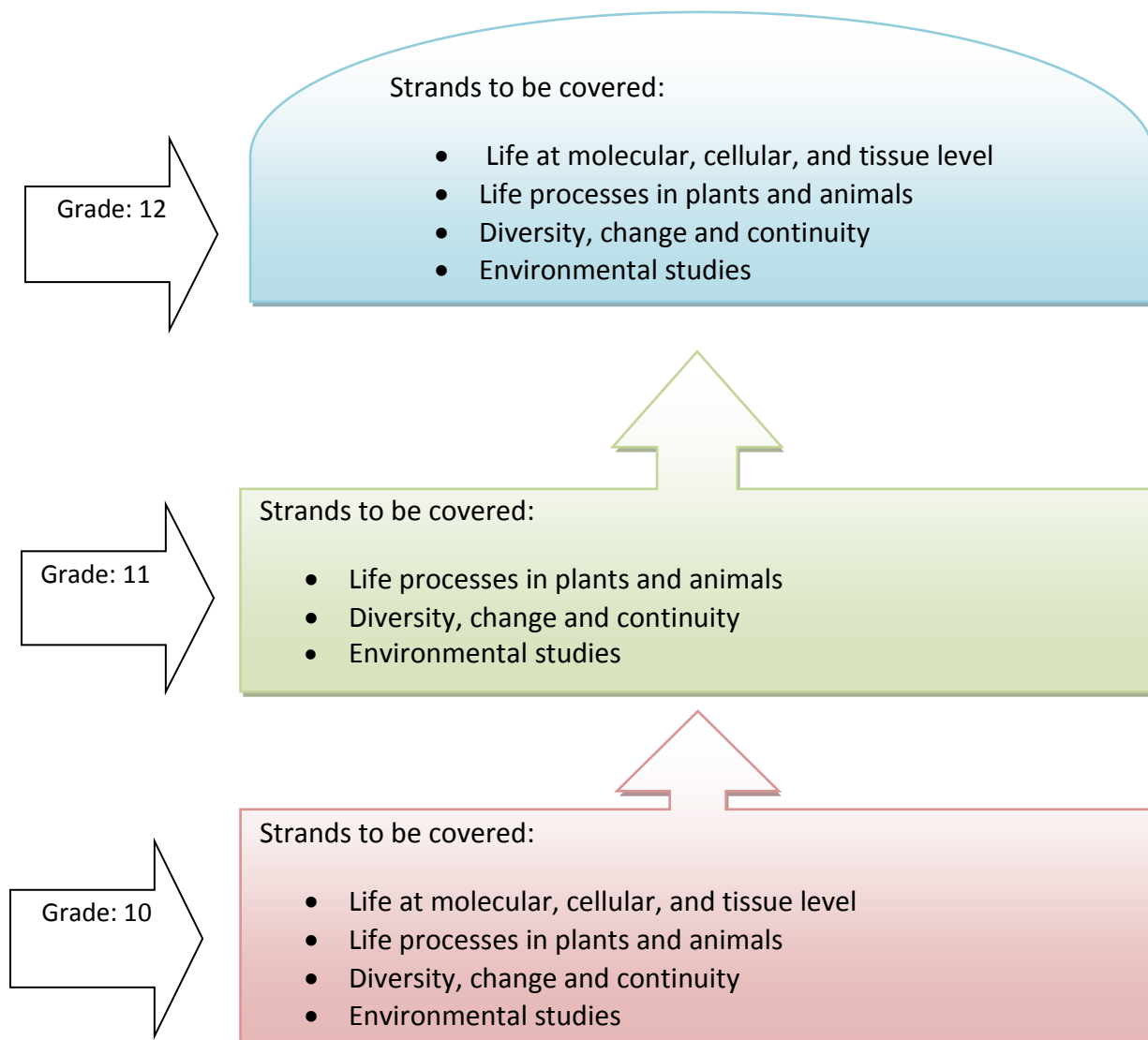
Figure 2.4 Strands to be covered in each year of the FET phase. (adapted from DoE, 2011, p. 9 – 10).

Analysis of the diagram reveals that the knowledge strand concerned with life at molecular, cellular and tissue level is not included in grade 11. The arrows indicate the component of progression through the various levels where there is a movement from the unknown to the known and to the more complex.

Unpacking the knowledge strands further involves stating the content that each strand is concerned with which relates to the organisation of the content. The table below lists the content to be explored in each knowledge strand in each year of the three-year phase.

Strands	Life at molecular, cellular, and tissue level	Life processes in plants and animals	Diversity, change and continuity	Environmental studies

Grade 10	• Chemistry of life
	  - Inorganic compounds
	  - Organic compounds
	• Cell – unit of life
	• Cell division (mitosis)
	• Plant and animal tissues
		• Support and transport systems in plants
		• Support systems in animals
		• Transport in mammals
			• Biodiversity and classification
			• History of life on Earth
				• Biosphere to ecosystems

Grade 11		• Energy transformations to support life: photosynthesis • Animal nutrition • Energy transformations • Gas exchange • Excretion	• Biodiversity-classification of microorganisms • Biodiversity-plants • Reproduction – plants • Biodiversity - animals	• Population ecology • Human impact on environment: current crises
Grade 12	• DNA code of life • RNA and protein synthesis • Meiosis	• Reproduction in vertebrates • Human reproduction • Nervous system • Senses • Endocrine system • Homeostasis	• Darwinism and Natural Selection • Human Evolution	• Human impact on environment: current crises Grade 11

Table 2.5 Content explored in each knowledge strand in the three-year phase (DoE, 2011, p. 10).

In terms of sequencing, CAPS (DoE, 2011) does indicate the order in which strands including the topics are to be covered in each grade. This is done by placing strands and topics into the four terms of the school year. For example, the table which follows on the next page illustrates the sequencing of a strand and topics for the first term of grade 10.

Term 1	
Strand: Life at the Molecular, Cellular and Tissue Level	
Topic	Content
The Chemistry of Life	• Molecules for life • Inorganic compounds • Organic compounds
Cells: The Basic Units of Life	• Molecular make – up • Cells • Structure and function
Cell Division: Mitosis	• The cell cycle • Chromosomes • Role of mitosis • Cancer
Plant and Animal Tissue	• Introduction to tissues • Plant Tissue

Table 2.6 Sequencing of a strand and topics for the first term of grade 10 (adapted from DoE, 2011, p. 22 – 26)

To contextualise the issue of content to this study an analysis of topics in terms of them being IKS in nature can also be done. The following table represents an analysis of CAPS (DoE, 2011) regarding the IKS topics to be explored through grades 10 – 12.

Grade 10	Grade 11	Grade 12

• Application of Indigenous Knowledge Systems and Biotechnology
 	
  - Traditional technology, e.g.,
	• Biodiversity
	  - Traditional technology to produce, e.g., beer, wine and cheese.
		Not mentioned

traditional medicines and healers - Medical biotechnology, e.g., immunity, vaccines, antibiotics and blood transfusion - Cloning of plant and animal tissues and stem cell research	• Loss of Biodiversity - Indigenous knowledge systems and the sustainable use of the environment e.g., devils' claw, rooibos, fynbos, the African potato (*Hypoxis*) and *Hoodia*	

Table 2.7 IKS topics explored through grades 10 – 12 (Adapted from DoE, 2011, p.22 – 65).

It is interesting to note that in grade 12 there is no content that stems from IKS. This non exploration of IKS can be viewed as a shortcoming of CAPS in terms of the content which it covers. Firstly, by not including content relevant to IKS in grade 12 an opportunity to build complexity is lost. Secondly, in a way it perpetuates the view that IKS as a knowledge base is not regarded with the same status as that of western knowledge as a result of its exclusion. This leads to its non assessment in a year of education which is regarded as having great importance to the learners' future. This compromises its status. In identifying the content covered in grades 10 and 11 one can make a link between the vision for teaching IKS as well as the criterion used in making decisions with regard to what content is included in the curriculum. From a vision perspective which has already been explored where value is ascribed to IKS where it is a fundamental part of the lives of the poor in terms of its importance in achieving control of their lives with regard to food and shelter production. Reinforced by the view that it enables sustainable development, environmental responsibility and cultural survival. That being stated, the link can be identified with regard to these being societal needs, which influence what content is to be included in the curriculum (Van den Akker et al., 2009). To illustrate this point, the grade 10 and 11 curriculum includes traditional medicines and healers and food production in terms of beer, wine and cheese respectively. These examples of content to be included are concerned with societal needs which it is envisaged will help in the survival of the poor of the country. The grade 11 curriculum also includes the sustainable use of the environment with regard to aspects concerned with IKS with reference to natural resources that include various plants. The inclusion of this content bodes well in IKS enabling environmental responsibility.

As CAPS is deeply rooted in the performance model of curriculum with the emphases on content and the increasing complexity of this content as one moves to the next level where the performance of the learner is of paramount importance, it is necessary to explore what factors, if any, in terms of content influence on learner performance. According to Hidi and Harachiewicz (2000) factors which are important for learning and academic performance include interest, goals and motivation. Krapp (2002) adds that a higher degree of deep – level learning stems from interest triggered learning activity. A study was conducted by de Villiers (2011) which explored what 125 Life Sciences and Natural Sciences pre – service teachers found interesting in the Grades 10 – 12 Life Sciences curricula in the FET phase. Although the sample of the study included pre – service teachers who completed Grade 12 in 2008 and 2009 under the revised Life Sciences (Biology) curriculum which focused on outcomes – based education, findings of the study can be used in this discussion as the themes (known as strands in CAPS) and topics for Grades 10 -12 are being utilised in CAPS. Findings included that the respondents consistently found the theme/strand of diversity, change and continuity least interesting through the phase. This suggests that it does not bode well in terms of learner performance for the current Grade 11 curriculum with reference to IKS as the topics relevant to IKS as stated in Table 2.7 are found within this theme/strand. On a much more positive note the theme/strand which respondents consistently found most interesting through the phase was tissues, cells and molecular study which is known in CAPS as Life at the molecular and tissue level. This suggests that it bodes well in terms of learner performance for the current Grade 10 curriculum with reference to IKS as the topics relevant to IKS as stated in Table 2.7. are found within his theme/strand.

2.10.4 Materials and Resources for teaching IKS

Resources are defined as any person or thing that communicates learning (Khoza, 2012) or "anything which helps learning to happen" (Criticos, Long, Moletsane & Mthiyane, 2005, p. 269). This suggests that a resource can be viewed as something which aids and supports the learning process. Khoza (2013a) identifies three types of resources that can be utilised in the learning process. Firstly, there is hard-ware resources which are any machine or tool utilised in teaching and learning (e.g. computers, projectors, white screen and television). Secondly, soft-ware resources which are any material that is generated for the hard-ware to display information or convey learning (e.g. transparencies for overhead projector, computer

programs and television programmes). Thirdly, there is the ideological-ware, resources of teaching and learning which are concerned with the part of teaching and learning that cannot be seen or touched (e.g. teaching/learning strategies, theories and others).

Rao (2010) and Arulsamy (2010) emphasise the importance of resources in the educational system in terms of their availability being imperative to the implementation of a subject found within a school curriculum. This suggests that the degree of resource availability influences the degree to which the implementation of a curriculum occurs, which implies that schools should be well resourced for there to be quality implementation of the curriculum.

To contextualise the issue of resources to South Africa an analysis of the curriculum document is essential. The CAPS for Life Sciences (DoE, 2011) lists the resources to be used for the teaching and learning of Life Sciences. The three types of resources identified by Khoza (2013a) are used to categorise the resources listed in the policy document: Hard-ware resources which are concerned with machines and tools include, textbooks, reference books, laboratory equipment, models, charts, televisions and DVD players. Soft-ware resources which are concerned with the generating of material for the hard-ware to display. This includes DVD's. This would suggest that computers, projectors and the soft-ware which is involved with these two are not used. However, according to Van den Akker et al. (2009) resources are mainly considered the domain of the micro level in terms of curriculum development where the teacher selects which resources to utilise. This suggests that the teacher decides what resources to use and when to use them as they see fit.

Listing the resources to be used suggests the location of teaching and learning which is concerned with Van den Akker et al. (2009) where teaching is taking place (Van den Akker et al., 2009). The location can be viewed as a hard-ware resource due to the fact that it could also be viewed as a tool which aids learning to happen as described previously. This location can be identified as a classroom or a laboratory with reference to the teaching of Life Sciences as the other resources mentioned can be found and stored in these locations. In identifying the location as a resource of teaching and learning, the influence of the location can be explored. This exploration of the location can be done in respect to the influence of the layout of the location on the teaching and learning process. Marx, Fuhrer, and Hartig (1999) observed how learners behaved in a classroom with traditional rows and columns as opposed

to a semicircle formation. It was found that the different seating arrangement does influence the teaching and learning process in terms of classroom interactions and learner engagement with the teacher. In the case of the semicircle formation, more questions were asked by the learners as opposed to the traditional seating arrangement where questions were posed by the learners who were seated in the front or in the centre. This suggests that the location as a resource, which aids in learning, does in fact impact on teaching and learning due to the level of interaction that it encourages or discourages.

In light of defining hard-ware and soft-ware resources, the comments of Rao (2010) and Arulsamy (2010) which were concerned with their availability being imperative to the implementation of a subject found within a school curriculum and the discussion of the types of curriculum where it was identified that the South African curriculum is strongly aligned with the characteristics of a performance curriculum, there needs to be exploration of the relationship if it exists between the availability of resources and the performance of learners.

A study conducted by Mudulia (2012) in Kenya which involved fourteen head teachers, fifty-six teachers and three hundred and eight form three students found that there is a relationship between the availability of teaching/learning resources and performance in secondary school science subjects. Data generating methods included the use of three questionnaires which were administered to head teachers, teachers and students. An analysis of seven low performing schools and seven performing schools resulted in more detailed findings which included that the availability of hard-ware resources was higher in the high performing schools as compared to the low performing schools. Findings showed that with regard to the low performing schools, laboratories were absent in some of them and the schools which did have laboratories lacked laboratory technicians. The majority of them were not fully equipped. Adding to the issue of laboratories was the fact that all of them did not have a library. On the other hand, all the high performing schools had more than one laboratory on site as well as a library. This suggests that if in the implementation of CAPS there is lack of resources which it lists, a possible result would be a low performance in learner achievement. This relationship between resources and performance could be used as an example to illustrate the vulnerable nature of the curricular spider web suggested by Van den Akker et al. (2009) as this would influence the success of the implemented curriculum. The successful

implementation which could be measured by learner performance as according to CAPS is deeply rooted in a performance model of curriculum.

In discussing the ideological-ware which is concerned with teaching/learning strategies, theories and others (which could include teacher conceptions and attitudes), Khoza (2012) states that the ideological-ware should be the one that drives any curriculum in education where there firstly needs to be full understanding of all ideological-ware resources by the teachers (implementers) of the intended curriculum before the implementation processes take place. These ideological-ware resources include whether the curriculum is driven by teacher-centred, learner-centred or content-centred approach. Their understanding increases the chances of achieving positive attained curriculum because of good alignment between the intended and implemented curricular (Khoza 2013a; Hoadley & Jansen 2013). This suggests that a lack of understanding of the ideological-ware which underpins a curriculum will result in failure with regard to its attainment. Therefore, with this in mind, the understanding or lack of understanding of the learning theory to be adopted will also have a similar impact on the attained curriculum.

In terms of a resource being a learning theory, a social constructivist learning theory has been identified and discussed in the section which explores the vision for including IKS in the school curriculum.

Other ideological-ware resources include teachers' understanding of a concept/topic and attitudes held by teachers of the concept/topic. The influence of teachers' understanding of IKS as a concept/topic based on their experiences impacting on their classroom practice is identified by Naidoo (2010) where it was mentioned that various experiences of teachers with regard to IKS informed their different classroom practices. The influence of the teacher attitudes towards content/topic formed from experiences impacting on their classroom practice has been explored by de Souza Barros and Elia (1998) which suggests that a lack of conceptual understanding of a concept/topic could result in a negative attitude towards the content/topic which would lead to it affecting the learning process and classroom practice negatively. As this study involves an exploration of participants understanding of NOS it is relevant to add that Brickhouse (1989) found that attitudes concerning teacher understandings of the NOS influenced their classroom practice with regard to the decisions made on what

they teach in terms of laboratory instruction and the manner in which demonstrations are utilised. These demonstrations can be viewed as resources which enable learning to take place. This suggests that as a resource an attitude towards a concept/ topic influences other resources.

In light of the discussion on attitudes influencing choices with regard to demonstrations in the classroom, a controversial issue related to demonstrations is animal dissections in the classroom. The grade 11 content of Life Sciences in CAPS states that one of the essential investigations in terms of the strand of life processes in plants and animals is concerned with animal nutrition is the dissection of a sheep's intestine. De Villiers and Somerville (2005) argue that it is important for the curriculum to consider teachers' and learners' cultures and religions when reflecting on the issue of dissections. In their study which aimed to determine prospective biology teachers' attitudes towards animal dissection involving 242 participants it was found that through an open-ended questionnaire 71% of the participants felt that they would expect their learners to do animal dissections. This suggests that they have a positive attitude towards animal dissections which would influence their classroom practice of them conducting animal dissections in the classroom. Reasons given for the carrying out of dissections include cognitive, skills, sensory and procedural. A point of interest of the findings was that 67% of the participants would rather do dissections themselves than watch video footage. De Villiers and Somerville (2005) in responding to the findings of their study state that the teacher must be sensitive to learners' needs by acquainting themselves with the cultural and religious concerns of all learners' in a diverse society which will allow them to create an awareness of alternative instructional tools. This suggestion of alternative instructional tools is in response to the fact that there was a minority group of participants who did not hold positive attitudes towards dissections. The call for teacher sensitivity in terms of culture and religion is in accordance with the principles underpinning the curriculum (DoE, 2011) which calls for inclusivity.

When exploring literature focusing on teachers' attitudes towards IKS, a prevailing theme identified was that teachers do in fact posses negative attitudes with regard to IKS (Shizha ,2007; Ogunniyi, 2007; Dziva et al., 2011), which have an impact on issues such as teacher behaviour and the implementation of IKS in the classroom.

This link between the understanding of a concept, an attitude and behaviour can be identified in the work of Dziva et al. (2011) whose study identified that the teachers who participated in their study exhibited a limited conception of IKS. When looking at their views on IKS which can be viewed as their attitude towards it, it emerged that they harboured negative attitudes towards IKS. Evidence of this negative attitude can be seen in participants' responses which included that they viewed IKS as retarding success in learning school science. This suggests that their negative attitude towards IKS may be a result of their limited conception of IKS, which de Souza Barros and Elia (1998) comment on. Another finding which is relevant to classroom practice is concerned with the analysis of the teachers' schemes of work which revealed that the teachers were not utilising teaching methods inherent in IKS which include folk stories, riddles, music and song. Evidence of the teachers not using teaching strategies inherent in IKS became clear when all learning was taking place indoors rather than outdoors where according to Michie (1999) is an environment without artificial boundaries conducive for the transmission of IKS. Looking at the above discussion which focused on the findings of the study which included the conception of a content/topic may have an influence on an attitude towards it. This in turn could have influenced the teachers' practice and could be taken as further illustration of the view that an attitude regarding a content/topic does in fact influence the teaching and learning process and therefore can be viewed as a resource.

Shizha (2007) also identified that teachers' posses' negative attitudes of IKS in a study which aimed to gain rural primary school teachers' insights into problems encountered in incorporating IKS into the science curriculum. This qualitative study which used a semi-structured interview as its data production method involved ten full time, fully qualified primary school teachers whose experience ranged from one to thirty years. Findings included that teachers exhibited negative attitudes towards indigenous science. These negative attitudes were identified as obstacles which impeded the effective incorporation of indigenous knowledge. Negative attitudes were based on teachers' lack of faith (negative attitude) that an IKS curriculum can practically contribute in addressing the needs of the people brought about by past injustices. Some comments by teachers included that traditional science had no place in the curriculum, indigenous knowledge usually has old values as well as their viewing science as a hierarchical structure, where indigenous knowledge is seen as inferior to western science.

Ogunniyi (2007) provides further evidence of teacher negative attitudes towards IKS through his study which explored the understanding of NOS and IKS gained by four teachers who were involved in a Practical Argumentation Course (PAC) for 6 months. A case study approach was adopted for the study where the data production methods included teacher responses to three pre – test and post – test questionnaires as well as follow-up interviews and two reflective essays. The questionnaires used are known as the Nature of Science Questionnaire (NOSQ), the Characteristics of IKS Questionnaire (COIKS) and the Nature of science and IKS Questionnaire (NOSIKSQ). The questionnaires involved the teachers providing a rating (agree, not agree or undecided) for each statement, providing explanations for their rating and specifying the sources of those explanations. With relevance to this study the Characteristics of IKS questionnaire's aim was to gain insights into the status and relationships between scientific understandings and personal beliefs. It involved each item presenting a brief scenario focusing on the origin of modern medicine and traditional healing, the origin of the rainbow and the source of lightning. Evidence of these negative attitudes towards IKS as mentioned above are apparent in the responses given by the teachers who participated in the study. Such responses include that before the PAC a teacher regarded IKS ideas as primitive and that science is right.

The above discussion focused on the theme of teachers possessing negative attitudes towards IKS. However, on a positive note, other responses from Ogunniyi (2007) which contributed to his findings suggest that teachers do have the ability to shift their attitudes from being negative to positive towards IKS once they attend a course similar to that of the PAC. This shift is evident in the response of a teacher post the PAC where he comments that he now values indigenous knowledge systems and is proud to be part of this system and that he wants to learn more.

The influence of attitudes of teachers towards IKS on their classroom practice has been acknowledged and explored in previous paragraphs. The discussion with regard to attitudes influencing classroom has been largely focused on the impact of negative attitudes. However, in light of the above findings of Ogunniyi (2007) regarding the ability of teachers to have a paradigm shift in terms of them changing from having a negative attitude to one that is more positive. It is then necessary in the interest of objectivity to explore how this paradigm shift could influence the classroom practice of teachers. Earlier work of Ogunniyi (2004) which

has already been introduced in a previous section involving teachers who participated in a module called the Psycho-socio-cultural Issues in Science and Mathematics Education (PISME), found that as a result of teachers' paradigm shift regarding their attitudes they do in fact make changes in their classroom practice, with reference the change of their pedagogy adopted in the classroom. Evidence of this can be seen in the following teacher excerpt, when asked to convey his views about attitudes and practices before and after the PISME module. He responded by saying that,

> *Before the module I was very strict with the pupils. I did not show any mercy to those who did not do their homework. After the module I have learnt how to respect others according to their culture and also their social circumstances. I became more at ease with the learners with much more patience the learners became more willing towards me, more open and find it easy to react. I show a lot more compassion towards learners' background which opens the door of communication between us, and find that they have different ways of solutions to problem given to them.*

(Ogunniyi, 2004, p. 302)

It is illustrated sufficiently from the above excerpt that this participant of the study has shifted paradigms. From the opening few lines which commented on the attitude before the PISME module the participant portrays an impression which is entrenched in the view that there are no other alternative worldviews. However, his after module comments show a shift in paradigm in terms of him becoming aware and valuing other alternative worldviews which includes IKS. This awareness and valuing of other alternate worldview could be seen as the participant exhibiting a positive attitude towards IKS which influences his classroom practice. The influence can be seen in the way he now acknowledges learners' backgrounds.

To further illustrate the influence of a teacher possessing a positive attitude towards content which impacts on their classroom practice where their classroom practice can be measured by learner performance is a study conducted by Adler (2005) in the subject discipline of Mathematics. Although concerned with Mathematics findings can be used to interrogate the phenomenon of the influence of teacher attitudes. The study found that teachers' attitude and

interest towards Mathematics influenced learner performance. Teachers who show positive attitude towards Mathematics may gain learners' interest in learning. This suggests that through their positive attitude a conducive learning environment is created as a result of the classroom practice.

2.10.5 Life Sciences teachers' role in relation to IKS and the curriculum

In discussing the role of a Life Sciences teacher a point of departure that can be used is to discuss the role of a teacher in general and then apply that to a Life Sciences context. According to the Government Gazette, no. 20844 of 2000 (DoE, 2000) which describes what is required to be a competent teacher. There are competencies which include an exploration of the roles of a teacher. These roles of a teacher include the teacher as an, learning mediator; an interpreter and designer of learning programmes and materials; leader, administrator and manager; scholar, researcher and lifelong learner; assessor; learning area/subject/discipline/phase specialist as well as having a community, citizenship and pastoral role. According to Hoadley and Jansen (2013) teachers can drive the curriculum by being a facilitator when the lesson learner-centred and an instructor when it is teacher-centred and content – centred. In light of the curriculum adopted at present in South Africa this suggests that a teacher needs to adopt various roles as the curriculum advocates a teacher-centeredness approach which emphasises much content. However, it does include elements of a competence approach involving learner-centeredness with the inclusion of IKS.

Links can be identified with regards to the roles stated in the above paragraph pertinent to this study as these roles are integrated. A teacher is expected to mediate learning (*mediator*) in a way that is sensitive to the diversity among learners, construct learning environments that are conducive to learning and demonstrate sound knowledge of subject content, strategies and resources applicable to teaching in a South African content. This description of a mediator is linked to the teacher being an *interpreter and designer of learning programmes and materials*. It is only through having sound knowledge which requires the teacher to be a *scholar* of the learning area/subject/discipline/phase that the teacher can interpret and design learning programmes and identify requirements for a specific context of learning, which involves suitable resources which are sensitive to the diversity of learners. These roles require the teacher to be a *leader* which involves making decisions regarding strategies and resources in *managing* learning in the classroom that supports learners. Teacher understanding is not

limited to the above mentioned aspects of teaching but also includes the teacher having an understanding of the importance of assessment *(assessor)* in the teaching and learning experience whose administration *(administrator)* is of great importance.

An example of the above description relevant to a Life Sciences teacher can be illustrated by highlighting the role of the teacher in terms of a particular topic found in the Life Sciences curriculum. Using the topic of Excretion in Humans found in the grade 11 syllabus. A Life Sciences teacher would need to have gone through being a scholar of the subject in order to interpret and design a learning programme using resources which will be sensitive to the diversity in the South African classroom. This example is used due to the fact that the teacher needs to consider the vast array of belief systems as this topic involves decisions regarding the inclusion or non inclusion of kidney dissections which may be in contradiction to some of the learners' belief systems. The teacher would therefore be required to factor in their beliefs in terms of learning and assessment strategies to be employed for this topic.

Researchers in a previous section commented on the value of using IKS in the teaching and learning of science in terms of the learning theory utilised. A teachers' role is an aspect concerned with a learning theory utilised in the teaching and learning process. The integration of indigenous knowledge with the implementation of a social constructivist learning theory is facilitated by what Jegede and Aikenhead (1999, p. 55) term the teacher being a 'culture broker' involving border crossing where the role of the teacher is to guide learners "between their life – world culture and the culture of science, help them resolve any conflict."

In explaining the role of the teacher as a "culture broker", there is an acknowledgement that learners possess different learning abilities and therefore the role of the teacher does change as a result of this situation. It is proposed that where learners require a high degree of guidance when border crossing, these learners would make up the learners who are regarded as weak learners, the teacher would be a tour guide culture broker. Characteristics of a tour guide culture broker, include, the individual exposing learners to the culture of science (included here is its phenomena, knowledge, skills and values), coaching learners on how to use science in their everyday lives, enabling learners to smoothly navigate this border crossing where difficulties are experienced and having the expectation that appreciation of science will be developed through the science programme.

On the other hand, when a teacher is dealing with learners who require less guidance, the role of the teacher is therefore different from the one proposed for the learners who need a high degree of guidance. In this instance the teacher will assume the role of a travel agent where there is the provision of incentives for pupils, with the intended purpose to create a sense of curiosity in knowing the science culture. This curiosity in the science culture constructs a bridge between learners' real life - worlds and the science culture where "the bridges assist pupils in constructing key scientific abstractions (e.g. DNA) and assist them to be articulate in analysing or critiquing the culture of science itself" (Jegede & Aikenhead, 1999, p. 56).

Adding to the discussion on the teacher being a 'culture broker' in border crossing is the acknowledgement that school science is embedded in western understandings which are very different to daily life experiences and indigenous ways of non western learners. This difference ultimately leads to conflict. Border crossing is the movement of learners from their activities/ understandings experienced in their everyday life to activities/understandings of school science. According to Mulholland and Wallace (2003) this movement from everyday activities/ understandings towards a more western view does not imply the total eradication of learners' indigenous ways. However, it enables other cultures to be more reachable and accessible which allows an individual to borrow valuable knowledge and skills from other cultures while still maintaining their own culture.

Relevant to the concept of border crossing is the question of what happens internally when learners engage in science learning due to the view that they experience the navigation of the borders apparent between their indigenous knowledge and class science knowledge. Jegede and Aikenhead (1999) speak of the theory of collateral learning to explain what happens in the minds of learners. They identify that there can either be an interaction or non interaction of the conflicting views of their indigenous knowledge and that of class science. The conflict of views is resolved where in the case of interaction, learners identify common threads in the different forms of knowledge which results in the learners manufacturing new ideas in their long term memory. Where there is no interaction the learners engage with the views individually depending on whether they are where indigenous knowledge is being used or where the class science is being used. According to Jegede and Aikenhead (1999) four types of collateral learning exist. Firstly, there is *parallel collateral learning* which is concerned

with the non interaction of views where the views are accessed independently according to the contextual needs of learners. Secondly, *simultaneous collateral learning* is when a particular concept is explored with the simultaneous use of indigenous knowledge and class science, where learners identify differences and similarities in the views of their indigenous knowledge and class science that relates to the concept being explored. Thirdly, *dependent collateral learning* is when there is a formulation and learning of new views due to the learner experiencing. For example, a learner may adjust his/her indigenous knowledge view based on an opposing view of class science. Lastly, *secured collateral learning* occurs when there is interaction of views, enabling these views to be resolved.

In order to integrate IKS with the implementation of the teacher's role being one of a culture broker in the classroom an environment that is conducive for the facilitation of this integration needs be created by the teacher. Snively (1995) suggests a number of instructional teaching strategies which will facilitate the role of the teacher being a culture broker. These instructional teaching strategies include the teacher using a variety of resources and materials which do not perpetuate racial stereotyping, oral narratives and the incorporation of heritage into school science, the language of science where aid is given to those learners who experience language difficulties, discussions about science to integrate various topics (history, justice, equality, freedom and spirituality), evidence from a variety of cultures which will facilitate a 'multicultural' view of science, activities which aid learners in identifying that there is the likelihood of continual change as well as use of learners' own ideas and beliefs which are identified through interactivity among themselves.

The teaching strategies which Snively (1995) proposes will help in creating an environment in which teachers facilitate the movement of learners between their real life-world and the science world due to them feeling at ease as a result of the flexibility of the environment created (Solomon, 1992).

The above discussion firstly outlined the various roles of a teacher, secondly it used the various roles to contextualise them to a Life Sciences teacher and then, lastly, proposed a role of a teacher that could be utilised with relevance to IKS. Bearing this in mind an important component making up the role of the teacher is concerned with the factors which could possibly influence it and therefore have an impact on their classroom practice. Considering

this aspect is important as a component of this study relates to the classroom practice of teachers, which involves the teachers' role, in relation to IKS. As already explored teacher attitudes do in fact influence the classroom practice of teachers. Previous discussion highlighted the impact of negative attitudes held by the teacher. Other factors influencing the role of the teacher include according to Shizha (2007), the reluctance of the teacher to use indigenous language due to language policy which requires one to teach in the official language of instruction, the non testing of indigenous knowledge owing to the fact that the official examination policy does do include the testing of IKS, the use of material resources such as textbooks which hinders the successful integration of indigenous knowledge and the lack of exposure to indigenous knowledge during teacher training with regard to exposing pre – service teachers to IKS with the incorporation of it in their modules. Sufficient training might aid in influencing a paradigm shift as mentioned by Ogunniyi (2004) with regard to attitudes towards IKS. This idea which refers to teacher training in relation to it being one of the challenges which IKS faces in its implementation which involves the teachers' role is summed up by Owuor (2007, p. 29) who states that "lack of capacity of trained indigenous educators became a hindrance to the curriculum implementation."

Commenting on the challenges faced by teachers with reference to teacher training which includes IKS as discussed above forces one to think about possible interventions which could be implemented during teacher training in order to address shortcomings in teacher training. The work of Ogunniyi (2004, 2007) which explored a PISME module and a Practical Argumentation Course respectively as well as Mudaly and Ismail (2013) which involved a Pedagogic Content Knowledge module illustrates the value of implementing such modules/course during teacher training. Evidence of this can be seen in the findings with reference to a change in attitudes towards IKS and in the case of Mudaly and Ismail (2013) who asked participants how pre-service teachers can be enabled to teach culturally inclusive science more effectively? Responses to this question suggest that pre-service teachers value such modules/courses and are calling for training in culturally inclusive content and teaching strategies where they view tertiary institutions as playing a role in facilitating the training of teachers to integrate culture into their lessons which is highlighted by a participant who felt that tertiary institutions should offer at least one compulsory module to teach the necessary IKS and ways of teaching culturally inclusive science.

2.10.6 Learning Activities

The component of learning activities found in the curricular spider web is concerned with how the teachers are teaching. Commenting on learning activities involving how teachers are teaching suggests that they are linked to learner experiences undertaken in the classroom. This is in line with Talla (2012) who defines learning activities as learner experiences which result in them acquiring certain behavioural competencies. A complementary relationship exists between the learning activities chosen by a teacher and the role of the teacher, as outlined in the section above, where both components are embedded in the learning theory (teaching strategies) adopted by the teacher in facilitating the teaching and learning process. Therefore, in discussing learning activities, the exploration of current learning theories adopted in science education is necessary in order to identify learning activities which are conducive to the teaching and learning process relevant to IKS.   Current learning theories employed by teachers in the teaching and learning science include constructivism and social constructivism which includes the teacher being a culture broker ensuring border crossing.

Research into the learning theory adopted by teachers in teaching scientific knowledge advocates the adoption of the constructivist approach for the teaching and learning of scientific concepts (Baxter, 1991). In the constructivist approach the emphasis is the learner, where the interaction between the teacher and learner is not perceived as one which involves the teacher pouring knowledge into a passive learner who waits like an empty vessel to be filled but rather the learner is encouraged to actively participate in his/her own experience of learning. A constructivist approach is described as an approach where knowledge is organised and interconnected into the learners' cognitive structures and further involves the "active participation of learners in abstracting relevant features of new knowledge and either assimilating these features into their cognitive structures or reorganising their structures to accommodate these features" (Zelik, Schau, Mattern, Hall, Teague, & Bisard, 1997, p. 998). Wheatley (1995) describes this approach as the individual making sense of their experiences. Baxter (1991) suggests that a benefit of the constructivist approach is that it has the ability to enhance classroom practice and is of the opinion that part of the constructivist approach is the designing of tests which serve the purpose of challenging the learners' original notions. Ozer (2004) writes that within a constructivist classroom there is present a variety of activities challenging learners to accept diversity, increasing their readiness to learn through the discovery of new ideas in the construction of their own knowledge.

Constructivism and Social constructivism as theories both call the construction of knowledge and indeed share similarities, however they differ according to Ozer (2004) in terms of how constructivism should be carried out in the classroom with the latter placing greater emphasis on the learning experience being a collaborative activity incorporating social interaction valuing cultural background which includes concepts such as history, social context, traditions, language and religion. A social constructivist classroom calls for school learning taking place simultaneously with real world learning.

Important to the discussion of learner activities is identification of two learning approaches; the learner centred and teacher centred approaches. The adoption of either of these learning approaches will have an impact on the learning activities chosen in the classroom as a particular learning approach lends itself to particular learning activities. This relationship between learning activities and learning approaches employed is not in isolation as the curriculum approach adopted also influences the learning approach employed. This suggests that ultimately the curriculum approach determines both the learning approach and learning activities.   Decisions on which type of activities to employ are influenced by the curriculum approach adopted.

Evidence of this tri-concept relationship can be seen in the characteristics relevant to the three concepts. In analysing the characteristics of the performance model which dominates the South African curriculum adopted at present is the identification that such a model calls for a teacher centred learning approach. A teacher centred approach which calls for according to Weinstein, Tomlinson-Clarke, and Curran (2003), learners being passive and doing their activities on their own resulting in them being less engaged during the learning process. As a consequence of learners carrying out activities on their own a teacher centred approach is one where there is little or no noise in the classroom. In contrast, a learner centred approach involves the learner constructing knowledge by working in groups and being an active participant in their learning experience where as Chall (2000) describes it, the classroom as being busy and noisy. According to Huba and Freed (2000) this construction of knowledge is done through gathering information and integrating it with skills of inquiry. The culture in this approach is co – operative, collaborative and supportive. Such behaviour is in line with a competence model. In exploring the two types of learning approaches it can be said that in fact one in particular lends itself to a constructivist/social constructivist learning theory. According to Matthews (2003) a learner – centred approach is consistent with a constructivist

learning theory. This is evident in terms of a learner centred approach being characterised by the view that learners do in fact construct knowledge and are not simply vessels for the transmission of knowledge to occur which are characteristics of the learning theory stated.

In the interest of objectivity concerning teacher-centred and learner-centred approaches to learning mention must be made of the benefits of both approaches. This is evident in the work of Chall (2000) which reviewed research relevant to teacher-centred and learner-centred approaches to learning. Benefits included that academic achievement (i.e., reading, writing, mathematics) of a teacher-centred approach was generally found to be more effective as compared to a learner-centred approach in terms of children with a lower socioeconomic status. In outlining the characteristics of a learner centred approach Weinstein et al. (2003) state that working in groups enables teaching and learning to be an enjoyable and a rewarding activity which results in learners understanding easier. This suggests that there is merit in adopting a learner-centred approach as working in groups is a characteristic of this particular learning approach. The above would suggest that a balance in the adoption of the learning approaches is required in the classroom as already outlined elements of the curriculum utilised currently include teacher-centeredness and a learner-centeredness.

Attempting to implement learning activities which are rooted in a constructivist/social constructivist learning theory as mentioned requires such activities that encourage skills of inquiry. According to Alberta Education (1990) inquiry-based learning is where learners are actively involved in their own learning through formulating questions, investigating and then building new understandings, meanings and knowledge. Kuhne (1995) suggests that the utilisation of inquiry-based learning contributes in learners becoming more creative, positive and independent. Researchers (Lindberg, 1990; Loyd & Contreras, 1985 and 1987) view the effectiveness of inquiry-based teaching in terms of it being a vehicle which fosters scientific processes, vocabulary knowledge, conceptual understanding and critical thinking. Inquiry-based learning involves teachers following a five steps (adapted from Bybee, 1989), which includes, the *engagement* of teachers with the learners in order to ascertain their prior knowledge resulting in interest being created. The *exploration phase* involves the learners receiving instructional or hands-on activities which promotes learning and leads to *explain phase* where the teacher poses questions and facilitates interactive discussions around the

activities completed in the exploration phase. The application of the newly acquired knowledge and skills to real life situations from the *explain phase* is carried out in the *elaborate phase*. Lastly, the assessing of learning is done by the teacher in the *evaluation phase*. In outlining the five steps of inquiry based learning one can identify that this type of learning can be utilised as a vehicle to implement a leaner centred approach which involves the adoption of a constructivist/social constructivist theory as it requires the teacher to not view the learners as empty vessels due to the teacher eliciting their prior knowledge as well as the teacher facilitating discussion.

2.10.7 Assessment

Kennedy, Hyland, and Ryan (2006) identify two types of assessment, namely formative assessment and summative assessment where formative assessment is usually carried out before or during a learning programme and aids in ascertaining how the learners are progressing. It is described by Black and William (1998) as activities conducted by both teachers and learners which provide information that is utilised as feedback in order to adjust the activities in which they are involved. This suggests that such assessments are entrenched with the view of them involved in the process of teaching and learning owing to them providing feedback which informs the modification of teaching and learning. Summative assessment on the other hand is normally conducted at the end of a programme attempting to summarise learner learning at some point in time. According to Brown and Knight (1994) it is an end of course assessment which produces a measure summing up of someone's achievement in the form of grade to be generated which highlights learner performance. This suggests that such assessments are entrenched with the view of them involved in the product of teaching and learning owing to them providing a measure of learner performance in the form of a grade.

According to the CAPS (DoE, 2011) for Life Sciences assessment is a continuous planned process of identifying, gathering and interpreting information on learners' performance, using a variety of forms of assessment. It further indicates that there are two types of assessment, namely informal assessment or daily assessment and formal assessment. Informal assessment is concerned with the daily monitoring of learners' progress and should be a precursor to

formal assessment. Examples of such assessment include daily tasks, observations, discussions, practical demonstrations, learner-teacher conferences as well as informal classroom interactions. It could involve simply stopping during a lesson in order to observe or to discuss how learning is progressing. Results generated from informal assessment are not taken into consideration in terms of the promotion of a learner. This type of assessment is in line with formative assessment as it attempts to inform the teaching and learning process rather than the promotion of learners.

In formal assessment, tasks are marked and recorded for progression purposes. Examples of formal assessments include tests, examinations, practical tasks, projects, oral presentations, demonstrations and performances where they form part of a yearlong programme of assessment in each grade and subject. This type of assessment is in line with summative assessment as it attempts to generate information in the form of grade which is used in deciding the promotion of learners.

Expanding on the view of formal assessment being a yearlong programme of assessment is the concept of continuous assessment proposed by Kennedy, Hyland, and Ryan (2006) where reference is made to a combination of formative and summative assessment. However, emphasis regarding this term of continuous assessment is given to the repetition of summative assessments where marks are generated and recorded for promotion purposes. For example, within the CAPS (DoE, 2011) for Life Sciences for grade 10 the summative assessment for the year includes four tests, one midyear examination, one project/assignment, three practical tasks, one end-of-year practical examination as well as two end-of-year examinations. these are carried out at the end of a programme of learning that is concerned with a topic and therefore meets a construct of summative assessment.

In commenting on assessment, one is enticed to enter into a discussion which is concerned with the reliability of assessments in terms of their frequency and variety with regard to the grade which is generated as a result of them. CAPS (DoE, 2011) states that a low frequency of summative assessments does not provide the most accurate and reliable evidence of every learner's performance and encourages teachers to carry out more than the minimum assessment as proposed in the document. This suggests that the minimum summative

assessments proposed can be viewed as criticism of the document, as in encouraging teachers to do more assessments is in fact acknowledging a shortcoming in the minimum summative assessments ability to provide an accurate measure of a learner's performance. In encouraging more assessments, teachers might ask, where is the time? as they are already burdened with their various roles.

As mentioned previously assessment should encompass various forms of assessment. However, according to Brown (1999), approximately eighty percent of assessment is summative assessment in the form of exams, essays and reports, which suggests that the range of assessments is very limited. There is no balance in terms of formative and summative assessments with regard to continuous assessment in CAPS. This suggests that the emphasis is on the product rather than the process of teaching and learning.

An area of concern within the CAPS document involves the weighting of cognitive demands for assessment of content for Grades 10, 11 and 12. The curriculum calls for the same standards of cognitive demands for assessment in the three grades in relation to the curriculum outcomes of it aided by the keywords used in Bloom's taxonomy. Table 2.8 illustrates this point.

	Knowing Science	Understanding Science	Applying scientific knowledge	Evaluating, analysing and synthesising scientific knowledge
%	40%	25%	20%	15%
Examples of Useful Verbs	- State - Name - Label - List - Define - Describe	- Explain - Compare - Rearrange - Give an example of - Illustrate - Calculate	- Predict - Apply - Use knowledge - Demonstrate - Solve - Implement - Judge	- Select - Differentiate - Analyse - Infer - Suggest a reason - Discuss - Categorise

Table 2.8 Weighting of cognitive demands for assessment of content in grades 10, 11 and 12 (DoE, 2011, p. 67).

Using table 2.8, one can see that if a performance approach to curriculum is being utilised in developing CAPS, which calls for greater complexity as one moves through the levels. Nonetheless, why have the weightings stayed the same? This greater complexity would suggest that by grade 12 the percentages for each objective should not be the same as found in grade 10. A higher percentage in evaluating, analysing and synthesising scientific knowledge should be found in grade 12.

2.10.8 Time

According to Berkvens et al. (2014) many learning opportunities are often ignored due to the conservative nature of timetabling as formal time for teaching is still considered to take place at school. This suggests that there are greater opportunities for learning outside the traditional timetabling of time for learning. As CAPS is descriptive in terms of the selection, sequencing and pacing of content it follows that it provides the time to be allocated to Life Sciences. According to CAPS (DoE, 2011) four hours per week are allocated for the teaching and learning of Life Sciences in Grades 10, 11 and 12. With the exception of grade 12, the curricula in both grades 10 and 11 have been designed to be completed within 32 weeks out of 40 weeks, leaving 8 weeks of the year for examinations, tests and disruptions due to other school activities. In grade 12 the curriculum has been designed to be completed within 27 ½ weeks leaving 12 ½ weeks of the year for examinations, tests and disruptions due to school activities.

Considering the views of Berkvens et al. (2014) who are concerned with timetabling being restrictive in providing learning opportunities and in light of the descriptive nature of CAPS regarding the time to be allocated to Life Sciences. CAPS is left open for criticism. According to du Plessis and Mbunyuza (2014) whose research focused on whether the Department of Basic Education can train in-service teachers and provide quality learning and teaching support materials (LTSM) to comply with the challenges of the implementation of a new national curriculum (CAPS), involving 15 different schools (11 primary and 4 secondary). It was found that participants felt that CAPS is very structured and fixed and teachers are teaching according to prescribed guidelines which do not encourage the teacher to be creative as advocated by a social constructivist learning theory according to which the teacher creates a context for learning suggesting that a curriculum laden with prescriptive measures stifles flexibility in its implementation.

2.10.9 Grouping

In discussing grouping two questions are asked in this study as a means to explore this component which is found in the curricular spider web. These questions are: who are they teaching? as well as, with whom are they teaching? Exploring the first question Berkvens et al. (2014) in commenting on component of grouping and refers to it in terms of accessibility where this accessibility is dependent on a number of factors such as the physical ones. This is concerned with whether it is possible for learners to reach the school. The financial factor is concerned with the the learner's position to afford education and, the cultural one which is concerned with whether the education programme is socially acceptable. From the description of the factors involved with securing accessibility for learners it is apparent that if accessibility is ensured, education for all is achieved. According to Berkvens et al. (2014) access to education should be granted to children regardless of their ethnicity, socio-economic status or gender. Evidence of the accessibility within the South African context can be seen in the intended curriculum currently being adopted where one of its purposes of it is concerned with equipping learners, irrespective of their socio-economic background, race, gender, physical ability or intellectual ability with knowledge which brings about self-fulfilment and meaningful participation in society (DoE, 2011). The intended curriculum further comments on inclusivity where sensitivity is given to issues of diversity which include poverty, inequality, race, gender, language, age and disability (DoE, 2011). The intended curriculum is closely aligned to a teacher-centred approach. It is one that involves systematic instruction and as Chall (2000) points out that this approach is effective for children with learning difficulties as it provides more structure and support. This suggests that by adopting a more teacher centred approach the current curriculum is attempting to ensure accessibility as structure and support could also involve taking care of children who come from low socio-economic backgrounds.

The second question; 'with whom are they teaching?' has not been fully explored in literature. This presents an opportunity for this study to fill gaps in research around teacher grouping in terms of finding out what really happens with regard to this factor at the *meso* (school) level of the curriculum.

2.11 Literature coverage
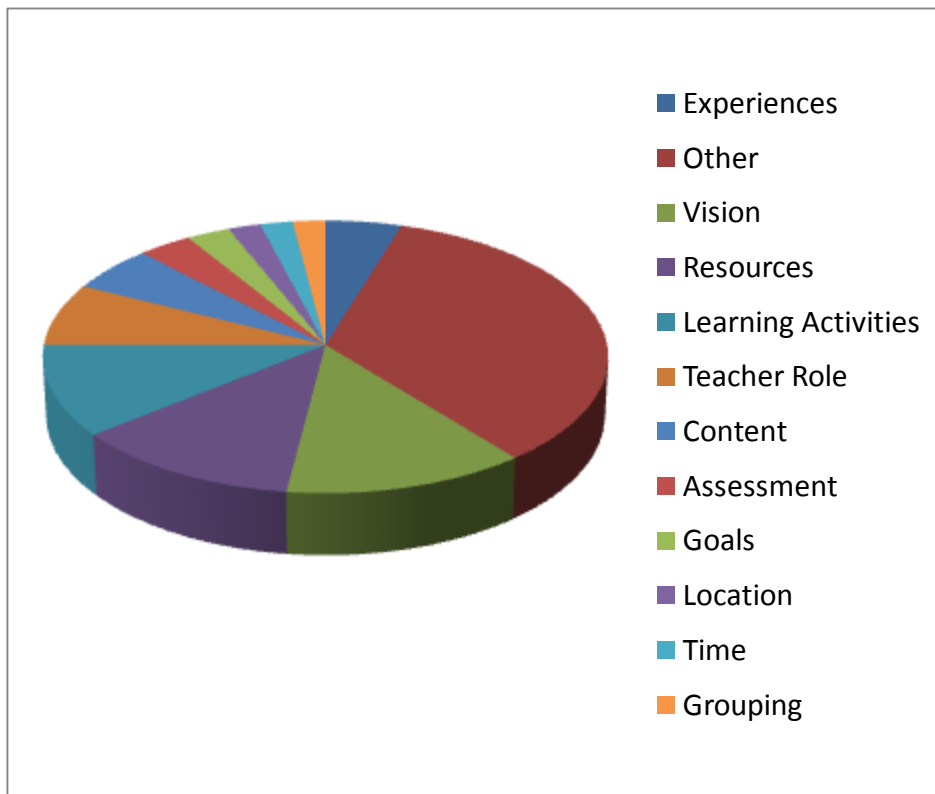
Figure 2.5 Pie chart of literature reviewed

Figure 2.5 above shows a pie chart which represents the literature reviewed which is firstly concerned with defining the phenomenon of this study which is experiences both prior and present in terms of them influencing understandings, attitudes and classroom practice. Secondly, it represents areas that concen curriculum in general (definition and types of it), its ideoligical nature, defining IKS, Western/Scientific Knowledge and Indigenous/Traditional Knowledge as well as the nature of science which has been referred to as 'other' in the above pie chart. The concepts pertaining to the curricular spider web are also represented. There is more literature that is concerned with the vision, resources, learning activities as compared to that which explores teacher roles, content, goals and assessment with the least amount on location, time and grouping which suggests that an opportunity exists for further research into these concepts. It is acknowledged that there is an overlap of some of the concepts in the literature as research used in the literature review touched on a number of concepts that are relevant to the curricular spider web. This viewpoint illustrates the inter connectivity or inter dependence of the respective concepts found in the curricular spider web.

2.12 Chapter Summary

The literature reviewed in this chapter is relevant to curriculum in general where a number of concepts were explored. It identified the complexities involved in defining IKS. The components of curricular spider web were used as themes to discuss literature relevant to this study. There is a varying degree of coverage of components in the literature. Components such as rationale, resources and learning activities are discussed the most. The next chapter discusses how the objectives of this study will be achieved where the various elements of the research methodology of this study are explored through discussion.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter explored curriculum in terms of the concepts found in the curricular spider web as it forms the conceptual framework of this study. The review of literature presented local and international research on science education where issues pertaining to experiences of teachers with curriculum were highlighted and where applicable experiences relevant to IKS were discussed. This study aims to explore the teachers' experiences of IKS found in the Life Sciences curriculum within a South African context. The study aims to achieve the following objectives:

- Explore teachers' experiences of IKS.
- Explore IKS teachers' experiences with reference to their classroom practice.

According to Christiansen, Bertram, and Land (2010) a research design is a logical sequence which relates data to a study's initial research objectives and conclusion. This chapter therefore provides details of the research design implemented in order to explore the research objectives stated above. It explains with justification the paradigm (interpretive) adopted, the research methodology (case study), the research approach (qualitative), sampling (purposive and convenience), data generation methods (questionnaires, semi-structured interviews and document analysis i.e. lesson plans), trustworthiness (credibility, dependability, transferability, conformability), data analysis (guided analysis), ethical issues and the limitations of the study.

3.2 Research Paradigm

Terre Blanche, Durrheim, and Painter (2006) describe paradigms as "acting as perspectives that provide a rationale for the research and commit the researcher to particular methods of data collection, observation and interpretation," (2006, p. 40). Kunh (as cited in Cohen, Manion, & Morrison, 2011) defines a paradigm as a way of viewing phenomena and pursuing knowledge involving a set of principles which determine how to investigate such phenomena. Christiansen et al. (2010) concur with the above views and further define a paradigm as supplying the researcher with the type of questions to be asked, what can be observed and investigated, how to generate and interpret data.

According to Christiansen et al. (2010) there are three key paradigms in research, namely the post-positivist, the interpretive and the critical paradigms each with their own way of looking at phenomena. Cohen et al. (2011) describe the post-positivist and critical paradigms where the former is striving for objectivity, predictability, patterning and the development of laws and rules of behaviour and the latter is aware of the political and ideological context involved with change. This study does not aim to secure objectivity and predictability nor does it attempt to bring about change. Therefore, the paradigm selected for this study is the interpretive paradigm as according to Christiansen et al. (2010). It is used in a study where the subjects of the research are people and is widely used in the area of Social Sciences which includes education where it assumes that the purpose of educational research is to develop understanding and meaning informing human behaviour. This point is in line with the reasons for using the interpretive paradigm for this study. Firstly, this study involves people (teachers) in the area of education. Secondly the use of this paradigm is based on the understanding that the area of social science is subjective where an aim of the interpretive paradigm is, according to Cohen et al. (2011) understand the subjective world of human experience. Relating this to the study, it aims to explore the teachers' experiences of IKS found in the Life Sciences curriculum and after identifying the teachers' experiences of IKS which incorporate their attitudes, to understand their behaviour. Their behaviour being the way they teach IKS (classroom practice) which could be subjective based on their experiences.

3.3 Research Methodology

Understanding the particular paradigm to be used for a study enables one to adopt and implement the suitable methodology due to the fact that it involves how a researcher will generate and analyse the data that is required to answer the research questions.

The methodology that was utilised in this research is a case study of three Life Sciences teachers at a high school. According to Cohen et al. (2011) a case study "provides a unique example of real people in real situations, enabling readers to understand ideas more clearly" (p. 289). Christiansen et al. (2010) add that it is an in-depth study of one particular case, which could involve a person, a group of people, a school, a community, or an organisation. Justification for the use of a case study for this study includes that firstly, a case study answers a number of pertinent questions that a researcher must be cognisant of when conducting research. One could argue that by implementing a case study guides or dictates the nature of the study by referring to these questions. These questions include what data must be generated so as to answer the research questions of the study, what data generation methods will be used and how will the data generated be analysed in order to understand it, secondly using the two descriptions of a case study mentioned above, this study aims to explore specific teachers' (group of people) experiences of IKS.

Thirdly, according to Hitchcock and Hughes (1995, as cited in Cohen et al., 2011) when a researcher has little control over events a case study methodology is valuable. I had no control over the participants' experiences and teaching. Having little control over events which have been identified as participants' experiences and teaching could be viewed as the unknown which therefore makes this study's research approach qualitative in nature. According to Creswell (2009) such research involves the exploration of unknown variables in the course of the study which are discovered through data generated from the research participants. Justification of this research approach can be seen in the fact that this study explores teachers' unknown experiences of IKS, their attitudes towards IKS and how these attitudes influence their teaching in the classroom. A qualitative study allowed me to gain valuable insight into the above issues.

Fourthly, using of a case study is linked to the strengths in the use of it. These strengths include, that it can be undertaken by a single researcher without needing a full research team and that it can capture features that are unique and that may otherwise be lost in surveys. These unique features could be of importance regarding understanding. The fifth strength is that it is in line with the interpretive paradigm, which seeks to understand human experience. Lastly, case studies, according to Leedy and Ormrod (2001), are very useful in developing understanding of situations which might have a lack of understanding or about which not much is known.

However, case studies have weaknesses too. One of their main weaknesses is that their results may not be generalised due to their dependence on a single case. However, Maree (2007) in defining the purpose of case study responds to this weakness by indicating that its purpose is not to generalise but instead to gain more insight and understanding of a specific phenomenon. Acknowledging this of a case study is important as such insight may be viewed as a possible benefit of this study which could aid other Life Sciences teachers in addressing similar issues which this study may identify. In an effort to overcome this weakness, the findings generated from the study are not going to be generalised to other cases.

Linking the research paradigm of this study (interpretive paradigm) and a case study, Creswell (1994) suggests that the use of both in tandem provides for a more holistic, descriptive and contextual exploration of the phenomenon at hand which ultimately manifests in a rich description of it.

3.4 Sampling

The method of sampling used in this study was purposive sampling which is in line with this study which is qualitative in nature. Cohen et al. (2011) concurs that sampling is a feature of a qualitative research approach. Purposive sampling according to Christiansen et al. (2010) is when a researcher makes specific choices about the inclusion of people to the sample. It involves the targeting of a particular group, which represents itself. The issue of the researcher making specific choices with regard to the people to include can be identified in the sample of this study where the participants in this study are three Life Sciences teachers from a school found in a Durban suburb which falls in the Pinetown educational district. The size of the sample is commented on by Hennink, Hutter, and Bailey (2011) who explain that a

small number of participants are required in qualitative studies, like this one, due to the fact that the very nature of qualitative study is concerned with the in depth exploration of issues which a small sample allows. The Life Sciences teachers were chosen purposively for this study as they are currently still working with the curriculum in terms of IKS and therefore are best positioned to engage with the aims of the study.

The three participants in the study are referred to as participant 1, participant 2 and participant 3. The participants were also chosen because they offer the necessary diversity of worldviews since they have varying qualifications and experience. The table below shows academic qualifications of the participants that were sampled for this study which is also complimented with a description of each participant. This serves to illustrate the diversity as stated above.

	Qualifications	Years of experience	Gender
Participant 1	• Diploma in Education • Bachelors Degree • ACE (Biology)	25 +	Female
Participant 2	• B. Paed. (Science) • B. Ed (Honours – Science) • M. Ed. (Science)	15	Female
Participant 3	• B. Ed. (Biological Science) • B. Ed. (Honours)	9	Female

Table 3.1 Profiles of participants of study

Participant 1, although not the most qualified in terms of academic qualifications which were obtained from a variety of institutions was the most experienced with regard to teaching the subject of Life Sciences as compared to the other two participants. This Life Sciences educator had extensive experience with the subject owing to the fact that she qualified in 1984 and had experienced first-hand the curriculum reform undertaken by this country. This

curriculum reform which involved a change to OBE post apartheid, name changes of subjects and the inclusion of new content to name but a few. Evidence of the inclusion of new content can be seen in the inclusion of topics such as Evolution and IKS. This experience that participant 1 possesses was of importance to this study as data generated from participant 1 was based on an extensive period of time which will in turn provide more depth and understanding of issues concerned with IKS thus added more value to the data generated.

Participant 2, was the most qualified in terms of academic qualifications and had the second most time with regard to experience in teaching Life Sciences. A point to mention is that participant 2 was the department head for Mathematics and Sciences at her school. Due to this fact she takes on other responsibilities in the day to day management of the school. These include managing staff within the department, grade controlling which involves spending time with ill disciplined learners and conducting parent interviews. The policy of the school is one which requires departmental heads to have less teaching loads and therefore this participant did not teach as many Life Sciences periods as the other two participants. This may provide an altogether different perspective related to issues around IKS.

Participant 3, was the youngest and the most recently qualified as compared to the other participants and therefore had the least experience but is qualified to teach Life Sciences. Her qualification background includes a B. Ed. Honours. However, this qualification was not in the specialisation of science. Her experience in teaching Life Sciences provides a different viewpoint from the other two participants.

According to Noor (2008) criticism of purposive sampling includes that it does not deal with issues of generalizability and has a lack of reliability. As pointed out earlier the findings of this study are not being generalised but rather the value of this study is accrued from it exploring a particular case where the participants involved are diverse. In terms of the lack of reliability, this concept is not applicable to this study since it does not measure but rather aims to describe meaning and personal experiences.

Employing purposive sampling for this study also involved the use of convenience sampling. Convenience sampling as the term suggests is concerned with a researcher choosing a sample

consisting of participants who are easy for him or her to reach. This point is warranted as I teach at the same school at which the research was conducted which ensured convenience owing to the participants' close proximity which enabled easy access to the participants. Added to this is the issue of having developed an excellent rapport with the participants stemming from having taught with each of them in the Mathematics and Science department for a varying number of years.

A weakness of convenience sampling according to Cohen et al. (2011) is that it does not deal with the issues of representative of the population by the participants. This weakness was overcome in this study by the fact that the participants involved in this study exhibit a range of diversity in terms on teaching experience and qualifications as outlined in their profiles, thereby representing the greater population of teachers as they too exhibit such diversity.

3.5 Data Generation Methods

Maree (2007) attributes the strength of a case study methodology to the use of multiple sources and techniques in the data gathering process. Being cognisant of this in terms of my study which was a case study of three teachers; three data generation methods were used in order to answer the research questions. The following methods were used to generate data a questionnaire, semi – structured interviews and the document analysis of lesson plans.

3.5.1 Questionnaire

Wilson and McLean (1994) define a questionnaire as a useful method for generating survey information which provides structured data and is able to be administered without the presence of the researcher. One could argue that the element of a questionnaire generating quantitative data is not in accordance with that of a study which involves an interpretive paradigm. Owing to the fact that in order to generate survey data one would incorporate close ended questions which is in direct conflict with the aims of an interpretive paradigm with regard to it being concerned with the generation of qualitative data. Involving open ended questions for textual data which if taken to a logical consequence would fulfil the concept of *fitness of purpose*. However, justification of the use of a questionnaire which incorporates closed ended questions is noted by Christiansen et al. (2010) who comment that a closed questionnaire may help gain insight into people's lived lives which this study aims to explore in terms of the participants' experiences.

In designing a questionnaire Christiansen et al. (2010) indicate that a researcher must ensure that the questionnaire generates the data which is needed to answer the research question it relates to and that it uses questions that are posed in the kind of language that the participants understand easily. In explaining how the data generated from the questionnaire would enable me to answer the research questions, a description of it in terms of the data it generates will be explored.

The questionnaire (Appendix 4) in this study was divided into three sections, namely Section A, Section B and Section C. The questionnaires were handed out to the participants who were informed that they could self-administer it in their spare time. This step of the questionnaire being self – administered was taken as it was envisaged that it would illicit honest responses due to the fact that I would not be present which could have made the participants feel threatened in some way by my presence. It being self – administered also complemented the concept of the use of convenience sampling as the questionnaire was convenient and could be completed in a short time without my presence.

Section A was concerned with the biographical information of the participants. This involved the participants' teaching experience of Life Sciences, their qualifications as well as their exposure to IKS. Including questions which were concerned with their exposure to IKS provided the necessary data about their experiences with IKS. For example, two questions in this section of the questionnaire enabled this. Firstly, one of the questions asked the participants if IKS was covered in their qualifications and another question asked if they personally or their school belong to any professional organisations or subscribe to magazines/journals that are related to the teaching of Life Sciences. Data generated from these types of questions informed the findings which relate to their experiences of IKS.

Sections B and C of the questionnaire were concerned with providing insight into the participants' understandings of the NOS and IKS respectively. It included these sections as a result of literature explored that their understandings of these two concepts which is based on their experiences in the teaching and learning of a science would inform their attitudes they held towards IKS which influences their classroom practice. The respective understandings of these concepts were explored by making use of firstly, the NOS statements which were informed by the consensus views held of the NOS (as adapted from Mc Comas, Clough, &

Almazroa, 1998). Secondly, for IKS, statements were informed by the assumptions underlying IKS (Ogunniyi, 2004). The format of these sections of the questionnaire involved making use of a Likert type scale to respond to statements related to the NOS and IKS. The scale included response categories, namely agree, disagree and uncertain. Likert scales are characteristic of quantitative studies, however this format was suitable for my study as it afforded me the opportunity to measure the participants' understanding of the NOS and IKS. According to Bell (2005) "scales are intended to help researchers discover strength of feeling or attitude," (2005, p. 167). The typical Likert scale as described in detail by Maree (2007) forces the participant to either agree or disagree with no possibility of being neutral. However, my design differs by allowing an 'uncertain' category on the scale, which encouraged honest responses. The nature of a Likert scale which involves participants giving closed-ended responses was appropriate for this study as they were quick to answer and therefore suitable for the school context as the educators involved were constrained by time. Data generated from sections B and C were concerned with me answering the research question which relates to the influence of the teachers' experiences of IKS on their classroom practice as sections B and C will reveal their understandings of the NOS and IKS which inform their attitudes. These attitudes which influence their classroom practice.

In an effort to ensure that questions were modelled in an accessible manner for the respondents, the activity of piloting the questionnaire took place prior to me handing the questionnaire to the participants. The questionnaire was piloted with other teachers in the Science and Mathematics department. Other Science and Mathematics teachers were chosen to pilot the questionnaire because they would be similar to the sample of the study in terms of their exposure to the type of language used in science.

3.5.2 Interviews

An interview is explained by Nieuwenhuis, (2007) as a two-way conversation, where the researcher asks the participants questions in order to learn about their ideas, beliefs, views, opinions and behaviours. According to Maree (2007, p. 87) it allows the researcher to "see the world through the eyes of the participants", which allowed me to explore and describe the participants' understandings that might be unique to them. This is in line with the purpose of an interview given by Christiansen et al. (2010) as being a method extensively used in interpretive research which this study is. It attempts to ascertain what a person thinks in terms of his/her attitudes based on their understandings.

In order to learn the above about participants, face-to-face/one-on-one interviews according to Leedy and Ormrod (2001) enabled the researcher to gain the participants' co-operation by establishing a relationship with them. Establishing such relationships allowed me to gain more data from the participants as they provided explanations of the concepts found in the curricular spider web which formed part of the conceptual framework of this study and their responses in the questionnaires regarding their understandings of IKS which informed my identification of their attitudes. Therefore, data generated from the interviews enhanced the data generated by the questionnaire. The participants providing data that were connected with the components found in the curricular spider web as these components, as already mentioned in the previous chapter, were utilised to explore Life Sciences teachers' experiences was done by them responding to open ended questions that were informed by the components. These open ended questions which are informed by the components of the curricular spider, will not only inform the findings of the study relevant to the question which was concerned with the teachers' experiences. As these components, inform the experiences of the teachers but also how these experiences influence their classroom practice. These questions are:

- Why were you teaching IKS?
- Towards which goals were you teaching IKS?
- What content were you teaching?
- Which activities were you using to teach IKS?
- What was your role as a teacher?
- What materials and resources do you use to teach IKS?
- How are learners grouped?
- Where do teach IKS?

- When do they teach IKS?
- How do they assess IKS?

The type of interview used for this study is a semi-structured interview. This type of interview afforded me the opportunity to structure some elements of my interview in a manner that relate to the components found in the curricular spider web. Even the predetermined order of the questions allowed for the discussion flow organically. This interview method was chosen because it allowed the participants to relax and respond to open ended questions which was facilitated by me asking probing and clarifying questions (Cohen et al., 2011). A semi-structured interview schedule (Appendix 6) was prepared to save time and most importantly to obtain additional clarity with regard to the data.

In terms of the probing strategy adopted during the interviews, I adopted probes as outlined by Maree (2007, p. 88) which included the *detailed-oriented probes* which assisted in understanding the "what" and "why" of the answers given by the participants. For example, a question such as, why were you teaching IKS? was followed by a sub question like, 'why did you think IKS has been included in the curriculum... do you think that IKS has added any value?'. The *elaboration probes* allowed me to obtain more details about certain questions. Lastly, the *clarification probes* were used to check my understanding of what was being said. I was able to pose probing questions as I had developed a good rapport with the participants which resulted in them not feeling threatened or intimidated by these probing questions. The freedom of the participants was also encouraged by the setting in which the interviews took place. All the interviews were conducted in the participants' classroom, which enabled them to relax. This helped them give insightful information. The responses were audio-recorded on a digital recording device and later transcribed for easy data analysis which is based on accurate recorded transcript that provide rich qualitative data. The recording was done only after consent was obtained from each participant. Two of the three participants had no objections to me recording their interviews. I documented in written form the responses to the questions posed during the interview of the one participant who objected to the recording of her interview. This issue of the one participant objecting to me audio - recorded is addressed later in this chapter where trustworthiness is explored.

3.5.3 Document Analysis

A sample of the participants' lesson plans (document) was analysed and used as a data generating resource because they provided insight into the participants' classroom practice. The analysis of lesson plans as a data generating method was used in order to identify the experiences and consistency/inconsistency between experiences which involve attitudes and classroom practice in terms of the curricular spider web of the participants.

The lesson plan analysis was informed by the components of the curricular spider web. The components included the following: the goals they were teaching towards, the content that was being taught, the learner activities used in teaching, the role as a teacher, the materials and resources used to teach, learner grouping, the location of teaching, the time of teaching IKS and the assessment of learning.

The template for the lesson plan that was issued to the participants followed a format not dissimilar to the format prescribed by the Department of Education (Appendix 5). The only changes made to the format of the template included the reconfiguration of it in terms of the layout design. The layout of the lesson plan was user - friendly as it allowed participants to mark with a tick certain relevant information. Examples of this can be found in the participants indicating with a tick which specific aims would be achieved and which resources would be used for the particular lesson. Space was provided for participants to add to the list of resources provided. This user - friendly nature of the lesson plan, it was hoped, would encourage the participants to fully engage with the various aspects contained in it. The lesson plan layout also included areas for the participants to provide textual data which illustrated their classroom practice in terms of their pedagogy. This allowed the participants to provide data that showed their individual styles which they used when teaching IKS as it was open ended and allowed them freedom to engage with the topic in their responses. For example, space was provided for the participants to state what teachers' and learners' activities would be done during the lesson.

.

	Research Question 1	Research Question 2
Why were data generated?	What are the teachers' experiences of IKS?	How do the teachers' experiences of IKS influence their classroom practice?
How were the data generated?	Questionnaire, Semi-structured interviews and document analysis (lesson plans)	Questionnaire, Semi-structured interviews and document analysis (lesson plans)
Who were the sources of data?	3 Life Sciences teachers from the same school	3 Life Sciences teachers from the same school
Where were the data generated?	At a high school in the Pinetown Education district	At a high school in the Pinetown Education district
How often were the data generated?	The participants were initially given a pack which included the questionnaire and the lesson plan. They were given two weeks to complete them. This was then followed by the semi – structured interview for each participant.	The participants were initially given a pack which included the questionnaire and the lesson plan. They were given two weeks to complete them. This was then followed by the semi – structured interview for each participant.
Reason for the plan used for data generated/generation?	The questionnaire afforded the participants an opportunity to explore their experiences in the absence of the researcher which allowed them the freedom to express themselves honestly	The questionnaire enabled the determination of understandings which influence/s attitudes.

	The semi – structured interviews and the lesson plans allowed for the researcher to obtain a detailed and in - depth description of the participants' experiences of IKS	The semi – structured interviews and lesson plans enabled the researcher to identify and understand the participants' experiences as they involved them giving in – depth description of their experiences which was used to understand them.

Table 3.2 How the generation of data was conducted.

3.6 Ethical Issues

According to Creswell (2009) certain ethical principles which include autonomy, non-malfeasance and beneficence need to be followed in all research studies. This is because research involves humans and therefore it is necessary to protect the rights of these individuals in order to ensure that no harm might be caused from their participation in the research.

As a point of departure to obtain ethical clearance that would allow me to conduct this study, the research proposal for the study was interrogated in the form of a defence interview. This defence of the research proposal involved me presenting it to a panel of lecturers. Subsequent to the defence and after consultation with my supervisor, corrections to the research proposal were made based on the feedback given by the panel. This process of making corrections helped to focus the study.

The research proposal was then submitted with an ethical clearance form to receive permission or ethical clearance from the university to conduct this research (see Appendix 1). Once the university ethical clearance was obtained, in the form of a certificate, permission was then sought in writing from the principal (see Appendix 2) of the school at which the research was to be conducted. A meeting appointment was made with this school principal where the research was explained and permission was given. This allowed the researcher to gain access to the Science and Mathematics department of the school. The next step which followed involved obtaining consent from the teachers at the school to participate in the study (see Appendix 3). According to Babbie (2007), anyone involved in research needs to be

aware of the general agreements about what is proper and improper (Babbie, 2007). Cohen et al. (2007, p. 52) explain that "informed consent is the procedure in which individuals choose whether to participate in an investigation after being informed of facts that would be likely to influence their decisions." Obtaining written consent from the participants involved having to explain and describe to them the purpose, the contents, the procedures, the reporting and dissemination of the study, the right to voluntary non – participation, withdrawal and re – joining the study, the right of the participants to anonymity (pseudonyms are used) and confidentiality, the right of the participants to ask questions about any aspect of the study and issuing them with a letter of consent which outlined the above to sign.

The participants were also informed about issues of confidentiality which would, among other things, ensure that all hard copies of the gathered data are stored in a locked cupboard and that passwords would be used to lock all the electronic copies of the data in order to prevent any other person from accessing the data for the next five years after which all the hard copies will be incinerated and all the electronic copies will be deleted.

3.7 Trustworthiness

Concepts such as Reliability and Validity are according to Christiansen et al (2010), concerned with measurement. Reliability is concerned with the extent to which a test or instrument can be repeated and still produce the same results. In terms of validity, Cohen et al. (2011) propose that validity is concerned with the researchers' instrument measuring what it claims to measure. Stemming from the fact that qualitative research like case studies do not measure but rather aim to describe meanings and personal experiences, terms such as reliability and validity are therefore not applicable for qualitative research. These terms are replaced by the term trustworthiness. According to Guba and Lincoln (1994), trustworthiness involves concepts such as credibility, transferability, dependability and conformability.

Trustworthiness in a qualitative study is attained by ensuring that there is intensive long – term involvement, rich data, respondent validation, intervention and triangulation (Cohen et al., 2011). According to Lincoln and Guba (1985), credibility is concerned with ensuring confidence in the truth of the findings. Techniques that are utilised in establishing the credibility of this study include prolonged engagement, triangulation and member checks (Lincoln & Guba, 1985). Prolonged engagement is described as the researcher spending

91

adequate time in the field in order to understand the social setting, the phenomenon of interest as well as developing relationships and rapport with members of a setting. Prolonged engagement was secured in this study as an extensive amount of time was spent understanding, through the review of literature, the phenomenon of this study which is the experiences of Life Sciences teachers of IKS. It was further secured from having taught with the participants for a number of years. This ensured that an understanding of the social setting and that a good rapport with the participants had been established. This good rapport with the participants ensured trust which was further enhanced by ensuring the anonymity of the participants. This led to open and honest discussion on the relevant issues that are concerned with their experiences of IKS. All this facilitated the construction of meaning. Prolonged engagement was also secured by the semi – structured interviews being recorded and transcribed. Repeating the recording several times in order to transcribe enabled important data not to be missed from the interview as it ensured that there was a prolonged engagement (long – term involvement) with the data in order to generate findings which are credible by providing sufficient evidence to back up interpretations.

Credibility was further enhanced in this study by the technique of triangulation which involves the use of multiple data generation methods (questionnaire, interviews and document analysis) in order to produce deeper understanding. In designing these multiple data generation methods, discussion took place with the supervisor of this study and consideration was given to the language used in them. The questionnaire was piloted which ensured it was appropriate for the targeted participants. It ensured trustworthiness by encouraging greater honesty and the privacy of completing it at the participants' leisure encouraged candid responses.

Lincoln and Guba (1985) describe member checks as being concerned with data being tested with those who have generated it. This technique in securing credibility provides an opportunity for the participants to correct errors and to volunteer additional information. Member checks were done with the aid of the transcriptions of the semi – structured interviews. The transcriptions were handed back to the participants in order for them to verify their responses (validation). In the case of the participant who did not want their interview recorded, the interview notes that were made during the interview were made available for the participant to check.

As mentioned before another concept involved in ensuring trustworthiness is transferability which, according to Lincoln and Guba (1985), is concerned with illustrating that the findings have applicability in other contexts. A technique utilised in securing transferability is thick description which is carried out by describing a phenomenon in sufficient detail where once done evaluation can take place in terms of the extent to which the findings are transferable to other contexts. Thick description in this study is that sufficient detail is manifest in the sufficient detail that is given with justification in terms of the literature reviewed, the conceptual framework adopted, the use of a case study, sampling, and the data generation and analysis methods. The exploration of the study in terms of supplying of a thick description does not only enhance trustworthiness with reference to transferability but also aids in the credibility of the study as thorough explanation enables the reader to have confidence in the findings.

Lincoln and Guba (1985) state that dependability refers to showing that findings are consistent and could be repeated. The detailed explanation with regard to the provision of a thick description as mentioned in the above paragraph will not only serve to secure trustworthiness with reference to transferability and credibility but also in terms of the dependability of the findings. Another technique that is used to enhance dependability of a study is that of external audits which is when a researcher not involved in the research process examines both the process and findings of a particular study in order to determine the accuracy of findings with regard to them being supported by the data generated. Such audits took place in the form of regular meetings with the supervisor of this study, who could be viewed as being not directly involved in the study. Where there was the engagement of the processes involved in the study. This engagement included the challenging of the processes and findings of the study which ultimately fostered accuracy of the study.

Conformability is concerned with the degree of neutrality to which the findings of the study are generated by the participants and not by researcher bias. External audits as described in the previous paragraph strengthened conformability as the supervisor of this study evaluated the processes and findings of the study for researcher bias. To further strengthen conformability, the technique of an audit trail was utilised. This involves a transparent description of the research steps of the study from the start to the reporting of the findings.

This is evident firstly, once again with reference to supplying a thick description and secondly, the explanation to the participants of the researcher role before data was generated. The issue of the questionnaire being designed to be self administered also eliminated researcher bias. When participants responded to it, it afforded them the opportunity to respond with no input which could have influenced them as researcher interests or motivation may have come to the fore during discussion regarding issues in the questionnaire.

3.8 Data Analysis

The *Collins Student's Dictionary* (2006) defines the term 'analysis' as the separation of a whole into parts for study or interpretation. This definition is pertinent because ultimately the researcher attempts to interpret in order to gain a greater understanding. Mc Millan and Schumacher (1993) further elaborate that the process of data analysis in a qualitative study is the integration of the operations of organising, analysing and interpreting the data. Data analysis occurs differently with quantitative data from how it is done with qualitative data. As this study generates qualitative data, data analysis of qualitative data is explored. The choice of the data analysis method for this study is in line with Cohen et al. (2011) description of qualitative data analysis as making sense of data, noting patterns, themes, categories and regularities. In terms of this study, guided analysis is used which involved the modification of themes and categories through the interaction with data Khoza (2013a).

Analysis which is involved with the inquiry of qualitative data can be guided or informed by two types of data analysis processes. These include the analysis of data using inductive and deductive reasoning as the reasoning processes to analyse data. According to Christiansen et al. (2010), most social research studies, which this is, incorporate both inductive and deductive reasoning processes where inductive reasoning is initiated by the generation of raw data. Once data have been generated, the researcher identifies patterns and categories that emerge from the data which by their very nature are open – ended and expository. This leads to the formulation of some tentative hypotheses that can be explored, which ultimately leads to the development of some general conclusions or theories. The themes found in the curricular spider web and other concepts which form part of the conceptual framework were used to organise the data generated into categories. This is in line with Gibbs (2007) who believes that the analysis of qualitative data is informed by pre – existing ideas and concepts

which the curricular spider web supplies. This supports the rationale for the use of guided analysis adopted for this study.

In terms of deductive reasoning the development of categories for organising data are based on theory relevant to the issue at hand. Deductive reasoning according to Christiansen et al. (2010), is often more theoretically informed and focused which makes it narrower in nature as opposed to inductive reasoning which is more open – ended. One of the elements of the conceptual framework is the teaching and learning theory of constructivism. This theory was used as a basis to inform the categorising of the data which were generated in order to explore the teachers' classroom practice.

In discussing the two types of reasoning processes used for this study, the relevant data will be included. The data generated from semi – structured interviews and the document analysis (lesson plans) will be analysed using inductive and deductive reasoning which brings the issue of how the questionnaire is analysed. Section A of the questionnaire explored the biographical information of the participants. Therefore, it was straightforward in stating their respective backgrounds in terms of their teaching experience of Life Sciences, their qualifications and their exposure to IKS both in the past and at present. The data generated from this section helped in informing participants of their respective experience in terms of IKS.

Sections B and C of the questionnaire explored the participants' understandings of NOS and IKS respectively using statements relevant to these two concepts. As previously stated, the format of these sections of the questionnaire involved making use of a Likert scale to respond to statements related to the NOS and IKS. The scale included response categories, namely *agree, disagree and uncertain*. Scores were used in analysing the participants' responses to the statements in order to ascertain their understandings of the two concepts explored in sections B and C. A response which demonstrated a good/adequate understanding of a statement relevant to a respective concept was given a score of '3' conversely, a response that demonstrated a poor understanding of a statement was given a score of '1'. For example, in section B which is concerned with the participants' understanding of NOS, *agree* is the correct answer to statement 1 (showing a clear understanding), therefore scores '3'. A response of *disagree* shows a poor understanding and thus scores '1'. Therefore, an overall

good understanding of the NOS would score highly, while a poor understanding would have a low score. A response which demonstrates uncertainty in relation to a respective concept was given a score of '2'. The same analysis procedure was adopted when analysing section C.

Obtaining the respective scores of the participants which ultimately allowed me to ascertain their understandings led me to ask another pertinent question that was related to their understanding. This question being concerned with what overall score of the participant reflects a good/adequate or poor understanding of the concept being explored. Naidoo (2008) in which thirty – eight teachers participated involved an analysis of a Value of the Nature of Science (VNOS) questionnaire. Scores obtained from the analysis process revealed that teachers that obtained over 60% were adequate in terms of their understanding of the NOS. The same percentage of 60% is therefore used in this study as a bench mark to ascertain the participants' understanding as being good/adequate or poor.

3.9 Study Limitations

In terms of the limitations of this study I acknowledge that it is a case study and as such, is limited to one school in the Pinetown District. The findings, however profound cannot be generalised to all Life Sciences educators. One could argue that another limitation of a case study involves that they are not easily open to cross-checking which leads to subjectivity and bias (Cohen et al., 2011). This was overcome by the techniques as described in securing the trustworthiness of the study. These techniques included an audit trail which encompassed thick description as well as triangulation where multiple data generating methods were used which involved the long intense analysis of them.

Another possible limitation of the study is concerned with the fact that one of my participants happens to be my senior at school. This fact could have a positive or negative influence on this participant's responses. Anonymity of the participants was ensured from the onset of the research, which enabled all participants, including this one, not to feel threatened by demonstrating their lack of understanding or being exposed to the wider public.

Time constraints due to extensive teaching loads, pressure to complete syllabi, marking, as well as department meetings influenced the time needed to administer the data generating

methods. An example of the result of the pressure the participants were faced with is that on stipulated days for the collection of questionnaires and lesson plans, participants had either forgotten to complete them or, in one instance, had misplaced their copies. Administering the data generating methods in quick succession would possibly have an adverse impact on the participants' responses which could lead to trustworthiness being compromised. Another limitation is concerned with one of the participants not being comfortable with the recording of the interview. To overcome this, the responses of all the participant were documented and these were made available to the participants to validate them.

3.10 Chapter Summary

This chapter presented in detail how this study will be conducted in order to answer the research questions. The research design selected and justification of it are discussed in terms of the research paradigm, the research approach, sampling, data generating methods, ethical issues, trustworthiness, data analysis and limitations where advantages are given in order to justify decisions. In the next chapter the findings of the study are presented which are based on the analysis of all the data collected through the data generating methods.

CHAPTER FOUR
RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

The previous chapter covered the research design and methodology applied in this study. Furthermore, in giving a detailed account of the data generating methods used, it also justified the choices made with regard to the research design. This chapter discusses the analysis of the data and the findings that emerged from this data. The data are presented, firstly by analysing the questionnaires. Secondly, the semi-structured interviews in conjunction with the document analysis (lesson plans) in order to answer the research questions relevant to these two data generating methods. The rationale for presenting data in a particular sequence is done in order to secure some logical sequencing in the flow of the chapter. However, where an opportunity presents itself in an attempt to enhance findings of that data generating method which is being analysed, the discussion related to the findings will also make mention of the findings from the other data generating methods in an attempt to secure triangulation. The data obtained from the semi-structured interview are presented in the form of verbatim quotations of the participants. The findings and discussions respond to the research objectives outlined in chapter one. The format of the chapter involves a brief introduction of what the data generation method, which is to be analysed, is envisaged to determine in terms of the research objectives.

4.2 Findings and Discussions

4.2.1 Analysis of questionnaires.

In analysing the questionnaire, the research objectives that pertaining to this data generating method need to be re-iterated in order to guide the analysis and discussion relevant to. The research objectives relevant to the questionnaire are:

- Explore teachers' experiences of IKS.
- Explore IKS teachers' experiences with reference to their classroom practice.

It is important to note that the questionnaire is used to determine the level of the three Life Sciences teachers' understanding of the NOS and IKS. The relevance of determining the level of the teachers' understanding of the NOS and IKS is pertinent to this study as literature

explored reveals that the understanding of a concept by a teacher has an impact on that particular teacher's attitude towards the concept which in turn influences their classroom practice.

The semi-structured interview will shed more light on the identification of teachers' experiences and the description of them as the analysis is presented component by component which forms the conceptual framework of this study.

As stated in the previous chapter that outlined the research design and methodology where there was a detailed description of the data generating methods, the questionnaire is comprised of three sections. Section A explores the biographical details of the participants which are described in the section which explained the sampling of this study. Section A also consists of questions which identify if the participants have had any prior experience in relation to IKS or if they, in any way, presently engage with IKS outside of the concepts which are included in the conceptual framework.

Question six of section A asked the participants if IKS was studied in their qualifications. All three of the Life Sciences teachers indicated that IKS was covered in their studies. This suggests that the three Life Sciences teachers should be familiar with various issues surrounding the concept of IKS as they have some experience with the concept. Such issues may be defining IKS.

Question seven of section A asked the participants if there were regular meetings/workshops for Life Sciences conducted by the Department of Education for all grades (10 – 12) in the F.E.T phase. All three of the Life Sciences teachers indicated that there are regular meetings/workshops conducted by the Department of Education for Life Sciences. This is an important point as it suggests that professional development within the subject is taking place. The topics covered at these meeting/workshops will be explored in the analysis of the semi – structured interviews.

Question nine of section A further asked the participants if they or their school belong to any professional organisations or subscribe to magazines/journals related to the teaching of Life Sciences. Participants 1 and 3 indicated that they and their school do not belong to any

professional organisations or subscribe to magazines/journals related to the teaching of Life Sciences. Participant 2 indicated that she does. This suggests that participant 2 could be more informed with issues relevant to the subject of Life Sciences and teaching of it which could include the concepts of the NOS and IKS as literature has concluded that a recent trend of research in Science teacher education has been on the NOS as well as IKS. Issues relevant to NOS and IKS may be discussed in publications that are related to professional organisations as well as in professional magazines/journals.

The above findings are in line with Naidoo (2010) who found that a variety of sources or experiences which include university modules, informed teachers' understanding of IKS and that the different approaches used by teachers in the classroom were informed by individual teachers' experiences. Departmental meetings, professional organisations and magazines/journals can be viewed as sources which also inform not only IKS but also NOS.

Sections B and C of the questionnaire are concerned with providing insight into the participants' understandings of the NOS and IKS respectively as literature has shown that teacher understanding of NOS and IKS informs their attitudes which influences their classroom practice. Deductive reasoning was used to analyse data generated by sections B and C where according to Babbie (2007), deductive reasoning is concerned with a researcher deducing a result with the use of a general theoretical understanding. The general theoretical understandings for both NOS and IKS were informed by the statements relevant to each concept which were used to deduce a result which indicated the level of the three Life Sciences teachers' understanding of the NOS and IKS. As previously stated, a Likert-type scale was used to determine the participants' level of understanding of the NOS and IKS. The participants' responses were scored according to response categories, namely *agree, disagree and uncertain*. A response which demonstrated a good/adequate understanding of a statement relevant to a respective concept was given a score of '3' conversely a response that demonstrated a poor understanding of a statement was given a score of '1'. A good/adequate understanding of the respective concept will score highly, while a poor understanding would have a low score.

Their NOS understanding is explored in section B by making use of the NOS statements which were informed by the consensus views held of the NOS (as adapted from Mc Comas,

Clough, & Almazroa, 1998). The teachers' responses were recorded in Table 4.1. For convenience, the participant number when responding to a particular statement is indicated in **bold italics** at the top of the relevant block while the score given to the statement response is located at the bottom of the same block.

Table 4.1. Responses to statements related to the Nature of Science

NO.	STATEMENTS	A	UN	DA
1.	Scientific knowledge while durable, has a tentative character.	*1,2* 3	2	*3* 1
2.	Scientific knowledge relies heavily on observation, experimental evidence, rational arguments, and skepticism.	*1,3* 3	2	*2* 1
3.	There is no one way to do science.	*1,2* 3	2	*3* 1
4.	Science is an attempt to explain natural phenomena.	*1,2,3* 3	2	1
5.	People from all cultures contribute to science.	*1,2,3* 3	2	1
6.	New knowledge must be reported clearly and openly.	*1,2,3* 3	2	1
7.	Scientists are creative.	*1,2,3* 3	2	1
8.	Science has both an evolutionary and revolutionary character.	*1,2,3* 3	2	1
9.	Science is part of social and cultural traditions.	*1,2,3* 3	2	1
10.	Science and technology impact each other.	*1,2,3* 3	2	1

The participants' level of understanding of the NOS was determined by totaling the scores obtained for each category of the Likert scale. As each category has a high score of 3 the total for all the categories is 30 due to the fact that there are 10 categories. Once the total was determined, it was converted to a percentage. The results for each participant are as follows:

Participant 1: 30/30 = 100%

Participant 2: 28/30 = 93%

Participant 3: 26/30 = 87%

The percentages obtained served to inform the level of the teachers' understanding of the NOS. Participant 1 who obtained the highest score therefore had the best understanding of the NOS in relation to the other participants. Participant 2 who obtained the second highest score had the second best understanding followed by participant 3 who obtained the lowest score. In determining if the participants' level of understandings of the NOS are adequate an exploration of a study conducted by Naidoo (2008) needs to take place, in which there was an analysis of a Value on the Nature of Science (VNOS) questionnaire. Through the scoring process it was determined that teachers who achieved above 60% had an adequate understanding of the NOS. In this study the participants' understandings of the NOS could be viewed as being above adequate as their scores are far above 60%. This is of particularly importance to this study as it reveals the level of teachers' understanding which informs their classroom practice. Shulman (1986) and Brickhouse (1990) argue that teacher understanding of the subject matter (which includes the NOS) significantly influences their classroom practice. Furthermore, de Souza Barros and Elia (1998) concur that a lack of understanding leads to a lack of confidence about subject content which results in a negative attitude towards the subject which would lead to it affecting the learning process negatively. The above adequate understanding therefore suggests that these teachers have positive attitudes towards the subject of Life Sciences in terms of the NOS. Bell (2005) pointed out that the purpose of scales is to help researchers discover an attitude. This finding has relevance to this study as one of the questions of it is concerned with how do the teachers' experiences informed by understandings) which inform attitudes towards IKS influences their classroom practice which the NOS is included. Further analysis of the scores was done by calculating the overall level of understanding of the NOS of the participants in the study by calculating the average of the scores obtained. The average of the participants is 93%. This suggests that the overall understanding of the participants was above adequate. It is interesting to note that participant 1 had the most teaching experience in relation to the other two participants. This could be the reason for her high score which could be a result of many years of professional development. On the other hand, participant 3, who had the lowest score when compared to the other participants had the least amount of teaching experience which is discussed by

participant 3 in the semi – structured interview in response to a question which asked which issues are discussed when attending departmental meeting/workshops. Participant 3 responded *"I have only been to a few as I have been only teaching Life Sciences for a few years".*

A deeper analysis of the participants' responses is carried out to illustrate where there is a lack of understanding of NOS. This can be found in the responses of participant 2 and participant 3. Participant 2 believes that scientific knowledge does not rely heavily on observation, experimental evidence, rational arguments and skepticism. This belief is of interest as it may influence her teaching of the subject of Life Sciences as it is laden with practical work where demonstrations are conducted in order for learners to observe scientific phenomena which suggests a reliance on observations. Participant 3 believes that scientific knowledge is not tentative in nature. This suggests that she believes that scientific knowledge is static and therefore cannot be changed or adjusted. This is in contradiction to her response to the statement concerning scientific knowledge relying heavily on observations, as new observations may provide evidence which would change or adjust scientific knowledge. Participant 3 also believes that there is only one way to do science. This suggests that scientists do not have the freedom to be creative. Here in lies a contradiction as she believes that scientists are creative. This contradiction in terms of her responses could have an influence on how she teaches as she might have some confusion in terms of being pulled between being creative and being set in one way which could be suggested by the intended curriculum which is deeply prescriptive in terms of sequencing, organizing and pacing.

It is worth mentioning in terms of relevance to this study that all three Life Sciences teachers believe that science is part of social and cultural traditions. This suggests that they possess an appreciation that firstly, in terms of their classroom practice a social constructivist learning theory could be used on their part in the teaching of Life Sciences due to the social nature of science and secondly, the cultural element which informs various forms of IKS.

A finding thus far supported by the results obtained from Table 4.1 is that all three of the participants of this study exhibit an above adequate understanding of the NOS as they all scored high above 60% and that participant 1 has the best understanding of the NOS, followed by participant 2 and then participant 3. A further finding is that participant 2 and

participant 3 show some inconsistencies with some of their responses as in some instances their responses were found to be contradicting other responses. For example, they might respond correctly for one statement but a subsequent answer demonstrates some misconceptions.

The participants' understandings of IKS were explored in section C by making use of assumptions underlying IKS (Ogunniyi, 2004). The teachers' responses are recorded in Table 4.2. For convenience, the participant number when responding to a particular statement is indicated in **bold italics** at the top of the relevant block while the score given to the statement response is located at the bottom of the same block.

Table 4.2. Responses to assumptions underlying IKS

NO.	STATEMENTS	A	UN	DA
1.	Nature is real, and partly observable and testable.	*1,2* 3	 2	*3* 1
2.	Time is real, continuous and cyclical.	*1,2,3* 3	 2	 1
3.	All events have only natural causes.	 1	 2	*1,2,3* 3
4.	The universe is orderly, metaphysical (abstract), partly predictable and partly unpredictable.	*1,2* 3	*3* 2	 1
5.	Indigenous generalizations have causal, personal, rational/non – rational, logical/non – logical dimensions.	*2* 3	*1,3* 2	 1
6.	Language is important as a creative force in the workings of both the natural and the unnatural worlds.	*2,3* 3	*1* 2	 1
7.	Indigenous knowledge is culture free.	 1	 2	*1,2,3* 3
8.	Indigenous knowledge is concerned with 'what', 'what ought to be' and 'why'.	*2* 3	*1,3* 2	 1
9.	Humans are capable of understanding only part of nature.	*1,3* 3	 2	*2* 1

10.	Indigenous knowledge systems only involve traditional healing.			*1,2,3*
		1	2	3
11.	Indigenous knowledge is constant and does not change over time.			*1,2,3*
		1	2	3
12.	Indigenous knowledge is well documented.		*1,3*	*2*
		1	2	3

The participants' level of understanding of IKS was determined by totaling the scores obtained for each category of the Likert scale. As each category has a high score of 3 the total for all the categories is 36 due to the fact that there are 12 categories. Once the total was determined it was converted to a percentage. The results for each participant are as follows:

Participant 1: 32/36 = 89%
Participant 2: 34/36 = 94%
Participant 3: 29/36 = 81%

The percentages obtained serve to inform the level of the teachers' understanding of the IKS. Participant 2 who obtained the highest score therefore had the best understanding of the IKS in relation to the other participants. Participant 1 who obtained the second highest score had the second best understanding followed by participant 3 who obtained the lowest score. The analysis of scores obtained in Section B in order to ascertain teacher understandings of the NOS is used in ascertaining teacher understandings of IKS. In this study the participants' understandings of the IKS could be viewed as above adequate as their scores are far above 60%. This is of particular importance to the study as one of the questions attempts to determine how the teachers' experiences (informed by understandings) which inform attitudes towards IKS influences their classroom practice, where already explored attitudes are influenced by the understanding of a concept. One can conclude that due to the participants in this study having an above adequate level of understanding of IKS they, will possess a positive attitude towards it. Evidence of the level of teachers' understanding IKS informing attitudes and therefore classroom practice can be seen in the work of Dziva et al. (2011) who found that the participants exhibited a limited conception of IKS where it emerged that they held views on IKS which suggested a negative attitude towards IKS, which

may have been the result of their limited conception of IKS, commented on de Souza Barros and Elia (1998). Another finding of the study which is relevant to this study as it is concerned with the classroom practice of the teachers was found in the teachers' schemes of work which revealed that the teachers did not use teaching methods inherent in IKS which include, folk stories, riddles, music and song. Evidence of the teachers not using teaching methods inherent in IKS can be seen in the fact that their schemes of work provided evidence that all learning was taking place indoors rather than outdoors. This classroom practice could be seen as a result of teachers possessing a limited conception of IKS which develops a negative attitude towards it and therefore influences their classroom practice.

Further analysis of the scores was done by calculating the overall level of understanding of IKS of the participants in the study by calculating the average of the scores obtained. The average of the participants is 88%. This suggests that the overall understanding of the participants was above adequate. Comparing the participants' overall understandings of the NOS and IKS, it was found that the participants of this study have a greater level of understanding of the NOS as compared to IKS. A possible reason for this could be that research into the NOS of science has a greater history than IKS and therefore the participants might be more comfortable with the concept of NOS as their exposure to it has been more intensive in terms of having been exposed to it for a greater amount of time. It is interesting to note that participant 2 who scored the highest in her understanding of IKS has the highest and most recent qualification in Science education in relation to the other two participants which suggests that her high score is informed by her experiences of IKS as in recent times much research into the topic of IKS from a Science perspective has taken place. Such research could have been explored in her qualifications. This point of participant 2 exhibiting a high level of understanding of IKS which may be the result of the concept being explored in her qualifications draws in the work of Ogunniyi (2004, 2007) who found that participating in particular educational modules enabled participants to undergo a paradigm shift of their attitudes which was informed by a greater understanding of the concept. This paradigm shifts in their attitudes influenced them in making changes in their classroom practice where data generated provided evidence that participants' classroom practice changed after such educational modules.

As suggested, the participants of this study possed a positive attitude towards IKS which was a result of their above adequate understanding of it. It is important that a deeper analysis of the teachers' understandings of IKS which inform their attitudes should take place as one of the questions of the study is concerned with how their experiences influence their classroom practice of which attitudes are a component of. The teachers' attitudes towards IKS have been identified, so a description of their understandings is done with a view to understanding this positive attitude. The description of their understandings utilises aspects that are concerned with IKS which were explored in the literature review.

All three participants showed their above adequate understandings of IKS in common areas. Strengths in their understandings can be seen in areas which included that IKS is not culture free. This is in line with Battiste and Henderson (2000) who commented on IKS being part of a particular clan, band or community which suggests a culture. This point was re iterated by participants 1 and 3 when asked in the semi – structured interview of their understanding of IKS. Participant 1 responded that *"IKS is knowledge that a particular culture, ethnic group or society possesses..."* and participant 3 responded that *"IKS is knowledge that is passed from or through a specific culture...".* Examples of it imbedded in culture can be seen in the way various cultures store maize (Prasad, 2009). Other examples which illustrated strengths are that IKS does not only involve traditional healing but it also has a dynamic quality. Onwu and Mosimege (2004) identified that it is a common belief that IKS only involves traditional healing which is actually a misconception as this belief illustrates their lack of understanding of the term 'system'. This suggests that the participants in believing that IKS incorporates more than traditional healing understand the term 'system'. Their belief of it being dynamic resonates with a part of a definition of IKS supplied by *Indigenous Knowledge and Development Monitor* (as cited in Hagar, 2003) which speaks of it as being knowledge in a constant adjustment which is influenced by changing circumstances and environmental conditions. Participants 3 responds in the semi – structured interview that *"it is not static; it is constantly changing...".*

Differences in their responses did occur. These differences can be used to highlight shortcomings and strengths in their respective understandings. One such difference which highlights shortcomings in their understandings was evident in the following instance: Participant 2 illustrated her strength in understanding by responding that she believed that

indigenous knowledge is not well documented while participants 1 and 3 were unsure about this statement. Participant 2's belief is in line with the concept of *agrapha* explored by Maurial (1999). The concept of *agrapha* involves the view that indigenous knowledge is not written down which suggests that in fact it is not well documented. It is rather transmitted from one generation to the next through indigenous peoples' mythical narrations in some instances which is in keeping with the complex oral traditions which prevail in indigenous peoples' culture. This issue of IKS being transmitted from one generation to the next through narrations can be identified in the responses of participants 1 and 3 obtained from the semi – structured interviews. Participant 1 responded that *"it has been passed down orally from generation to generation..."*. Participant 3 responded that *"more of an oral culture where it is passed through storytelling, through methods of perhaps showing how things were done in the culture..."*.

Shortcomings in the participants' understandings can be used to inform the view that there are complexities inherent in defining IKS. In looking at the results of participants 1 and 3 it is apparent that even though they achieved an above adequate result, they did experience some difficulty in defining IKS. Evidence of this can be seen in that they both responded with an uncertain response to four of the twelve statements. This point speaks to difficulties experienced by teachers in defining IKS as found by Dziva et al. (2011).

4.2.2 Analysis of semi – structured interviews and document analysis.
The following section analyses data generated from the semi-structured interviews and where applicable, the document analysis (lesson plans) in order to establish findings relevant to the research objectives of this study. These research objectives are to:

- Explore teachers' experiences of IKS.
- Explore IKS teachers' experiences with reference to their classroom practice.

Findings of the questionnaire are also discussed in an effort to enhance findings of the analysis of the semi – structured interviews and the document analysis in order to secure triangulation. The data generated is presented by making use of the components of the curricular spider web which inform the conceptual framework of this study. Data presentation further involves firstly, the question which was posed relevant to the components found in the

curricular spider web and secondly, the responses of the participants are done with verbatim quotations of the participants which are used to initiate discussion around the findings. As the curricular spider web is used as the conceptual framework which informs the teacher experiences, the following table shows the components and categories of experiences which became apparent from the data generated. An attempt is made to discuss each component in the order which is found in Table 2.3 in the literature review. However, in one instance the order does not follow as in the case of learning activities being discussed before teacher role. This is done as the findings concerned with teacher role lead on from learning activities.

Component	Question	Categories
1. Vision	Why are you teaching IKS?	Personal reasons (pedagogical) Societal reasons (beneficial) Professional reasons (content)
2. Goals	Towards which goals are you teaching IKS?	Objectives
3. Content	What content are you teaching in IKS?	Traditional technology: traditional medicines and healers, beer, wine and cheese. Loss of Biodiversity Indigenous knowledge systems and sustainable use of the environment
4. Materials and Resources	What materials and resources are used when teaching IKS?	Hard – ware resources Soft – ware resources Ideological – ware resources
5. Location	Where are you teaching IKS?	Inside the classroom
6. Learning activities	What activities are you	Learner centred

	using to teach IKS?	Teacher centred Inquiry based
7. Teacher role	What is your role in teaching IKS?	Facilitator Interpreter Leader Manager Assessor Specialist
8. Assessment	How do you assess IKS?	Formative Assessment Summative Assessment
9. Time	When do you teach IKS?	Hours Weeks Amount
10. Grouping/Accessibility	With whom are you teaching with?/ Who are you teaching?	Other teachers Physical Financial Cultural

Table 4.3 Components, questions and teachers' experiences categories guided by the curricular spider web.

4.2.2.1 Component 1: Vision

Why are you teaching IKS?

The reasons given by the teachers are represented in two categories. These categories are personal (pedagogical) and societal (beneficial). Although the professional (content) reason is found in the table above it is not commented on in this discussion on vision as it only became apparent as a vision while exploring findings concerned with the component of content. Below are the responses of the teachers during the data generation process to the above question which provides evidence of these categories identified.

Participant 1 *"IKS can help individuals in rural communities to improve their quality of life. They could also make use of ethnic medication since they have a lack of medical facilities. It*

helps us to learn to use our natural resources in a sustainable way so they can be preserved for future generations...".

Participant 2 *"Learners prior knowledge is important for future learning and a learners' prior knowledge generally comes from home. So to build on future learning I think it's important to take into account what the learner already knows… it makes learning science more meaningful...".*

Participant 3 *"Lots of the content that we teach to learners is above their heads and are difficult for them to conceptualise but if you bring their knowledge and their understanding that they have in their culture of certain concepts, it makes it easier for them to grasp something that you are trying to teach them. Also we have to get over the idea of children being empty vessels and us filling them with knowledge and so they have their own knowledge that they bring to the table as well...".*

Participant 1's response suggests that her reason for teaching IKS is in line with the societal vision (Schiro, 2013) of teaching and learning where the needs of society are at the centre. This is evident in her speaking of IKS helping rural communities to improve their quality of life. This issue of IKS improving the quality of life is in alignment with the WorldBank (1998) which views IKS as being part of the strategies which local communities implement in order to obtain development, where IKS is a fundamental part of the lives of the poor and is further explained by Semali and Kincheloe (1999) as having transformative power.

IKS enables individuals in making responsible decisions regarding the sustainable use of natural resources which the societal vision encompasses as it is also concerned with producing individuals who are mature and contributing members of society. This in line with Emeagwali (2003) who views IKS as enabling sustainable development and environmental responsibility. This point of their vision for teaching IKS being societal is re enforced by the basis on which the curriculum has been developed, as it is based on the values of the Constitution of South Africa where in the preamble of the Constitution which includes its aims states that it aims to "heal the divisions of the past and improve the quality of life of all citizens" (DoE, 2011, p. 1). These aims of the Constitution on which the curriculum is based, is definitely in line with a societal vision which the teachers possess. This identification of the

participants having a societal vision could be in accordance with Khoza (2015a) who found that teachers' visions are strongly aligned with the visions of the intended curriculum which are found in the policy document.

The responses of participants 2 and 3 suggest that IKS can be utilised in a pedagogical sense (personal) as both mention the importance of using the learners' prior knowledge in the teaching and learning process. In a way these responses are aligned with the societal vision, as well, as learning in societal vision is attributed to learners' competencies in the form of learners' prior knowledge being drawn upon. In terms of a pedagogical sense (personal) Jegede and Aikenhead (1999) view the inclusion of indigenous knowledge in the teaching of science as being in line with a social constructivist learning theory, which places importance on the role of prior knowledge or indigenous knowledge in the construction of meaning in a new situation. IKS as prior knowledge serves as a vehicle to promote learning through it motivating children due to the fact that they start to see acknowledgement being given to what they do and say in their communities (George ,1999).

In an effort to further ascertain the participants' attitudes towards IKS which was initially done from the data generated from the questionnaires, I asked the participants if they thought IKS should be included in the Life Sciences curriculum.

Participant 1 *"To a certain degree. It could help learners understand why our natural resources need to be used in a sustainable way. They could learn to appreciate nature and try to preserve it and in so doing prevent the further extinction of species...".*

Participant 2 *"Yes, I think it should be as it places western science into perspective so western science is not taught in isolation... it could add value to western science...".*

Participant 3 *"Yes, I do think it should be allowed as learners knowledge has value to them, it also has value within the science curriculum. So by including it in the Life Sciences curriculum they can see how their knowledge is important in the way science functions or works...".*

The three participants are of the view that IKS should be included in the science curriculum. This is evident in the responses of participants 2 and 3 who speak of IKS adding value to the science curriculum while participant 1 in agreeing with the inclusion of IKS is of the opinion that it could aid learners understand the need for individuals to sustainably use our natural resources. Agreeing with the idea of the inclusion of IKS on the above bases leads one to further identify that the participants of this study have a positive attitude towards IKS.

This positive attitude of the teachers of IKS could also be utilised to re enforce the identification of a personal reason for teaching Life Sciences which involves IKS as content. Kilinc and Mahiroglu (2009) identified that teachers chose Biology (Life Sciences) to teach as a result of them having an enjoyable experience with the subject at school which fosters a positive attitude. The point of teachers' having an enjoyable experience with a subject which influences their choice to teach that subject is in line with the personal vision as one of the characteristics of this vision is concerned with school being viewed as an enjoyable place. This suggests that informed by their positive attitudes, the participants' experiences in relation to their own schooling was one that they enjoyed.

4.2.2.2 Component 2: Goals

Towards which goals are you teaching IKS?
Participant 1 *"Specific aim 3 which deals with application..."*

Participant 2 *"Lends itself to specific aim 3 in the CAPS curriculum..."*

Participant 3 *"Links up with specific aim 3 which is the development of the science concepts through ideas through different cultures and its influence on the way that science has developed through time...".*

All three participants responded with a short response of specific aim 3 which suggests that the policy document is of importance to them as on a cursory read of the specific aim 3 makes it apparent that it does encompass IKS. This identification is also done in the lesson plans of the participants. By not expanding on the aim identified in terms of content, activities and assessment suggest that the participants' understanding of goals to be achieved

is superficial or limited. This suggested superficial understanding of goals is illustrated by the participants not mentioning this specific aim in terms of it being an objective. There is also no mention of broad general aims of the curriculum as well more specific than objectives, outcomes. Stating the specific aim suggests that they view this as a general aim which is cause for concern as, in order to achieve a general aim, more specific goals need to be achieved which are not even referred to like objectives and outcomes. Objectives are short term teaching intentions which the teacher intends to cover in a particular area and an outcome is what learners should achieve at the end of a lesson. Being aware of this, in order for a learner to achieve the general aim he or she would need to firstly achieve an outcome and then secondly, an objective. This lack of understanding of goals which could be superficial and limited is in line with Khoza (2015a) who discovered that teachers did not understand the difference between aims and objectives.

The identification of the participants' lack of understanding of issues around goals to be achieved is of importance in terms of the implementation and sustainability of a curriculum being successful Van den Akker et al. (2009) explain that each concept which make up the curricular spider web which is flexible yet vulnerable needs equal attention in order for the successful implementation of a curriculum to occur. The finding thus suggests that the implementation of the Life Sciences curriculum will suffer as a result of the participants' lack of understanding of goals.

The implementation of the curriculum can be further discussed in terms of the different forms of curriculum identified by Van den Akker et al. (2009). These are the intended, the implemented and the attained curriculum. The intended curriculum has been stated in the policy document in the form of the exploration of the goals to be achieved. The implemented and attained curriculums are where the problem lies when considering the participants of this case study. Identifying that the participants have a lack of understanding of goals suggests that they will experience difficulty in interpreting the intended curriculum in order to implement it which would have a ripple effect on the attained curriculum where the attainment of learning outcomes is used as a measurement to determine the learning experiences perceived by learners.

4.2.2.3 Component 3: Content

What content are you teaching?

Participant 1 *"All topics listed in the curriculum are taught as stipulated..."*

Participant 2 *"Diseases, especially the treatment part of the diseases. I think IKS lends itself quite nicely to that. Cellular Respiration, Microbes even the teaching of evolution...".*

Participant 3 *"We tend mostly to focus on the science content and that IKS is usually taught as an add-on. For example, looking at bacteria, we look at the structure etc. and look very briefly at how bacteria are used in society and one of the things that we can talk about is the making of traditional beer...".*

The responses of the three participants suggest that indeed a performance approach to curriculum is being implemented in South Africa. The responses of participant 1 and participant 2 suggest that the policy document which contains the intended curriculum is followed in terms of identifying the content to be taught in relation to IKS as participant 1 speaks of all the topics listed in the curriculum including Microbes which involve the topic of Cellular Respiration that is mentioned by participant 2 which is stated in the policy document. These two participants following the policy document suggests that the content which is stated to be covered is envisaged to meet the needs of society as it has been decided to be covered by policy makers where the content is to be used as a vehicle to secure the aims of the Constitution where the transformative power of IKS in terms of healing the divides of the past and improving the quality of life is acknowledged. The reliance on the policy document by the teacher manifests in the teachers having control over the selection, the sequencing and pacing of the content which is in line with the characteristics of a performance approach of curriculum which also involves the identification that there is vertical knowledge (Bernstein, 1999) where the complexity increases through the levels. The identification of a performance approach to curriculum being implemented through the teachers' responses to the question around the component of content can be used to comment on the earlier component of vision which has been explored. Although in their responses to the question around vision they did not illustrate a professional vision for teaching IKS. From the identification of a performance approach a professional vision can also be identified in

terms of a vision as their responses to the component of content imply it. Due to the fact that a professional vision the content is hierarchical in nature which a performance approach to curriculum advocates.

Participant 3 speaks of traditional technology of IKS in terms of only the uses of IKS in society such as traditional medicines and healers, beer, wine and cheese which also implies exposing individuals to knowledge which would improve their lives. A suggestion by participant 3 only refers to the uses that there is a greater emphasis on the science content which could be seen as western knowledge that is found within the policy document which also contributes in defining the curriculum being implemented as a performance one. In this approach to curriculum there is a greater emphasis on school knowledge (western/scientific knowledge). Evidence of this is seen in that IKS is viewed as an add-on by participant 3. A possible reason for this view may be that according to Durie (2004) there is a belief that western knowledge is superior to indigenous knowledge. Maurial (1999) in commenting on this inferior status of IKS in relation to western knowledge terms it as 'subjugated knowledge'. This view of IKS being seen as an add-on through the perpetuation of it being inferior knowledge is a consequence of the type of curriculum which is implemented in South Africa. As mentioned before, the curriculum implemented in South Africa is deeply rooted in the performance approach to curriculum where there is a focus on formal school knowledge as opposed to everyday knowledge and experiences (Hoadley & Jansen, 2009).

4.2.2.4 Component 4: Materials and Resources

What materials and resources are used when teaching IKS?
Participant 1 *"In most instances examples of specimens are used by showing pictures since actual specimens are not available...".*

Participant 2 *"I keep it simple using pictures from textbooks or magazines which I enlarge so I can project on a OHP as not all our learners have textbooks... as well as the learners as they bring into the classroom their ideas and experiences which I also learn from...".*

Participant 3 *"I use videos which expose the learners that haven't had experience of that particular knowledge system... also the learners as a resource in the class where the learners*

are asked to bring their knowledge and understanding if they have experience with that particular IKS in their life...".

The responses of the participants suggest that a combination of materials and resources is used. These are hard-ware, soft-ware as well as ideological ware. Hard-ware in terms of white screens for the OHP, soft-ware in terms of transparencies and ideological ware in terms of the learning theory which they implement. Enhancing this finding with regard to the hard-ware and soft-ware used is the data generated from the analysis of the lesson plans. Materials and resources stated include videos, computers, DVD's and the chalkboard. The ideological-ware can be identified in the implementation of the constructivist learning theory as participants 2 and 3 make mention of the learners being a resource. This is in line with the constructivist learning theory involving prior knowledge.

Both participants 1 and 2 imply the lack of availability of resources evidence of this is them making mention of the fact that actual specimens are not available and that not all learners have textbooks respectively. This claim was enhanced by Participant 2 in a response concerned with learning activities where she commented on the lack of furniture which facilitates group work. In discussing resources Rao (2010) and Arulsamy (2010) speak of the availability of them being imperative to the implementation of a subject found within a school curriculum. This lack of resources as Mudulia (2012) found impacts on the achievement of the learners where a lack of resources was found to be evident in low performing schools.

The relationship between the lack of resources and low performance can be seen in the statistics concerned with learner performance relevant to Life Sciences at this school. Statistics as recent as September 2014 obtained from the school's head of statistics indicate a low learner performance as in grades 10 and 11 fifty-two percent of learners achieved below forty percent where forty percent is regarded as a first rate pass as opposed to thirty percent. This low performance could be attributed to the lack of resources (F. Kirsten, personal communication, May 17, 2015).

Discussing materials and resources leads to the component of **location (component 5)** which is found in the conceptual framework of this study. This component is concerned with the

question of '**where are you teaching IKS**?' From the data generated from the question that pertains to the materials and resources used by the participants and the analysis of their lesson plans, it is evident that they use normal classrooms. In fact, participant 2 further enhanced the finding of the lack of resources by mentioning that her classroom does not even have running water. The location of where teaching is taking place can be viewed as a hard-ware resource as it can also be viewed as a tool which aids learning to happen (Criticos, Long, Moletsane, & Mthiyane, 2005). A logical progression of this discussion involves the influence that the location has on learning. As an initial point of discussion in terms of the influence that the location has with reference to IKS, Michie (1999) writes that outdoor learning rather than indoor is more conducive for the transmission of IKS as it is an environment which has no artificial boundaries. Therefore, the participants' location of a classroom could be viewed as a hindrance to the learning of IKS.

A further point of discussion around the influence of the location on the learning can be seen in the layout of the location. Marx et al. (1999) observed that different seating arrangement influences the learning experience in terms of classroom interactions and learner engagement with the teacher. It was found that a semi - circle formation encouraged learners to ask more questions as opposed to the traditional seating arrangement where the majority of questions were asked from the learners sitting in the front and centre. As the semi-structured interviews were conducted in the all three participants' classrooms. From observing all three participants' classroom arrangements as being traditional in their layout suggests that classroom interactions and learner engagement through learners asking questions which are used in classroom discussions are not encouraged. This finding of the arrangement of the classroom not encouraging discussion is of importance to another finding to be discussed, which identifies that the participants attempt to implement a constructivist learning theory which encourages discussion around learners' experiences. Therefore, the arrangement of the classroom could be viewed to be in conflict with the implemented learning theory adopted by the participants.

4.2.2.5 Component 6: Learning Activities

What activities are you using to teach IKS?

Participant 1 "*A discussion takes place during the lesson where learners are allowed to voice their experiences. All comments are acknowledged by the teacher and learners are encouraged to share with others in their class...*".

Participant 2 "*I initiate the discussion by asking a few leading questions...which gives me their input of how certain things are in their culture or how they do things at home. I seldom use group work because it is very time consuming and noisy and we just don't have the furniture to cater for the group work setup. So I like teacher-learner discussion. But take certain topics like evolution, I would try to an enquiry method because evolution is very controversial by nature and I think it's better for learners to formulate their own conclusions by presenting the evidence and they formulating their own conclusions...*".

Participant 3 "*I like to ask learners about their experiences some learners tend to be shy about sharing knowledge that they might bring...*".

The responses of the participants reveal that a combination of a learner centred and teacher centred approaches are utilised. As already discussed in the literature review, the curriculum being utilised currently is strongly aligned with the performance approach to curriculum, however, there are components of the curriculum which are in line with a competence approach. One such component is found in the general aims of the curriculum which is the acquisition of knowledge with the aid of the learners' own experiences and everyday knowledge in the teaching and learning process which are viewed as IKS. Evidence of the combination of the two approaches is that the three participants use discussion in order to draw upon learners' experiences and knowledge. The element of learning activities utilised by the participants involving discussion is also evident in the lesson plans completed by participants. Evidence from lesson plans included that participant 1 in teaching the human impact on the environment encourages discussion on the importance of biodiversity as well as creates a debate on whether traditional healers should be compensated for indigenous knowledge.

The use of discussion implies the active participation of learners. In identifying this competence strand of the curriculum which utilises the learner centred approach, one is drawn into mentioning the learning theory which lends itself to this approach, the constructivist learning theory (Matthews, 2003), which involves the construction of knowledge where learners are not simply vessels for the transmission of it. This learning theory calls for the active participation of learners as does the learner centred approach (Weinstein, Tomlinson – Clarke, & Curran 2003). The finding of the learner centred approach and the constructivist learning theory implemented is further enhanced by participant 2 who mentions the use of the inquiry method of learning as a constructivist learning theory that requires such activities that encourage skills of inquiry. According to Alberta Education (1990) learners are engaged in their own learning through them formulating questions, and investigating which develops new understandings, meanings and knowledge.

The teacher centred approach is evident in the non mention of group work by participants 1 and 3 and the response of participant 2 who stated that she seldom uses group work as she found it time consuming and noisy. This suggests the adoption of the teacher centred approach as the learners need to be quiet and passive as the teacher passes on the knowledge. The non-use of group work suggests that the learners work alone which is a characteristic of a teacher centred approach. The teacher centred approach of the participants can be further seen in their lesson plans in which a common feature that was identified was that the teacher activities section consists of far more items than the learner activities section. This suggests that the teacher is in control of the learning.

In identifying the constructivist learning theory being employed by the participants another component found within the conceptual framework of this study, **the role of the teacher (component 7)**, can be explored. All the participants indicated that discussion involving learners' own experiences takes place. Participant 1 commented that these are acknowledged. This suggests that the participant in adopting a constructivist learning theory in the integration of IKS is facilitated by what Jegede and Aikenhead (1999, p. 55) term the teacher being a 'culture broker' involving border crossing where the role of the teacher is to guide learners "between their life – world culture and the culture of science, help them resolve any conflict." Therefore, identifying their role as being a 'culture broker' suggests that they

facilitate learning. They facilitate the movement of learners between the two cultures. As already explored that a performance approach to curriculum is being utilised where the teachers' role is overt in following guidelines in terms of selection, organising and sequencing, it suggests that they also have roles of being managers and leaders. Where they manage and lead curriculum in order for it to be implemented. Manage could be viewed in terms of managing materials and resources, learners and assessment which also makes them being assessors. Leading on the other hand could be viewed in terms of the teacher leading discussions. Other roles which could be attributed to the performance approach are that of a specialist and an interpreter. In the performance approach there is vertical knowledge (Bernstein, 1999) involving the hierarchical complexity within the subject discipline. This vertical knowledge requires the teacher to fully understand the content found within the curriculum which is done by them studying the content. From being a specialist in understanding aspects of the curriculum which include content, goals and assessment, it would involve the teacher being an interpreter of the curriculum as they would need to interpret the intended curriculum in order to sustainably implement it.

4.2.2.6 Component 8: Assessment

How do you assess IKS?

Participant 1 *"As it has to be tested in the course of the year during tests and examinations. It counts for a few marks only..."*.

Participant 2 *"I don't assess IKS formally. I would get the learners to do perhaps a case study in class and we would discuss the answers around the case study but it's not assessed formally towards their CASS mark or towards the exam..."*.

Participant 3 *"Its very rarely done and if it's done its sort of done as a booster in the exam where learners can gain marks if they are struggling a bit. As far as practicals in the class we don't assess IKS..."*.

Participants' responses to this question indicate that they are carrying out assessment differently. Their responses suggest that they are not conducting assessment as intended by the policy document which could be a result of a lack of understanding of issues concerning

assessment. Participant 1 through her response indicates that forms of assessment utilised include tests and examinations which speaks to summative assessment and formal assessment as described by Brown and Knight (1994) and the CAPS (DoE, 2011) for Life Sciences respectively which generates a summing up an individuals' achievement in the form of a grade. She does not mention any form of formative (Black & William,1998) and informal assessment (CAPS, 2011) being carried out before or during a learning programme which provide information used to modify the teaching and learning experience. The above suggests that participant 1, by using summative assessments, places more emphasis on the outcome rather than the process of teaching and learning. This emphasis on summative assessment is in conflict with the policy document for this subject which views assessment as "a continuous planned process of identifying, gathering and interpreting information on learners' performance, using a variety of forms of assessment" (DoE, 2011, p.66) which involves the incorporation of both informal and formal assessment. However, her emphasis on summative assessment is in line with the practice of the repetition of summative assessments in the conducting of continuous assessment where marks are generated and recorded for promotion purposes (Kennedy, Hyland, & Ryan, 2006).

Participant 2 and 3 stated that they both do not assess IKS formally. Participant 2 does however state that a bit of informal assessment is done. This too is in conflict with the policy document which, as already mentioned, calls for continuous assessment. Possible reasons for these responses could be seen in their responses to the question: 'when do you teach IKS?' They both stated that they do not spend much time on the teaching of IKS as it was not really tested. Evidence of the non assessing of IKS can be seen in the analysis of the June 2014 Life Sciences common test set by the KwaZulu-Natal Department of Education. Background to the grade 11 syllabus shows that at the time of the June testing period topics such as Microorganisms and Cellular Respiration would be covered. Where there is an exploration of IKS in terms of traditional technologies producing beer, wine and cheese. An analysis of the common test revealed that IKS was not assessed in the test. This suggests that the participants have taken their stance of not assessing from the lead of educational specialists who set the common tests, who could be viewed as policy makers. This further enhances the finding that the performance model of curriculum which emphasises the product of the learning influences not only other areas such as time spent on IKS but also the area of assessment.

4.2.2.7 Component 9: Time

When do you teach IKS?

Participant 1 *"The amount of time given to this section is also determined by the work schedule which is issued by the subject advisor..."*.

Participant 2 *"Given the time constraints that we are faced with, I wouldn't spend a lot of time teaching IKS because I need to finish the syllabus...when I look at the exam papers that have been coming across from the department, there isn't much focus in the exam papers. So why spend so much time on teaching IKS in the classroom when it is not tested as much in the papers..."*.

Participant 3 *"Very little time is spent on it, barely a period if that for IKS. Not enough time is given to it and because the exam tends to focus on the science content we tend not to focus on IKS..."*.

The responses of the participants further suggest once again that they are implementing a performance model of curriculum. Participant 1 mentions once again the reliance on policy documents which determines the selection, pacing and sequencing of topics. Mentioning the policy document suggests that the component of time is being experienced by participant 1 in terms of hours and weeks as scheduled by the timetable of the school. Both participants 2 and 3 mention that they do not spend a great amount of time on IKS due to firstly, time constraints placed on them to finish the syllabus. This further illustrates the overt role of the teacher and suggests that the syllabus is vast, covering a number of concepts. This is in line with the professional vision Schiro (2013) where there is an emphasis on knowledge derived from academic disciplines involving the learning of such knowledge in terms of its particular content which is structured hierarchically. Secondly, the limited amount of time spent on IKS is a result of the fact that, IKS is not focussed on in examination papers where there is a focus on formal school knowledge which could be viewed as scientific knowledge as opposed to everyday knowledge and experiences. This could be viewed as IKS. Evidence of this is explored in the section which dealt with assessment.

The issue of the participants not spending a lot of time on IKS is further scrutinised against the backdrop of data generated from the analysis of the lesson plans. Participant 1 through her lesson plan provides evidence that suggests that in fact not much time is spent on IKS. Her topic as mentioned previously is concerned with the human impact on the environment which involves a vast amount of content on issues such as the atmosphere and climate, water availability, water quality and food security. Two periods, which amount to 80 minutes, have been allocated for these issues to be covered. The IKS in terms of the traditional healers' compensation to be discussed, will not be afforded sufficient time as a result of the other issues using the time allocated for this topic. Participant 3 allocated one period which amounts to 40 minutes for the teaching of bacteria. She indicates that time will be spent on explaining the general characteristics and structure of bacteria. She uses the word "mention" in her discussion on how bacteria are used in preparing traditional beer. The word "mention" suggests that not a lot of time is spent on the IKS to be explored pertaining to this topic as the characteristics and structure of bacteria would use much of the time for this lesson.

4.2.2.8 Component 10: Grouping/Accessibility

With whom are you teaching? / Who are you teaching?
In this component two questions are relevant. In order to justify why the first question around grouping was posed in the above manner (as from an initial point) it may seem that this component of grouping is concerned with the grouping of learners. It attempted to ascertain if the teachers were involved with other teachers or if learners were grouped as findings from the discussions on the activities and, materials and resources they used to teach IKS revealed that group work amongst learners was not utilised. This was due to time constraints with regard to the activities. Secondly, the lack of furniture and its arrangement in regard to materials and resources was another factor. The second question is relevant to this component and is concerned with who they are teaching in terms of accessibility. It was found that participants did not address this issue fully as other components found within the curricular spider web revealed that they do teach learners. However, issues around accessibility such as physical, financial and cultural as mentioned above were not addressed. Therefore, findings related to accessibility are made from the researcher's knowledge of the school environment. The researcher has worked closely with the participants for 11 years as a colleague teaching in the same school.

Participant 1 *"Other Life Sciences teachers at school who teach the grade...".*

Participant 2 *"At school we sort of team teach. There is about two or three teachers sharing a grade and the school belongs to a cluster comprising of about ten or so teachers, we gather each term and moderate each other's work...".*

Participant 3 *"We tend to share the Life Sciences load usually between two teachers. Each teacher can approach the content in a different way, the way they feel is best suited. We very rarely hook up with other schools in our cluster group...".*

It is evident that there is grouping of teachers working together at the school in this case study. All three responses of the participants show consistency as they mention that they teach Life Sciences with other teachers at the school. This suggests that with this grouping there is a sharing of ideas in respect to content which encompasses IKS. The mention of cluster groups is refreshing as this implies that there would be a sharing of experiences from other cultures which would enhance their implementation of the intended curriculum. However, it is somewhat disappointing to see, as participant 3 states, that they very rarely meet with other teachers in their cluster. This is enhanced by participant 2 who stated that these cluster meetings take place once a month. A possible reason for this is the time constraints which they are faced with as identified in a previous finding. Therefore, there are measures in place to enhance the teaching and learning process. However, it is clear that they are not being fully utilised.

In terms of accessibility, the teachers do teach learners. Regarding the physical issue, it is possible for these learners to reach the school by means of walking and with the use of public transport as a percentage of learners do live outside a walking distance from the school. The learner population does not consist of any learners with physical disabilities. This allows the infrastructure of the school to be suitable as there are no learners with special needs. Learner can easily access resources such as the classrooms.

In terms of the financial issue, the school fee for the 2015 academic year was R1250.00. Discounts are also provided for learners coming from the same family. This amount could be

regarded as affordable when compared to other schools. The learners come from varying socio – economic backgrounds. Those who come from low socio – economic backgrounds are afforded the same opportunities in terms of the learning environment created by the teachers and the opportunities afforded to them in terms of extra – curricular activities.

In terms of the cultural issue which is concerned with whether the educational programme is socially acceptable (Berkvens et al., 2014). The educational programme offered by the school is indeed socially acceptable as the learner population does not comprise of one race group which the management and teachers of the school handle by incorporating the various cultures into the ethos of the school. For example, the cultural day at school involves a representation of various cultures.

4.3 Chapter Summary

The findings of the study are presented in this chapter based on the data generated from the questionnaires, semi – structured interviews and the analysis of lesson plans in a manner which involved data presentation, analysis and discussion. The data was discussed in terms of the data generating methods attempting to fulfil the research objectives of this study. Firstly, the questionnaire was discussed in an attempt to ascertain in some part their prior experiences and their understandings of the NOS and IKS which were used to identify their attitudes. Secondly, the semi – structured interviews and the analysis of lesson plans were discussed in relation to the concepts found in the curricular spider web which forms the conceptual framework of this study. These subsequently inform the findings concerned with experiences, the identification of attitudes and the influence of these experiences on the participants' classroom practice. It was found that although the participants possess positive attitudes towards IKS which are informed by their understandings of the NOS and IKS, these positive attitudes do not totally translate into their classroom practice. Their classroom practice reflects through their experiences a performance approach to curriculum which influences content, activities, assessment, the grouping of learners and time. In some instances, findings reveal a lack of understanding of certain curriculum issues. It was found that a relationship exists between the components within the curricular spider web where there is a misalignment between the intended and implemented curriculum. In the final chapter there will be a presentation of the conclusions and recommendations of this study.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The previous chapter offered the findings of this study by presenting, analysing and discussing the data generated. In this chapter findings are drawn upon to present conclusions in an attempt to answer the research questions which were explored in chapter one. Based on these conclusions recommendations are made. The structure of this chapter involves the stating of the research questions which is followed by a discussion of findings. From the discussion of findings the emergence of conclusions take place.

5.2 Overview of study

This study attempted to explore teachers' experiences of Indigenous Knowledge Systems (IKS) found in the Life Sciences curriculum and was directed by research questions as mentioned above.

5.2.1 What are the teachers' experiences of IKS?

In answering question one, "What are the teacher's experiences of IKS?" the study analysed the data generated through the three data generating methods. The conclusions relevant to this research question will firstly be discussed from the findings derived from the questionnaire as it focused on their past experiences regarding IKS. Secondly, the conclusions follow the concepts found within the curricular spider web.

The findings from the questionnaire revealed that the participants have had a variety of experiences with IKS which occurred through different sources. These different sources included their respective qualifications, departmental meetings and in one instance, the subscription to magazines related to the teaching of Life Sciences. Naidoo (2010) found that a variety of sources or experiences which include university modules, informed teachers' understanding of IKS and that the different approaches used by teachers in the classroom were informed by individual teachers' experiences. The conclusion of the participants being exposed to a variety of experiences with regard to IKS would seem, on face value, to bode well for their understanding of IKS and therefore their classroom practice.

In terms of the curricular spider web being used to inform teacher experiences the following conclusions emerged as per concept:

5.2.1.1 Vision for teaching IKS?

From the findings it emerged that teachers are teaching IKS as it is viewed, firstly, in some way contributing in the achievement of the needs of society where individuals can make responsible decisions. This speaks to the societal vision (Schiro, 2013) for including content into a curriculum. The achievement of the needs of society can be seen in IKS being viewed as giving transformative power to the poor (Semali & Kincheloe, 1999) which contributes to the improvement of the quality of life (WorldBank, 1998).

Secondly, it also emerged that value is also ascribed to IKS in terms of it being used in a pedagogical sense which is in line with a personal vision where the inclusion of IKS is viewed as being in line with a social constructivist pedagogy (Jegede & Aikenhead, 1999). IKS as prior knowledge serves as a vehicle to promote learning through motivating children due to the fact that they start to see acknowledgement being given to what they do and say in their communities (George,1999), as their prior knowledge is drawn upon during the learning process.

It also emerged with the identification of a performance approach of the curriculum that the teachers have also a professional (content) vision as the performance approach calls for the increase of complexity in terms of content with regard to it being explored in a subject discipline.

5.2.1.2 Towards which goals are they teaching IKS?

A conclusion which emerged from the findings is that the participants of the study exhibit a superficial or limited understanding of the goals to be achieved when teaching IKS as the participants did not expand on elements surrounding the goals. The participants illustrated this superficial or limited understanding by only stating a specific aim with no reference of it being an objective. They also did not make the connection between general aims, objectives and outcomes in terms of their respective achievements influencing the others. The participants' lack of understanding of goals is illustrated by the exclusion of pertinent elements of goals. Undoubtedly presents a problem for the successful implementation and

sustainability of IKS found within the curriculum. They will experience difficulties in interpreting the intended curriculum which will influence the implemented curriculum negatively which in turn would also have a negative impact on the attained curriculum. This resonates with the curricular spider web and its use in the successful implementation of a curriculum where, due to its vulnerable nature, equal attention must be given to each concept in order for a curriculum to be successfully implemented (Van den Akker et al., 2009).

5.2.1.3 What content are they teaching?

The findings indicated that there was a strong reliance by the participants of the study on the policy document in the identification of the content to be taught which is in line with a performance model of curriculum where the teacher has overt control over the selection, sequencing and pacing of the content. It also emerged from the data that factors such as time and assessment also influence the content that is taught as there is a bias towards science content or western knowledge as it is this type of knowledge that requires more time to be spent on it due to the pressure to complete the syllabus. It also emerged that IKS is not really assessed. Thus the view that IKS is 'subjugated knowledge' (Maurial, 1999) was re-enforced. This once again is an example of the performance model of curriculum as it promotes formal school knowledge/western knowledge at the expense of everyday knowledge/IKS. This emphasis on western knowledge is cause for concern as through this emphasis an indirect result could be the marginalisation of IKS as a knowledge base which would be further establishing it as inferior knowledge. It could also be said that in an attempt to improve performance with the curriculum reform of the implementation of CAPS where there is an emphasis on western knowledge serves to re-introduce the problems associated with CNE and colonisation where there was the marginalisation of knowledge and the exclusion of people. As it has already been identified, the needs of society should influence the content of the curriculum. This is an important point as many people in South Africa need to improve their lives. However, a performance approach may only serve to re-establish the ills of the past.

5.2.1.4 What materials and resources are they using?

From the findings, participants observe that there is a lack of resources. However, it was revealed that a combination of resources is used which suggested that there are in fact resources available as they listed many resources that are used. These resources included DVDs, overhead projectors, screens for overhead projectors, transparencies, videos, computers, chalkboards and learners. Therefore, a conclusion is that this perception of the lack of resources is rather a lack of a progressive plan regarding the utilisation of resources in terms of the teaching of IKS. For example, there is furniture available, however teachers do not fully utilise it in a way which will encourage a learning theory which is conducive to IKS. This conclusion could be used to evaluate teacher performance in light of the under achievement of learners as the availability of resources is of importance to the implementation of a subject within the school curriculum.

This perceived lack of resources by the participants could be seen as justification of the under achievement of learners. The participants need to fully engage with this issue, which calls for the adjustment in their use of the resources available in the teaching of Life Sciences. They could inculcate non traditional methods which could involve calling in elders from the community to demonstrate and explain topics concerned with IKS.

5.2.1.5 Where are they teaching?

From the findings concerned with the materials and resources used in their teaching it emerged that the location of their teaching is their classrooms. Michie (1999) observes that a classroom does not create an environment conducive for the learning of IKS. In fact, it could be viewed as a hindrance in the teaching and learning of IKS. A further hindrance to the teaching and learning of IKS related to the classroom is concerned with it not facilitating a social constructivist learning theory which facilitates it. It emerged that the participants' classrooms are arranged in a traditional seating layout, which does not facilitate learner engagement with regard to the discussions which is an aspect of a social constructivist learning theory.

5.2.1.6 What learning activities are they using?

The findings reveal that a combination of learner-centred and teacher-centred activities is utilised by the participants of the study. However, teacher centred activities dominate the classroom activities. This dominance of teacher-centred activities is in line with a performance approach to curriculum which calls for the teacher to be in control of the learning where lessons are not flexible but rather structured. An aspect which illustrates this point of the dominance of teacher-centred activities is the non use of group work due to time constraints which, if adopted, would manifest in a more flexible approach in terms of time and a less structured learning experience for learners. The adoption of teacher-centred activities as the predominant approach is influenced once again by time and assessment.

In terms of learner-centred activities, the participants in some way allow for discussion to take place. This is in line with the principle of active participation of learners which a learner centred approach values. Embracing this learner-centred approach resulted in the identification of a learning theory (constructivist learning theory) which lends itself to this approach, and calls for the active participation of learners as does the learner-centred approach.

5.2.1.7 What is their role in teaching IKS?

A host of roles are prescribed for teachers in general. These include the teacher as a/an, learning mediator/facilitator; interpreter and designer of learning programmes and materials; leader, administrator and manager; scholar; researcher and lifelong learner; assessor; learning area/subject/discipline/phase specialist as well as having a community, citizenship and pastoral role. As a result of time constraints fulfilling these varying roles is almost impossible. However, due to the learning theory they attempt to adopt and in conjunction with the curriculum approach some of the above roles were identified. These being in the case of them being 'culture brokers' in terms of the learning theory adopted they have a facilitator role. In terms of the approach of the curriculum being performance based leading the teachers to adopt a role which is overt. Roles can be identified in terms of them being managers, leaders, interpreters, specialists and assessors where controlling the learning process enhances structure. Enabled by a teacher centred approach which a performance approach calls for.

5.2.1.8 How do they assess IKS?

A conclusion which emerged from the findings is that the assessment practices that are used by the participants of this study are in conflict with the policy document for Life Sciences. They are not conducting assessment as intended by the policy document as there is a dominance of summative assessment which is in opposition to the policy document which a prescribes a more balanced approach to assessment with regard to it being continuous in nature. One of the possible reasons for this behaviour is that they show a lack of understanding of key concepts related to assessment in terms of the aims, objectives and outcomes. The issue of time is another factor affecting the completion of syllabus where they have observed that common tests set by the department of education do not assess IKS. Regarding time, one can see that they do not value the importance of IKS in terms of the time allocated for it as the non - assessing of it does not warrant the time spent on it. This is of concern as these teachers are taking the lead of policy makers that could be identified as individuals who set common tests. A relevant question to be asked that speaks to this reality related to this conclusion is how are teachers expected to assess IKS if policy makers are not assessing IKS. This further enhances the performance model of curriculum which emphasises the product of the learning rather than the process.

5.2.1.9 When were they teaching IKS?

In relation to time it can be concluded from the findings that there is an imbalance in the time spent on the knowledge bases found within the Life Sciences curriculum. These knowledge bases are the school/scientific knowledge and everyday knowledge/IKS, as the participants in this study are not following the prescribed time as stipulated in the policy document. The component of time is experienced by the participants in terms of hours and weeks as scheduled by the timetable of the school as prescribed by the policy document. However, the participants are making their own decisions with regard to the time spent on teaching IKS. This is influenced by the pressure placed on them to finish the syllabus which they view as important as the curriculum which is also driven by a professional (content) vision that has an emphasis on knowledge derived from academic disciplines. In terms of assessment, the participants have observed that IKS is not focussed on in examination papers where there is a focus on formal school knowledge which could be viewed as scientific knowledge as opposed to everyday knowledge and experiences which could be viewed as IKS.

5.2.1.10 With whom are they teaching? /Who are they teaching?

From the conclusions that are concerned with learning activities, time, materials and resources, and location it can be surmised that the participants of this study in their classroom practice do not use group work with the learners. However, it can be concluded in terms of grouping that they themselves are involved in group teaching as they share teaching loads at school and are part of cluster groups where the sharing of ideas in terms of IKS takes place which would enhance their implementation of the intended curriculum. This sharing of ideas is stifled by time constraints as meetings of cluster groups rarely take place.

It also emerged that they do in fact teach learners in terms of accessibility. From an assessment of the issues concerned with accessibility, i.e. physical, financial and cultural in relation to the school involved in this case study concerned with the case study, it can be concluded that these three issues are successfully initiated and attained by the school. However, from a perspective of CAPS in relation to the emphasis of school knowledge which could be viewed as marginalising a group of people's knowledge, which was discussed in the conclusion concerned with content, it may be viewed as not achieving accessibility in relation to the issue of being socially acceptable (cultural) due this exclusion of some aspects of a people's knowledge.

5.2.2 How do the teachers' experiences of IKS influence their classroom practice?

In commenting on this particular research question, the link between experiences, conceptual understandings and attitudes influencing classroom practice is drawn upon. A conclusion relevant to this question and based on the experiences of the teachers as outlined in making conclusions for the first research question is that although the participants in this study exhibit a positive attitude towards IKS, which is informed by their above adequate understanding of it which may have been the result of various experiences or sources both prior and present, this positive attitude does not translate into an implemented classroom practice which would achieve the intended curriculum that is set out for IKS. Reinforcing the identification of this positive attitude towards IKS is evident in the participants ascribing value to the science curriculum with its inclusion. This positive attitude can only be seen in the participants' limited attempt to include IKS with respect to a social constructivist learning theory. In terms of their role of a teacher where there is an appreciation that a social constructivist learning theory could be used on their part in the teaching of Life Sciences due

to firstly, the social nature of science and secondly, the cultural element which informs various forms of IKS. A number of components from the curricula spider web which informs their experiences for this study and is pertinent to their classroom practice exhibit a non-implementation of the intended curriculum. Which may be the result of what Khoza (2015b) found in his study that teachers were unable to interpret the intended curriculum because they did engage with all the components of the curricular spider web. These components which inform their experiences of this study. Issues relevant to this non-implementation can be identified by the lack of understanding of the components and the influence of time on the teaching and learning process with regard to a performance approach to curriculum. These components include goals, learning activities, time, materials and resources, location and the grouping of learners. This conclusion is of serious concern as it points to the implementation of the Life Sciences curriculum in terms of IKS being unsuccessful and unsustainable as these components of the curricular have not been afforded much attention which will result in the collapse in the curriculum.

5.3 Suggestions for further research

The conclusions of this study that explored Life Sciences teachers' experiences of IKS found in the curriculum, brought about an awareness of further research which could be conducted within this field of research. Further research could involve the exploration of teachers' understandings of the components found within the curricular spider web as it became apparent from this study that a lack of understanding exists with regard to these components. This type of research could be used to inform pre-service teacher education as it could illustrate shortcomings in understanding which could be the result of pre-service misunderstandings formulated during pre-service teacher education. Another opportunity exists in terms of each component of the curricular spider web being explored individually in order to ascertain a deeper understanding of teachers' experiences with regard to each component. The issue of the concepts that were not covered extensively in the literature review such as time, location and grouping suggests that an opportunity exists for further research into these concepts.

5.4 Recommendations

The following recommendations are derived from the above conclusions of this study.

Recommendation 1

As a direct response to the conclusion that is concerned with the misalignment of the implemented curriculum experiences of the participants of this study with the intended curriculum as outlined by the policy document, which could be due to their lack of understanding of a number of concepts found in the curricular spider web, a recommendation is that stakeholders in education, which include educational departments and pre-service teacher education institutions, should get actively involved in addressing this issue. A way of addressing this issue is firstly by respective education departments mobilising suitably trained individuals to design interventions to re - train current teachers as this would aid in, one could say, stopping the rot in terms of the implementation of the intended curriculum. Secondly, pre – service teacher education institutions should include modules which fully engage prospective teachers in the understanding of the concepts found in the curricular spider web which will result in them having a deeper understanding of them. This will translate in the correct interpretation of the intended curriculum.

Recommendation 2

As a way of adding to the recommendation of ongoing professional development of teachers in terms of training, professional development should be added as a component to the curricular spider web proposed by Van de Akker et al. (2009), as it is of importance to the successful implementation and sustainability of a curriculum. Just as if one of the components of the current curricular spider web does not get the necessary attention to the detriment to curriculum implementation. The impacts of that can be expanded to the case of professional development. This has relevance to curriculum change in terms of the CAPS as teachers are seen as technicians to fix it without understanding it (Msibi & Mchunu, 2013). This understanding may be acquired through professional development.

Recommendation 3

It is recommended that curriculum reform be kept to a minimum as in the last twenty years there has been a number of curriculum reforms which call upon teachers to reflect on the teaching and learning process. It is understandable that change is necessary in terms of an ever changing societal landscape, however, policy reformers need to be visionaries who can predict this change and make minor adjustments to the curriculum which will enable the teacher to be confident in his or her role as extreme change would bring about confusion and pressure which would ultimately influence the implementation of the intended curriculum. This call for a minimal curriculum reform may lead to an increase in the availability of finances since a change in curriculum will invariably increase costs due to the printing of documents and training. This increased finances could be utilised for materials and resources, and accessibility.

Recommendation 4

There is a need for the policy document for Life Sciences to be explicit in its explanation of the relevant learning theory to be adopted in the teaching of IKS. The policy document which has a performance model approach to curriculum, in a way marginalises the topic of IKS as learning theories conducive to IKS, one may say, are rooted in a competence model of curriculum which calls for the use of learners' prior knowledge and experiences. This, in some way, causes confusion amongst teachers which ultimately leads to a misalignment of the intended curriculum and the implemented curriculum.

Recommendation 5

In order to take the above recommendation even further, policy makers should evaluate the topic of IKS as a whole. In terms of curriculum reforms, it is a recommendation even though it might seem radical that IKS be made a subject on its own. In this way it would be recognised as important and not be viewed as 'subjugated knowledge' due to its perceived inferior status when compared to other knowledge bases. Other subjects such as Mathematics, Arts and Culture, Technology and as previously pointed out, the Sciences have elements of IKS. Topics relevant to IKS from these subjects could be put together to form a separate IKS curriculum. Having a separate IKS curriculum from the above subjects would allow teacher education institutions to design modules which will equip pre – service teachers with the necessary individualised skills pertinent to the teaching and learning experience conducive to

IKS. In terms of the necessary skills required, the policy document for this new subject could be a competence model of curriculum which will call for learning theories which are more conducive for the teaching and learning of IKS. The establishment of this new subject will aid in eliminating the view that IKS is just an add - on and in doing so, ensure equal status of IKS.

Recommendation 6

It is recommended that the Life Sciences curriculum developers should review the number of topics currently explored by the curriculum in each grade where a balance needs to be found between scientific knowledge and IKS as the current scientific content – laden curriculum places too much pressure on teachers which results in the implementation of the curriculum being exam – driven and results in IKS not being given attention.

Recommendation 7

Educational specialists concerned with the assessment of Life Sciences need to include IKS in the assessment strategies as the non assessment of IKS almost gives teachers a justification not to include in their assessment strategies. This would result in the elevation of the status of IKS in the classroom as more time will be allocated in the teaching and learning of it.

Recommendation 8

As education is viewed as a system comprising of various stakeholders which include the community, teachers should use non-traditional forms of materials and resources in the teaching and learning of IKS. Non-traditional forms of materials and resources could be defined as materials and resources which are not listed in the policy document of the subject. These non-traditional forms could involve the community calling upon community members such as cultural leaders and elders to be actively involved in the teaching and learning of IKS. This would help in some way to preserve the cultural ways of doing things which cultural leaders and elders have a vested interest in preserving.

5.5 Conclusion

The Life Sciences teachers' experiences of IKS found within the curriculum, display a disparity between its implementation and that of the intended curriculum as outlined by the policy document. This disparity may be a result of their lack of understanding of the components found within the curricular spider web. This suggests an unsuccessful implementation of the curriculum which, if not addressed would result in the collapse of the curricular spider web as some concepts are not being given equal attention (Van den Akker et al., 2009). Although teachers have a positive attitude towards IKS, it does not secure the achievement of the intended curriculum. In the endeavour to achieve the goals of a curriculum that is deeply rooted in a performance approach to curriculum, certain components within the curricular spider web are being neglected. This can only serve to perpetuate the non – implementation of the curriculum. One such component which leads to the neglect of others is time. This is in terms of the limited amount of time allocated for the teaching and learning of IKS. This limited amount of time allocated influences components which include learning activities, learner grouping, assessment as well as the role of the teacher with reference to the learning theory adopted. The limited amount of time allocated for the teaching and learning of IKS is as a result of firstly, there being a great emphasis on the completion of the syllabus which is dominated by scientific knowledge whose completion is naively thought to secure performance. Secondly, in the pursuit of this performance through the limited allocated time results in the IKS are never taken seriously by both learners and teachers. There is a need to move the teaching and learning of IKS to a competence model in order to fully engage it with the components found in the curricular spider web. Doing so would, inter alia, provide sufficient time with regard to the adoption of a learning theory which enables the achievement of the intended goals of the curriculum.

REFERENCES

Abrahams, F. (2000). *The SASE of South African state schools*. Retrieved November 15, 2014, from http://www.wcc-coe.org/wcc/what/interreligious/cd35-02.html

Adler, J. (2005). Mathematics for teaching: What is it and why is it important that we talk about it. *Pythagoras,* (62), 2-11.

Adler, J., Pourara, C., Taylor, D., Thorne, B., & Moletsane, G. (2009). Mathematics and science teacher education in South Africa: A review of research, policy and practice in times of change. *African Journal of Research in MST Education*, *Special Issue*, 28 – 46.

Agrawal, A. (1995). Dismantling the Divide Between Indigenous and Scientific Knowledge. *Development and Change*, *26*(1995), 413 – 439.

Aikenhead, G. S. (1996). Science education: border crossing into the subculture of science. *Studies in Science Education*, *27*(1996), 1 – 52.

Alberta Education. (1990). *Focus on research. A guide to developing students' research skills*. Edmonton, A. B: Alberta Education. Retrieved July 28, 2014, from http://www.library.ualberta.ca/documents/focus on research.pdf.

Apple, M.W. (2004). *Ideology and curriculum* (3rd ed.). New York: Routledge Falmer.

Arulsamy, S. (2010). *Curriculum Development*. New Delhi: Neelkamal Publications.

Ayerst, P., Langley, R., Majozi, P., Metherell, A., & Smith, D. (2005). *Shuters Life Sciences Grade 10 learner's book*. Pietermaritzburg: Shuter& Shooter.

Babbie, E. (2007). *The practice of social research.* (11th ed.). California: Thomson Wadsworth Publisher.

Battiste, M., & Henderson, J.Y. (2000). *Protecting indigenous knowledge and heritage*. Saskatoon, Saskatchewan, Canada: Purich Publishing Ltd.

Baxter, J. (1991). A Constructivist Approach to Astronomy in the National Curriculum. *Physics Education*, *26*, 38 – 45. Retrieved March 04, 2010, from http://iopscience.iop.org/0031 - 9120/26/1/007

Bell, J. (2005). *Doing your research project*. New York: Open University Press.

Bell, R. (2008). *Teaching the nature of science: Three critical questions. National Geographic Science*. Retrieved October 20, 2013, from http://www.ngsp.com

Berkvens, J., van den Akker, J., & Brugman, M. (2014). *ADDREESING THE QUALITY CHALLENG: REFLECTIONS ON THE POST-2015 UNESCO EDUCATION AGENDA*. Netherlands National Commission for UNESCO.

Bernstein, B. (1975) *Class, codes and control: Towards a theory of educational Transmission.* London: Routledge.

Bernstein, B. (1999). Vertical and horizontal discourse: An essay. *British Journal of Sociology of Education, 20*(2), 157-173.

Bishop, A. J. (1990). Western mathematics: The secret weapon of cultural imperialism. *Race & Class*, *32*(2), 51 – 63.

Black, P., & William, D. (1998) *Inside the Black Box: Raising Standards through Classroom Assessment*. London: Kings College.

Brickhouse, N. W. (1989). The teaching of the philosophy of science in secondary classrooms: case studies of teachers' personal theories. *International Journal of Science Education*, *11*(4), 437-449.

Brickhouse, N.W. (1990). Teachers' beliefs about the nature of science and their relationship to classroom practice. *Journal of Teacher Education*, *41*(3), 53-62.

Brown, S. (1999). Institutional Strategies for Assessment. In S. Brown & A. Glasner (Eds), *Assessment Matters in Higher Education*, Buckingham: SRHE and OU Press.

Brown, S., & Knight, P. (1994). *Assessing Learners in Higher Education*. London: Kogan.

Bybee, R.W. (1989). *Science and technology education for the elementary years*: *Frameworks for curriculum instruction*. Washington, D.C.: The National Centre for Improving Instruction.

Carl, A. E. (2012). *Teacher Empowerment through Curriculum Development: Theory into Practice.* (4th ed.). Cape Town. Juta & Company Ltd.

Chall, J. S. (2000). *The Academic Achievement Challenge: What Really Works in the Classroom?* New York: Guilford Press.

Christiansen, I., Bertram, C., & Land, S. (2010). *Understanding Research* (3rd ed.). UKZN Faculty of Education.

Cobern, W. W. (1996). Worldview theory and conceptual change in science education. *Science Education, 80*(1996), 51-59.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education* (7th ed.). London and New York: Routledge.

Collins. (2006). *Student's Dictionary* (2nd ed.). Glasgow: HarperCollins Publishers.

Corsiglia, J., & Snively, G. (2000). *Rejoinder: Infusing Indigenous Science into Western Modern Science for a Sustainable Future*. John Wiley & Sons, Inc.

Creswell, J.W. (1994). *Research design: Qualitative and quantitative approaches*. London: SAGE.

Creswell, J. W. (2009). *Research Design; Qualitative, Quantitative and Mixed Methods Approaches* (3rd ed.). California: SAGE Publications.

Criticos, C., Long, C., Molestane, R., & Mthiyane, N. (2005). *Getting Practical about Outcome – based Teaching*. Cape Town: Oxford University.

Dash, B. N. (2012). *Principles of Education* New Delhi: Neelkamal Publications.

Department of Education. (2000). Norms and Standards for Educators. *Government Gazette* Volume 415 No.20844. Pretoria: Government Printer.

Department of Education. (2003). *National Curriculum Statement 10-12 (General), Learning programme guidelines, Life Sciences.* Pretoria: Government Printers.

Department of Education. (2011). *Curriculum and Assessment Policy Statement, Life Sciences. Further Education and Training Phase, Grades 10 – 12*. Pretoria: Government Printers.

de Souza Barros, S. & Elia, M. (1998). *Physics teacher's attitudes: How do they affect the reality of the classroom and models for change?* Retrieved May 08, 2014, from http://pluslucis.univie.ac.at/Archiv/ICPE/D2.html

De Villiers, R., & Sommerville, J. (2005). Prospective biology teachers' attitudes toward animal dissection: implications and recommendations for teaching biology. *South African Journal of Education*, *25*, (4), 247 – 252.

de Villiers, R. (2011). Student teachers' views: what is an interesting Life Sciences curriculum? *South African Journal of Education*, *31*(4), 535 – 548.

Durie, M. (2004, March). *Exploring the Interface Between Science and Indigenous Knowledge*. Paper presented at the 5th APEC Research and Development Leaders Forum, Christchurch, New Zealand.

du Plessis, E.C., & Mbunyuza, M.M. (2014). Does the Department of Basic Education Take the International Call to Provide Quality Education for all Seriously? *The Journal of Social Sciences, 41*(2), 209 – 220.

du Preez, P., & Reddy, C. (2014). *Curriculum Studies: Visions and Imaginings*. Cape Town: Pearson Holdings Southern Africa (Pty) LTD: Liesbet van Wyk.

Dziva, D., Mpofu, V., & Kusure, L. (2011). Teachers' Conception of Indigenous Knowledge in Science Curriculum in the context of Mberengwa District, Zimbabwe. *African Journal of Education and Technology*, *1*(3), 88 – 102.

Emeagwali, G. (2003). *African Indigenous Knowledge Systems (AIK): implications for the Curriculum*. Retrieved September 13, 2014, from http://www.africahistory.net/AIK.htm

Farber, P. (2003). Teaching evolution and the nature of science. *The American Biology Teacher*, *65*(5), 347-354.

Gibbs, G. R. (2007). *Analyzing Qualitative Data*. London: SAGE Publications Ltd.

George, J. M. (1999). Indigenous Knowledge as a Component of the School Curriculum. In L. M. Semali & J. L. Kincheloe (Eds.), *What is Indigenous Knowledge? Voices From the Academy* (pp. 79 – 94). New York and London: Falmer Press.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 105 – 117). Thousand Oaks: Sage Publications.

Hagar, C. (2003, May). *Sharing Indigenous Knowledge: To share or Not to Share? That Is the Question*. Paper presented at the annual Canadian Association for Information Science, Halifax, Nova Scotia.

Hammrich, P. L. (1997). Confronting teacher candidates' conceptions of the nature of science. *Journal of Science Teacher Education*, *8* (2), 141-151.

Hennink, M., Hutter, I., & Bailey, A. (2011). *Qualitative Research Methods*. London: Sage.

Hidi, S., & Harackiewicz, J. M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research*, *70* (2),151-179.

Hoadley, U., & Jansen, J. D. (2009). *Curriculum: Organising knowledge for the classroom*(2nded.). Cape Town: Oxford University Press.

Hoadley, U., & Jansen, J. D. (2013). *Curriculum: Organising knowledge for the classroom*. Cape Town: Oxford University Press.

Horsthemke, K. (2004). 'Indigenous knowledge'- Conceptions and Misconceptions. *Journal of Education, 32*(2004), 31 – 48.

Huba, M. E., & Freed, J. E. (2000). *Teacher – centred vs. learner – centred paradigms*. Retrieved August 10, 2015, from: http://assessment.uconn.edu/docs/TeacherCentredVsLearnerCentredParadigms.pdf.

Jansen, J (1999). Setting the scene: historiographies of curriculum policy in South Africa. In J. Jansen & P. Christie (Eds.), *Changing curriculum: studies on outcomes – based education in South Africa* (pp.3 – 18). Cape Town: Juta& Co.

Jansen, J., & Taylor, N. (2003). Educational Change in South Africa 1994 – 2003: Case Studies in Large – Scale Education Reform. *Education Reform and Management Publication Series*, *II*, 1 – 43.

Jansen, J., & Vithal, R. (1997). *Designing your first research proposal*. Juta and Co. Ltd.: Kenwyn.

Jegede, O.J. (1999). Science Education in Nonwestern Cultures; Towards a Theory of Collateral Learning. In L.M. Semali & J.L. Kincheloe (Eds.) *What is indigenous knowledge? Voices from the Academy.* New York: Palmer Press.

Jedege, O. J., & Aikenhead, G. S. (1999). Transcending Cultural Borders: implications for science teaching. *Research in Science Technological Education, 17*(1), 45 – 66.

Kardos, S. M., & Johnson, S. M. (2010). New teachers' experiences of mentoring: The good, the bad, and the inequity. *Journal of Educational Change*, *11*(1), 23-44.

Kennedy, D., Hyland, H., & Ryan, N. (2006). *Writing and Using Learning Outcomes: a Practical Guide*. Bologna: European Higher Education Area (EHEA).

Khoza, S. B. (2012). Who helps an online facilitator to learn with students in a day? *Melvana International Journal of Education*, *2*(2), 75 – 84.

Khoza, S.B. (2013a). Can they change from being digital immigrants to digital natives? *Progressio: South African Journal for Open and Distance learning Practice, 35*(1), 51 – 68.

Khoza, S. B. (2013b). Learning outcomes as understood by 'Published Research' facilitators at a South African university. *Mevlana International Journal of Education, 3*(2), 1 – 11.

Khoza, S.B. (2015a). Student teachers' reflections on their practices of Curriculum and Assessment Policy Statement. *South African Journal of Higher Education*, *29*(4),101-119.

Khoza, S.B. (2015b). Using curricular spider web to explore a research facilitator's and students' experiences. *South African Journal of Higher Education, 29*(2), 122-143.

Kilinc, A., & Mahiroglu, A. (2009). The Attractors of Teaching Biology: A Perspective from the Turkish Context. *Australian Journal of Teacher Education, 34*(5), 15 – 39.

Klep, J., Letschert, L., & Thijs, A. (2004). *What are we going to learn?* Enschede: SLO.

Krapp, A. (2002). Structural and dynamic aspects of interest development: theoretical consideration from an ontogenetic perspective. *Learning and Instruction*, *12*(4), 383-409.

Kuhne, B. (1995). The Barkestorp project: Investigating school library use. *School libraries worldwide, 1*(1), 13-27.

Lederman, N. G. (1992). Students' and teachers' conceptions of the nature of science: A review of the research. *Journal of Research in Science Teaching*, *29*(4), 331-359.

Leedy, P.D., & Ormrod, J.E. (2001). *Practical research: planning and design*. (7th ed.). Ohio: Merril Prentice Hall.

le Grange, L. (2004). Western science and indigenous knowledge: Competing perspectives or complementary frameworks? *South African Journal of Higher Education*, *18*, (4) 82 – 91.

Lincoln, Y.S., & Guba, E.G. (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage Publications.

Lindberg, D. H. (1990). What goes round comes round doing science. *Childhood Education, 67*(2)*, 79-81.*

Lloyd, C. V., & Contreras, N. J. (1985). *The role of experiences in learning science vocabulary.* Paper presented at the annual meeting of the National Reading Conference, San Diego, CA. ED 281-189.

Lloyd, C. V., & Contreras, N. J. (1987). What research says: Science inside out. *Science and Children, 25*(2), 30-31.

Loubser, J.A. (2004). Unpacking The Expression ―Indigenous Knowledge Systems. *Indilinga: African Journal of Indigenous Knowledge Systems*, *4*(1), 74-88.

Marx, A., Fuhrer, U., & Hartig, T. (1999). Effects of Classroom Seating Arrangements on Children's Question – Asking. *Learning Environments Research, 2*(3), 249 – 263.

Matthews, W. J. (2003). Constructivism in the Classroom: Epistemology, History, and Empirical Evidence. *Teacher Education Quarterly*, Summer (2003), 51 – 64.

Maree, K. (Ed.). (2007). *First steps in research.* (1st ed.). Pretoria: Van Schaik.

Maurial, M. (1999). Indigenous knowledge and schooling: A Continuum Between conflict and Dialogue. In L. M. Semali & J. L. Kincheloe (Eds.), *What is Indigenous Knowledge? Voices From the Academy* (pp. 59 – 77). New York and London: Falmer Press.

McComas, W.F., Clough, M.P. & Almazroa, H. (1998). *The role of and character of the nature of science in science education. The Nature of Science in Science Education: Rationales and Strategies.* Drodrecht: Kluwer Academic Publishers.

Mc Millan, J. H., & Schumacher, S. (1993). *Research in education. A conceptual introduction.* (3rd ed.) New York: Harper Collins College Publishers.

Michie, M. (1999, December 13 - 16). *"Reforming Learning, Curriculum and Pedagogy: Innovative Visions for the New Century".* Paper presented at the Fifth UNESCO-ACEID International Conference Bangkok, Thailand.

Mohanlall, F. (2013). Life Sciences teachers' understanding of the nature of science within the context of teaching evolution. Unpublished master's thesis. University of KwaZulu – Natal, Durban, South Africa.

Msibi, T., & Mchunu, S. (2013). The knot of curriculum and teacher professionalism in post-apartheid South Africa. *Education As Change, 17*(1), 19-35.

Mudaly, R., & Ismail, R. (2013). Teacher Learning through Tapping into Indigenous Knowledge Systems in the Science Classroom. *Alternation*, *20*(1), 178 – 202.

Mudulia. A. (2012). The Relationship between Availability of Teaching/Learning Resources and Performance in Secondary School Science Subjects in Eldoret Municipality, Kenya. *Journal of Emerging Trends in Educational Research and Policy Studies, 3*(4), 330 – 336.

Mulholland, J., & Wallace, J. (2003). Crossing borders: learning and teaching primary science in the pre-service to the in-service transition. *International Journal for Science Education, 25*(7), 879-898.

Msila, V. (2007). From apartheid education to the revised national curriculum statement: Pedagogy for identity formation and nation building in South Africa. *Nordic Journal of African Studies,16*(2), 146-160.

Naidoo, K.K. (2008). *Post-graduate physical science teachers' knowledge of and classroom practice in the nature of science in KwaZulu-Natal.* Unpublished master's thesis. University of KwaZulu-Natal, Durban, South Africa.

Naidoo, P. (2010). *Teachers' interpretation and implementation of the policy on indigenous knowledge in the science national curriculum statement*, Unpublished doctoral dissertation, University of KwaZulu – Natal, Durban, South Africa.

Nieuwenhuis, J. (2007). Qualitative research designs and data gathering techniques. In
K. Maree (Ed.), *First steps in research*. Pretoria: Van Schaik.

Nnadozie, I. J. (2009). *The integration of indigenous knowledge systems (IKS) in the teaching
of conservation of biodiversity and natural resources: A critical case study of grade
10 Life Sciences educators in the Pinetown district*. Unpublished master's thesis,
University of KwaZulu – Natal, Durban, South Africa.

Noor, K. B. M. (2008). Case study: A strategic research methodology. *American journal of
applied sciences, 5*(11), 1602-1604.

Ogawa, M. (1995). Science education in a multiscience perspective. *Science Education,
79*(5), 583-593.

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

Ogunniyi, M.B. (2007). Teachers' Stances and Practical Arguments Regarding a Science –
Indigenous Knowledge Curriculum: Part 1. *International Journal of Science
Education, 29*(8), 963 – 986.

Onwu, G., & Mosimege, M. (2004). Indigenous knowledge systems and science and
technology education: A dialogue. *African Journal of Research in SMT Education*,
8(2), 1 – 12.

Owuor, J. (2007). Integrating African Indigenous Knowledge in Kenya's Formal Education
System: The Potential for Sustainable Development. *Journal of Contemporary Issues
in Education, 2*(2), 21 – 37.

Ozer, O. (2004). *Constructivism in Piaget and Vygotsky*. Retrieved September 10, 2014, from http://www.fountain magazine.com/Issue/detail/CONSTRUCTIVISM – in – Piaget – and – Vygotsky.html

Pillay, S. (2006). *Responses of Science Teacher Educators to the Curriculum Change Process in South Africa.* Unpublished doctoral dissertation, University of KwaZulu - Natal, Durban, South Africa.

Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Common core standards the new US intended curriculum. *Educational Researcher*, *40*(3), 103-116.

Prasad, M. V. (2009). Indigenous Knowledge Use in Maize Cultivation in Andhra Pradesh. *Indian Research Journal of Extension Education, 9*(1), 65 – 68.

Rao, V. (2010). *Curriculum Development*. New Delhi: Saurabh Publishing House.

Schiro, M.S. (2013). *Curriculum theory: Conflicting visions and enduring concerns* (2ed.) Thousand Oaks: Sage

Semali, L. M., & Kincheloe, J. L. (1999). What is Indigenous Knowledge and Why Should We study It? In L. M. Semali & J. L. Kincheloe (Eds.), *What is Indigenous Knowledge? Voices From the Academy* (pp. 3 – 57). New York and London: Falmer Press.

Shah, M. Z. (2009). Exploring the conceptions of a science teacher from Karachi about the nature of science. *Eurasia Journal of Mathematics, Science and Technology Education*, *5*(3), 305-315.

Shizha, E. (2007). Critical Analysis of Problems Encounted in Incorporating Indigenous Knowledge in Science Teaching by Primary School Teachers in Zimbabwe. *The Alberta Journal of Educational Research, 53*(3), 302 -319.

Shulman, M. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 152*(2), 4-14.

Singh, S. K. (1998). *Exploring teachers' beliefs about the nature of science and their relationship to classroom practices: A case-study with special reference to physical science teachers in the Empangeni-Richards Bay area*. Unpublished master's theses, University of KwaZulu-Natal, Durban, South Africa.

Snively, G. (1995). Bridging traditional science and Western science in the multicultural classroom. In G. Snively & A. MacKinnon (Eds.), *Thinking Globally about Mathematics and Science Education* (pp. 53 – 75).

Snively, G., & Corsiglia, J. (2001). Discovering Indigenous Science: Implications for Science Education. *Science Education, 85*(1), 6-34.

Solomon, J. (1992). *Getting to know about Energy*. London: Falmer Press.

Spooner, M., Flowers, C., Lambert, R., & Algozzine, B. (2008). Is more really better? Examining perceived benefits of an extended student teaching experience. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *81*(6), 263-270.

Taba, H. (1962). *Curriculum development: Theory and practice*. New York: Harcourt Brace and World.

Talla, M. (2012). *Curriculum Development: Perspectives, Principles and Issues*. Pearson.

Terre Blanche, M., Durrheim, K., & Painter, D. (Eds.). (2006). *Research in practice* (2nd ed.). Cape Town: University of Cape Town Press.

Tyler, R. (1949). *Basic principles of curriculum and instruction*. Chicago: University of Chicago Press.

Van den Akker, J., de Boer, W., Folmer, E., Kuiper, W., Letschert, J., Nieveen, N., & Thijs. (2009). *Curriculum in Development*. Enschede: Axis Media Ontwerpers.

Van Manen, M. (1977). Linking ways of knowing with ways of being practical. *Curriculum inquiry, 6*(3)*,* 205-228.

Weinstein, C. S., Tomlinson – Clarke, S., & Curran M. (2003). Culturally responsive classroom management: Awareness into action. *Theory into practice, 42*(4)*,* 269 – 276.

Wheatley, G.H. (1995). Problem Solving from a Constructivist Perspective. In D.R. Lavorie (Ed.), *Towards a cognitive – science perspective for scientific problem solving: A monograph of the National Association for Research in Science Teaching, 6,* (pp.1 – 12). Ag Press: Manhattan.

Wilson, B. (1981). *Cultural contexts of science and mathematics education: A bibliographical guide*. Leeds, UK: Centre for Studies in Science Education, University of Leeds.

Wilson, N., & McLean, S. (1994). *Questionnaire design: a practical introduction*. Newton Abbey: University of Ulster Press.

WorldBank. (1998). *Indigenous Knowledge for Development: A Framework for Action*. Retrieved October 11, 2013, from http: www. worldbank.org/afr/ik/ikrept.pdf

Zelik, M., Schau, C., Mattern, N., Hall, S., Teague, K., & Bisard, W. (1997). Conceptual Astronomy: A novel model for teaching postsecondary science courses. *American Association of Physics Teachers*, *65*(10), 987 – 996.

APPENDICES

Appendix 1- University Ethical Clearance

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

07 February 2014

Mr Marcell Mc Knight (971162797)
School of Education
Edgewood Campus

Protocol reference number: HSS/0679/013M
Project title: Teachers' experiences of Indigenous Knowledge Systems (IKS) found in the Life Sciences Curriculum: A
case study of Life Sciences teachers at a high school in the Pinetown District.
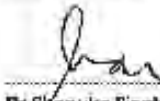
Dear Mr Mc Knight

Full Approval – Expedited

With regards to your response to our letter dated 19 August 2013, the Humanities & Social Sciences Research Ethics
Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent
Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved
through the amendment/modification prior to its implementation. In case you have further queries, please quote
the above reference number.

Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Dr Shenuka Singh [Chair]

/ms

Cc Supervisor: Dr SB Khoza
cc Academic Leader Research: Dr MN Davids
cc School Administrator: Mr Thoba Mthembu

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 Facsimile: +27 (0) 31 260 4609 Email: snymanm@ukzn.ac.za snymanm@ukzn.ac.za mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood   Howard College   Medical School   Pietermaritzburg   Westville

154

Appendix 2 – Principal Consent Letter

<div align="right">
38 Roman Place
Newlands East
Durban
4037
</div>

The Principal

Dear Sir/ Madam
PERMISSION TO CONDUCT RESEARCH AT THE SCHOOL

I am a Masters student in the School of Education at the University of KwaZulu-Natal. My study is entitled: **Teachers' experiences of Indigenous Knowledge Systems (IKS) found in the Life Sciences Curriculum: A case study of Life Sciences teachers at a high school in the Pinetown District.**

The purpose of the study is to explore the teachers' experiences of Indigenous Knowledge Systems found in the Life Sciences Curriculum. I wish to request your permission to distribute a teacher reflection instrument among the Life Sciences teachers and thereafter if necessary conduct interviews

The teachers' participation in this study is voluntary. Teachers may refuse to participate or withdraw from the study at any time with no negative consequences. There will be no monetary gain from participating in the survey. Confidentiality and anonymity of records will be maintained by the School of Education, UKZN.

The study may benefit curriculum developers in teacher-education institutions by evaluating experiences of teachers with regard to Indigenous Knowledge Systems found within the curriculum. Should you have any concerns about the study, you may contact me or my supervisor at the contact details listed below.

Thanking You

_____

Researcher: Mr. Marcell Mc Knight 079 494 5231   email - marcell@webmail.co.za
Supervisor: Dr. S. B. Khoza (031) 260 7595   email - khozas@ukzn.ac.za

Response of Principal:

I…………………………………………………………………… (full   names   of
principal) hereby confirm that I understand the contents of this document, the
nature of the research project and I grant the researcher permission to
distribute a teacher reflection instrument among the Life Sciences teachers
and thereafter if necessary conduct interviews.

…………………………………………   ……………………………
SIGNATURE OF PRINCIPAL   **DATE**

Appendix 3 – Teacher Consent Letter

<div align="right">
38 Roman Place
Newlands East
Durban
4037
</div>

Dear Participant

I am a Masters student in the School of Education at the University of KwaZulu-Natal. A requirement for successful completion of this degree is the completion of a research project. My research project is entitled: **Teachers' experiences of Indigenous Knowledge Systems (IKS) found in the Life Sciences Curriculum: A case study of Life Sciences teachers at a high school in the Pinetown District.**

The purpose of the study is to explore the teachers' experiences of Indigenous Knowledge Systems found in the Life Sciences Curriculum. Therefore, it will be highly appreciated if you could read this document, sign the declaration below and hand it back to me.

The study aims to identify teachers' experiences of IKS, understand teachers' attitudes/beliefs towards IKS as well as understand the influence of teachers' experiences of IKS in teaching. The study may also benefit curriculum developers in teacher-education institutions by evaluating experiences of teachers with regard to Indigenous Knowledge Systems found within the curriculum.

Please take note of the following issues:

1. There will be no limit on any benefit that the participants may receive as part of their participation in this research project;
2. Answer all the questions;
3. Respond to each question in a manner that will reflect your own personal opinion;
4. Your identity will not be divulged under any circumstance;
5. There are no right or wrong answer;
6. All your responses will be treated with strict confidentiality;
7. Real names of the participants will not be used, but symbols such as A, B, C or X, Y, Z … will be used to represent participants' names;
8. The participants are free to withdraw from the research at any time without any negative or undesirable consequences to themselves;
9. The participants will not be under any circumstance forced to reveal what they don't want to reveal.

This research project is supervised by Dr SB Khoza. His telephone number is (031) 260 7595 at the University of KwaZulu-Natal and his email address is khozas@ukzn.ac.za

Thank you for your support, co-operation and valuable time.

M. Mc Knight
Tel.: (031) 577 5701
Cell.: 079 4945231

Please sign the following declaration and include your full names as indicated:

I…………………………………………………………………… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

…………………………………………

SIGNATURE OF PARTICIPANT

……………………………

DATE

Appendix 4 – Questionnaire

Teacher Questionnaire

The purpose of the study is to explore the teachers' experiences of Indigenous Knowledge Systems found in the Life Sciences Curriculum: A case study of Life Sciences teachers at a high school in the Pinetown District.

All responses to the teacher questionnaire are strictly confidential and are for research purposes only.

If you experience any difficulties with the teacher questionnaire, please contact, Marcell Mc Knight, on 0794945231.

THANK YOU

SECTION A: TEACHER BIOGRAPHICAL/GENERAL INFORMATION

Indicate by placing a cross (X) in the appropriate option.

1. Gender:

Male	Female

2. Age Group:

20 – 30yrs	31 – 40yrs	41 – 50yrs	51 – 60yrs	+ 60yrs

3. Teaching Experience in Life Sciences:

1 – 5 yrs	6 – 10yrs	11 – 15yrs	16 – 20yrs	21 – 25yrs	+ 25yrs

4. Indicate the grades you have taught the subject of Life Sciences.

Grade 10	
Grade 11	
Grade 12	

5. List your teaching qualifications?

Degree/Diploma	Institution (in full)	Fulltime or part – time	Date obtained

6. Was Indigenous Knowledge Systems covered in your qualifications?

Yes	No

7. Are there regular meetings/workshops for Life Sciences conducted by the Department of Education for all the grades (10 -12) in the F.E.T band.

Yes	No

8. If no, which grades do not have regular meetings/workshops?

_____

_____

_____

9. Do you or your school belong to any professional organisations or subscribe to magazines/ journals related to the teaching of Life Sciences?

| Yes | No |

10. If yes, please provide details of such professional organizations or magazines/journals.

_____

_____

_____

_____

SECTION B:

The following table is concerned with issues around the nature of science. Please indicate if you agree with, disagree with, or uncertain about each statement in the table by placing an X in the appropriate column. The following key applies to the table:

A	AGREE
DA	DISAGREE
UN	UNCERTAIN

TABLE 1: Nature of Science

NO.	STATEMENTS	A	UN	DA
1.	Scientific knowledge while durable has a tentative character.			
2.	Scientific knowledge relies heavily on observation, experimental evidence, rational arguments, and skepticism.			
3.	There is no one way to do science.			
4.	Science is an attempt to explain natural phenomena.			
5.	People from all cultures contribute to science.			
6.	New knowledge must be reported clearly and openly.			
7.	Scientists are creative.			
8.	Science has both an evolutionary and revolutionary character.			
9.	Science is part of social and cultural traditions.			
10.	Science and technology impact each other.			

SECTION C:

The following table is concerned with issues around indigenous knowledge systems. Please indicate if you agree with, disagree with, or uncertain about each statement in the table by placing an X in the appropriate column. The following key applies to the table:

A	AGREE
DA	DISAGREE
UN	UNCERTAIN

TABLE 2: Indigenous Knowledge Systems

NO.	STATEMENTS	A	UN	DA
1.	Nature is real, and partly observable and testable.			
2.	Time is real, continuous and cyclical.			
3.	All events have only natural causes.			
4.	The universe is orderly, metaphysical (abstract), partly predictable and partly unpredictable.			
5.	Indigenous generalizations have causal, personal, rational/non – rational, logical/non – logical dimensions.			
6.	Language is important as a creative force in the workings of both the natural and the unnatural worlds.			
7.	Indigenous knowledge is culture free.			
8.	Indigenous knowledge is concerned with 'what', 'what ought to be' and 'why'.			
9.	Humans are capable of understanding only part of nature.			
10.	Indigenous knowledge systems only involves traditional healing.			
11.	Indigenous knowledge is constant and does not change over time.			
12.	Indigenous knowledge is well documented.			

Appendix 5 – Lesson Plan Template

Life Sciences: Lesson Plan Sheet

Teacher:		Grade:	
Date:		Venue:	
Duration:		Term:	

Strand:		Topic:	
		Content:	

Specific Aims: (Tick the appropriate aim)	Specific Aim 1: Knowing Life Sciences		Specific Aim 2: Investigating Phenomena in Life Science		Specific Aim 3: Appreciating and Understanding the History, Importance and Applications of Life Sciences in Society	
Prior Knowledge:						

Teacher activities	Learner activities	Resources		Written task or activity
		Chalkboard		
		Charts		
		Posters		
		Magazines		
		Newspaper		
		Video		
		DVD		
		Worksheet		
		Learners		
		Other (list below)		
		Enrichment:		
		Homework:		
		Teacher reflection:		

Additional Notes:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix 6 – Teacher semi-structured interview schedule

1. What is your understanding of the term 'Indigenous Knowledge Systems'?

2. Why are you teaching IKS?

- Why do you think IKS has been included in the Curriculum?
- Does IKS in your opinion add value to the Curriculum?
- Do you think IKS should be included in the Life Science Curriculum?

3. Towards which goals you teaching IKS?

4. What content are you teaching?

- Which topics related to IKS have you taught?

5. What materials and resources do you use when teaching IKS?

6. Where are you teaching IKS?

7. What activities are you using to teach IKS?

8. How do you assess IKS?

9. When do you teach IKS?

- Allocation of the same amount time for areas of IKS in relation to other areas of content.

10. With whom are you teaching? / Who are you teaching?

11. When attending Departmental meetings/workshops related to Life Sciences curriculum, what issues are discussed?