An Exploration of Basic 7-9 Science and Technology Teachers' Conception of IK as drawn from their lived Experiences and Classroom Practices in Imo State Nigeria

by

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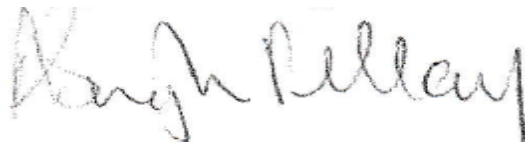
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FEBRUARY, 2015

DECLARATION

I declare that **" An Exploration of basic 7-9 science and technology teachers' conception of IK as drawn from their lived experiences and classroom practices in Imo State Nigeria"** is my own work and that all the sources I have used or quoted, have been indicated and acknowledged by means of complete references.

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ETHICAL CLEARANCE

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31 October 2014

Mr Godson Chinenye Nwokocha (212558483)
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Dear Mr Nwokocha,

Protocol reference number: HSS/1206/014M
Project title: Exploration of Basic 7-9 Science and Technology teachers' conceptions of Indigenous Knowledge as drawn from their lived experiences and classroom practices in Imo State, Nigeria

Full Approval – Expedited Application

In response to your application received on 17 September 2014, 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.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

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

Yours faithfully

Dr Shenuka Singh (Chair)

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DEDICATION

This work is dedicated to my dearest mother and my beautiful wife for their love and unwavering support.

ACKNOWLEDGEMENTS

ABSTRACT

The importance of contextualising science and technology education in Africa through the integration of Indigenous Knowledge (IK) or Indigenous Knowledge Systems (IKS) has been long emphasised. Some research studies focusing on teachers' conceptions and understandings of indigenous knowledge/indigenous knowledge systems and ways of integrating them into their pedagogical activities has been conducted in many countries across Africa. However, within the Nigerian educational context, there seems to be a lack of such articulate discussions. It is against this background that this study sought to explore basic 7-9 science and technology teachers' conceptions of indigenous knowledge as drawn from their lived experiences and classroom practices in Imo State, Nigeria.

The research was framed under the interpretivist paradigm and conducted within a qualitative case study methodology. Selection of the participants was based on convenient and purposive sampling. The data was analysed and discussed in relation to postcolonial theory and inter-epistemological dialogue. The methodology involved a three phased data collection using narratives and three focus group discussions. The study considered two research questions, namely:

- *What are the conceptions of basic 7-9 science and technology teachers' of IK in Imo State, Nigeria as drawn from their narratives about IK?*

- *Are these conceptions enacted in the classroom? (a) If so, how are they being enacted and what informs their enactment? (b) If not, what informs their practice?*

Analysis of the data collected showed that five conceptions were held by the participants, namely: *Informal Knowledge*, *Relational Knowledge*, *Traditional Knowledge, Technological Knowledge* that is scientifically based and *Lost Knowledge*. Furthermore, the analysis revealed that five key qualifying components were embedded in their conceptions of IK, these were classified as the "*what*" (properties), the "*how*" (process) the "*where*" (place or source) the "*who*" (holders) and the "*when*" (time or era). In addition the analysis showed that two conceptions (*Relational Knowledge* and *Technological Knowledge* that is scientifically based) out of the five were enacted by some of the teachers. On what informs the enactment of these

conceptions, the analysis revealed that different factors informed their enactment and these included the need to: *link local knowledge to western and school knowledge*; *facilitate understanding; understand how some local knowledge should be applied and developed*; and *provide avenues for enculturation.* Additionally, in their enactment of their IK practices, the analysis seems to point to a very pertinent issue: the participants play a significant role as teachers, that is, that of *cultural brokers*. In other words, they encouraged *inter-epistemological dialogue*.

For the two participants that do not enact their IK conceptions in the teaching of basic 7-9 science and technology, the analysis showed that four key issues inform their pedagogical activities: curricular issues; lack of teaching resources; learner ability; and workload. One key revelation of the analysis is that even though these teachers hold certain conceptions and understanding of IK, their teaching practices are not informed by such conceptions. It is obvious that these teachers, supposedly *cultural brokers*, failed to encourage epistemological dialogue in their classroom even though they are appropriately positioned to do so. This situation means that science and technology will have little or no meaning to learners' because it will always remain at a remove and hence a mystery in terms of their lived experiences.

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ABBREVIATIONS

IK   INDIGENOUS KNOWLEGDE

IKS   INDIGENOUS KNOWLEGDE SYSTEM

I-TECH   INDIGENOUS TECHNOLOGY

AIK   AFRICAN INDIGENOUS KNOWLEDGE

AIKS   AFRICAN INDIENOUS KNOWLEDGE SYSTEM

CHAPTER 1: INTRODUCTION

1.1 Introduction

It has been argued that the delivery of school science and technology across Africa does not take into consideration learners' socio-cultural background and ways of knowing (Ogunniyi & Ogawa, 2008). In other words, there seem to be a cultural mismatch between home and school (science and technology) culture and perhaps this situation limits the academic achievements of indigenous learners. This has led to calls for the rebirth and re-curriculisation of science and technology in Africa (Semali & Kincheloe, 1999; Emeagwali, 2003; Eze & Ike-Nne, 2013). In this regard, scholars such as Jegede (1999) proposed the implementation of context familiar educational policies and pedagogical approaches, conceptualised as a "cross-cultural paradigm" for teaching science and technology in schools across Africa. According to Jegede (1999), many teachers have lamented the abstract delivery of school science and technology, given that it does not integrate or ever consider learners' socio-cultural knowledge and identities. In agreement with the above view, Gallivan (2014) contends that teachers must adopt appropriate teaching strategies to effectively teach students whose cultural backgrounds and experiences differ from school culture and expectations. Therefore designing and adopting a cross-cultural curriculum and pedagogy is imperative as it will best serve the interest of indigenous learners across Africa.

In the light of these developments, scholars such as Kriek and Basson (2008) suggest that knowing teachers beliefs and conceptions about curriculum (content) and practice is vital, given that they are the ones who implement the curriculum in the classroom. Reasoning along the same line, Gallivan (2014) suggests that teachers bring certain conceptions about students and teaching to the teaching profession and these conceptions may impact their chances of successfully implementing a culturally relevant curriculum. Agreeing to this, Keys and Brayan (2001 cited in Jones & Carter, 2007) maintain that every aspect of teaching is influenced by complex conceptions (beliefs) and attitudes that teachers hold, including knowledge acquisition and interpretation, defining and selecting instructional tasks and interpreting course content. It can, therefore, be considered necessary to explore teachers' conceptions and views about the curriculum and contents thereof. It is assumed

that the teachers' conceptions and views about particular content will influence the way in which they implement that content in the classroom. Drawing from the forgoing premises, this study seeks to explore, through employing a qualitative case study methodology, how basic 7-9 science and technology teachers conceive Indigenous Knowledge (IK) in Imo State, Nigeria.

1.2 Purpose and significance of the study

The purpose of the study is to explore basic 7-9 science and technology teachers' conception of IK as drawn from their lived experiences and classroom pedagogy in Imo State, Nigeria, and to explain whether these conceptions are enacted in the classroom and what informs their enactment. Thus, this study will be beneficial to pre- and in-service basic science and technology teachers, policy makers, and learners. The study will contribute to the existing literature on conceptions of IK from the perspectives of teachers. It will provide a platform for looking at ways to integrate Nigeria's rich IK and practices into the basic 7-9 curriculum, given that no research has been conducted so far to explore teachers' conceptions of IK in Imo State in particular and in Nigeria in general. It will thus be beneficial to policy makers, curriculum developers and teacher training programmes in Nigeria. In addition, this research study may help me and the participants to engage in reflective nuanced practice regarding integration of IK into the basic 7-9 science and technology curriculum.

1.3 Rationale for the study

In retrospect, my interest in IK in general and this topic in particular evolved from personal experiences of, and interactions with, a range of indigenous practices while growing up in Imo State, Nigeria. I was often bored with the abstract nature and delivery of basic science and technology lessons in school, yet I was intrigued by the chores that I did at home such as the processes and procedures of indigenous food and beverage preparation. It has now dawned on me that processes and procedures of indigenous food and beverage preparation (in particular) using local or traditional methods and skills were re-enacted in lesson contents and practical demonstrations in basic science and technology subjects during my primary and secondary school days without being acknowledged or mentioned as such. The use of indigenous local food preparation and processing technologies could have been deliberately used to enhance basic 7-9 school science and technology delivery in Nigeria

My lived experiences spurred me into thinking and believing that local, indigenous and contextual processes and knowledge can be very useful in enhancing the content delivery of basic 7-9 science and technology curriculum in Nigeria. Given that the delivery of basic science and technology in schools is still approached abstractly there is a dire need to engage with this challenge by exploring basic 7-9 science and technology teachers' conception of IK as drawn from their lived experiences and classroom practices. The disjuncture between my lived experiences in terms of IK practices and the contents of the basic 7-9 science and technology curriculum serves as a platform for this study.

In addition, scholars such as Jegede (1999), Emeagwali (2003), Onwu and Mosimege (2004), Nel (2005) and Eze and Ike Nnia (2013) have been advocating for a re-think or re-curricularisation of the school science and technology curriculum especially in the Africa context in order to make the teaching and learning of science and technology in schools contextually relevant. However, in Nigeria the discourse on re-inventing the science and technology curriculum in high school in order to make it contextually relevant and embrace IKS like in other countries is noticeably absent. The Nigerian education system and education managers' continued silence about the re-thinking of the science and technology curriculum has catalysed my interest in undertaking this research work. It is expected that these concerns (silence and dearth of research in terms of teachers' conceptions of IK and re-curricularisation of basic technology and science in Nigeria) will be significantly addressed through this research.

1.4 Statement of the problem

According to Jegede (1995) the study of science and technology in Africa is presumably an effective means of scientific literacy, technological advancement and national development. However, its delivery or presentation is largely restricted to providing information or facts rather than encouraging and nurturing creative/reflective thinking and personal construction of knowledge. As pointed out before, Jegede (1995) further asserts that the teaching of science and technology in African classrooms does not proceed from, or even connect to, the learners' sociocultural environment. In other words, the delivery of science and technology in African classrooms is at a remove from learners lived or daily

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experiences, it does not take into account or seek to explain learner's daily experiences or interaction with local science and technology (Jegede, 1995).

Jegede (1999) maintains that there is a sharp decline in the number of learners and students undertaking science and technology subjects in schools even though science and technology subjects supposedly present better educational and work opportunities/benefits. A decade later the above status quo prevails and Naidoo (2010) concurs with Jegede (1999). This decline according to Jegede (1999) and Ogunniyi (2000) is perhaps traceable to poor pedagogical practices (curriculum implementation) or lack of relevance of school science and technology to learners worldviews. The argument of the above scholars is sustained by Semali and Kincheloe (1999) who assert that science and technology curriculum that recognises student's ways of knowing (such as those available in South Africa today) will attract and sustain learners' interest in science and technology. Thus, it can be said that a science and technology curriculum that does not take into consideration learners worldviews (i.e. IK) will be difficult to implement in African classrooms, given that learners' everyday experiences are unrecognised.

Given the foregoing concerns about the abstract delivery of science and technology in schools that enroll high number of indigenous learners, Cajete (1999), Nel (2005) and Brayboy and Castagno (2008) advocate a renaissance or re-curriculisation of school science and technology in schools. In this regard, Semali and Kincheloe (1999) call for a contextually relevant curriculum and appropriate pedagogical practices that initiate and sustain the interest and performance of indigenous learners in science and technology across Africa.

In keeping with the foregoing assertion, (Nel, 2005) and (Brayboy & Castagno, 2008) highlight vital reasons why educators should engage in culturally responsive schooling for indigenous learners. These include what learners/students come to school with and what educators want them to leave school with. Therefore, there is a growing need to encourage culturally responsive schooling and to prepare teachers that can oversee this type of schooling because learners/students bring different learning styles and cultural practices that leads to incongruity between teaching and learning (Brayboy & Castagno, 2008). Accordingly, teachers should be able to harmonise the difference or conflicts that exist between what students come to school with (their ways of knowing) and what they want them to leave with (western science and technology).

Fundamentally, a culturally relevant schooling approach requires shifts in teaching methods, curricular materials, teacher dispositions, and school-community relations (Brayboy & Castagno, 2008). Firstly, teachers need to be adequately prepared to undertake the implementation of such a curriculum. So, effective implementation of a contextually relevant curriculum (IKS/Science and Technology curriculum) requires that the teacher will have knowledge of what IK represents before they can teach it. As stated by Grange (as cited in Nnadozie, 2010), effective implementation/integration of IK in science classrooms can only be achieved if teachers understand what integration of IK means and have the competence to properly integrate IK in their teaching. Thus, teachers need to be adequately prepared to undertake the implementation of such a curriculum. Also, the identity of teachers, that is to say, who they are in school and out of school, is the foundation upon which education can be built in each classroom context (Yazzie-Mintz, 2007). This implies that the belief/being of teachers and their conceptions of IK together with social cultural context of the school is of critical importance as it plays an essential role in the teaching and learning of science.

Having said that, it is important to explore teachers' conceptions of IK and how it can influence their teaching. In line with the forgoing, Basson (2008) maintains that knowing teachers conceptions about any curriculum reform/change is vital, given that the failure or success of the curriculum lies in their hands. It is against this background that this work position itself to explore basic 7-9 technology teachers' conception of IK system in Imo State, Nigeria using a qualitative research methodology. Thus, this study will explore the following research Questions:

1. What are the conceptions of basic 7-9 science and technology teachers' conceptions of IK in Imo State, Nigeria as drawn from their narratives about IK?
2. Are these conceptions enacted in the science and technology classroom?
   (a) If so, how are they being enacted and what informs their enactment?
   (b) If not, what informs their practice?

1.5 Objectives of the study

The objectives of this study are to:

1. Identify basic 7-9 science and technology teachers' conceptions of IK in Imo State, Nigeria as drawn from their lived experiences and classroom pedagogy.

2. Explain the extent to which these conceptions are enacted in the basic 7–9 science and technology classroom.

   (a) And, if indeed they are enacted, to determine what informs their enactment.

   (b) And, if they are not, to explore what really informs these teachers practice.

1.6 Context of the study

This study is located within Owerri Metropolis, Imo state (South East), in Nigeria (see Figures 1 and 2). Imo State is about 12,689 square kilometres with 2,938,708 people living in the state. Imo state is home to the Ibo tribe in Nigeria and the language of communication is the Igbo language. The indigenous or traditional practices in Imo state include indigenous farming, fishing, music, clothing, folklore, sports, court system, traditional marriage etc. Owerri is the administrative headquarter (capital) of Imo State, Nigeria. Being, the state headquarters, the schools located within Owerri are expected to offer better learning facilities to the learners than other schools within the state (those located in the rural areas). There are 27 local governments in Imo state of which Owerri municipality/metropolis is one of them. There are 10 basic (secondary) schools, located within Owerri Metropolis, Imo State and there is an average of 20 basic 7-9 science and technology teachers at these 10 schools. It is interesting to note that in spite of Owerri being the administrative headquarter of Imo state, two out of the three schools where this research was conducted that are managed by the state government have inadequate learning facilities and thus can be classified as an under-resourced schools. Teachers and learners in these schools are highly disadvantaged in terms of basic facilities for teaching basic science and technology. Nevertheless, the teachers in these two schools ensure that the teaching and learning of basic 7-9 science and technology is as exciting and informing as possible.

On the other hand, the third school which is managed by the federal government enjoys a lot of modern learning facilities and resources such as modern ICT facilities, library, science laboratory and technology workshop etc. This school can therefore be classified as a "well-resourced school". The school provides a better opportunity for teachers and learners to engage in comprehensive teaching and learning of basic science and technology. The teachers in all the schools where this research was conducted share the same cultural background as the learners. The teachers and learners are mostly Igbo speaking from South East Nigeria and come from similar economic backgrounds (homes).

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This perhaps facilitates the teaching and learning of basic science and technology and also presents the opportunity of synchronizing school culture and learners' cultures.

Figure 1: Map of Nigeria Showing Imo State
(www.en.wikipedia.org/wiki/Imo_State)

Figure 2: Map of Imo State Showing Owerri Municipality
(www.imostategovernment.blogspot.com)

1.7 Outline of the study

This chapter which is the introductory chapter outlines the background of the study, the purpose and significance of the study and the rationale behind the study. Also, this chapter presents the objectives of this study, the critical research questions, the problem statement and context/location of the study.

Chapter 2 is the literature review of the study. It explores literature dealing with IK and indigenous knowledge systems, an overview of basic science and technology curriculum in Nigerian, school science and technology curriculum across. This chapter also considers literature on teachers' conceptions of IK in the classroom and an outline of IK (indigenous technology) across Nigeria.

Chapter 3 discusses the theoretical underpinning of this research study, namely, post-colonial theory. The chapter provides the historical background and emergence of post-

colonial theory, post-colonial theory in science education and the application of post-colonial theory to this study.

Chapter 4 explores the research methodology guiding this research. This includes the research paradigm, type of research, methods of data collection, sampling and sample size, location of the study, validity of the research data analysis, ethical issues and limitations of the study.

Chapter 5 focuses on the data analysis and presentation. Furthermore, the findings for Phase One and Phase Two dealing with Research Question One and Two respectively are presented in this chapter.

Chapter 6 discusses the key research findings as they relate to critical issues raised in the review of literature and the theoretical framework. Recommendations for teachers, educational gatekeepers and further studies are presented.

1.8 Conclusion

This chapter provided a detailed overview of this research study. The chapter presented the rationale, the background information and the context of the study. Furthermore, the chapter presented the research questions, the objectives of the study and the outline of the study. The next chapter will be a review of relevant literature.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

There have been increased discussions and contestations around IK and indigenous knowledge systems (IK) and the diversity of students in the classroom in post-colonial Africa. Many scholars such as Ogunniyi (2000), Nel (2005) and Ezeh and Ike-Nnia (2013) have lent their voices in support of the concept while some have questioned the rationale behind the sudden interest and advancement of IK within the academy. Irrespective of these conflicting voices or perspectives, some critical steps have been taken towards cementing the place of IK/IKS in the academy (from primary school to the tertiary) in many countries. Countries like South Africa, for instance, have moved a step further by integrating their numerous IK practices into their science and technology curriculum. This was done in order to make the teaching and learning of science and technology effective and relevant to learners (Nel, 2005). Despite these "positive" developments, some researchers such as Ogunniyi (2000) suggest that the interface between IK and school science has been neglected by curriculum developers and academic gate-keepers until recently. Agreeing to this, Quigley (2009) maintains that current literatures related to diversity of students in the classroom does not address complex issues of indigenous learners or students and IK in their postcolonial environment. As a result of this Quigley (2009) argues for the need to promote and support IK.

In the light of these developments, this chapter will first explicate the concepts "indigenous knowledge" and "indigenous knowledge systems" by way of definitions. Second, this chapter will examine the basic science and technology curriculum in Nigeria and the position of IK (space for IK integration) in formal schooling arrangements. Furthermore, the chapter will consider the curriculum and delivery of basic science and technology across Africa. In addition, this chapter will discuss the need to explore teachers conceptions in relation to the curriculum and pedagogy. The last part of this chapter will outline some notable IK practices in Nigeria and beyond as a way of making a case for the inclusion of such practices in formal schooling arrangements in Imo State Nigeria.

2.2 Definition of the term "indigenous"

According to Vandeleur (2010) there is no consensus on the definition of the term "indigenous" and arriving at a universally acceptable definition seems to be a difficult task. Despite that, various interesting conceptions have emerged on the term "indigenous". Literally, the term indigenous can be defined as original, native to a place or aboriginal people to an area (Mawere, 2014). According to the International Labour Organisation (1989 cited in Vandeleur, 2010), the term indigenous applies to

> Tribal peoples in independent countries whose social, cultural and economic conditions distinguish them from other sections of the national community, and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations

Indigenous people are found in various parts of the world, and within one country there can be different indigenous people/groups (Nnadozie, 2010). For instance, the Shona and Ndebele people in Zimbabwe, the Ibo and Ijaw people in Nigeria. Essentially, indigenous people are commonly bound by socio-cultural and environmental traits. This implies that indigenous people share the same language, tradition and values; hence, they are easily identified by these obvious characteristics. Therefore, it may be said that the term "indigenous" is synonymous with the term "native" and it refers to the people and places bound by common traits. This category of people and places are distinguished from the larger society by their language, culture and value system.

2.3 Definition of the term "indigenous knowledge"

Indigenous knowledge, also known as Traditional Knowledge, Community Knowledge or Native Knowledge (Mapara, 2009) circles have received visible interest and wide publicity in recent times, especially within the academic domain across Africa. Nonetheless, IK is yet to receive a universally acceptable definition, perhaps because of the variations and mode of application of the concept in different localities and disciplines (Battiste & Henderson, 2000, cited in Onwu & Mosimege, 2004). That notwithstanding, many scholars have proffered some tangible perspectives and definitions of what IK represents. According to Takawira (2002 as cited in Zazu, 2008), IK is local community based knowledge that exists uniquely in a given culture and evolves from one generation to another. This knowledge is a reflection of the norms and values of that community as well as the relationship between the people and the environment. In concurring with the forgoing perspective, Melchias (2001 cited in Eze & Ike Nnia, 2013) conceptualised IK as

what indigenous people know and do and what they have known and done for ages – that is, practices that evolved through continuous trials and errors and proved to be dependable. (Adewopo, 2014)

Agreeing with this, Njoku (2001 as cited in Higgs & Van Niekerk, 2002) offered a somewhat elaborate view of IK as a form of knowledge coming from native or local people themselves, this type of knowledge includes knowledge available in the land, in its past and present, its culture, its memory, its geography and its linguistic heritage. In keeping with the above assertion Zazu (2008) presented a more succinct definition of IK as "Contents (facts), processes (methods) and practices (application) relating to communities, their knowledge, cross-generational mechanisms and associated daily practices" (Zazu, 2008).

Looking critically at the forgoing definitions, it can be said that IK, community knowledge or native knowledge (Mapara, 2009) is an evolving local or community form of knowledge, contents, practices and ways of knowing and living of a particular people inhabiting or occupying a particular space or locality. This knowledge is created by the interaction of the people with each other and with the environment. Such knowledge is rooted in the tradition of that particular indigenous group and by virtue of being a member of that community or locale you may have access to them. Hence, IK does not exist in vacuum, rather, it is purely community based and it can only be accessed through the community where it is operational. Thus, IK is not book learnt, but is handed down from one generation to another (inter-generational) orally or via apprenticeship by those who hold it such as elders (experienced practitioners) in the community (Mawere, 2014). This means it is epistemologically and methodologically different from western science and technology which is basically acquired through formal schooling arrangements (Agrawal, 1995). It is significant to note that both worldviews employ different approaches to investigate reality (Agrawal, 1995) given that science is based on a mechanistic paradigm, while on the other hand IK is based on an anthropomorphic paradigm (Ogunniyi 1988 cited in Ogunniyi, 2000). The next section will provide some perspectives on IKS.

2.4 Definition of the term "indigenous knowledge systems"

Evidently, "indigenous knowledge" is often used interchangeably with "indigenous knowledge systems" in most cases (Nnadozie, 2010; Mawere, 2014). Consequently, it has

become imperative to further explicate the difference between these concepts especially for the purpose of this study. According to Hoppers (2002 as cited in Nnadozie, 2010) IKS is a combination of different facets of IK of indigenous people which is technological, medical, scientific etc. Mawere (2014) explains that "indigenous knowledge" and "indigenous knowledge systems" can be applied to mean one and the same thing and thus can be used interchangeably because the former derives its meaning from the latter. Similarly, Onwu and Mosimege (2004) define IKS as a variety of knowledge that covers technologies and practices that were used and are still being used by indigenous people for existence and survival in various situations and environments. Such knowledge evolves as it interacts with internal and external circumstances. This knowledge covers areas such as medicinal and indigenous plants, agriculture, engineering, government and other social systems (Onwu & Mosimege, 2004). Therefore, it can be concluded from the above that IKS is an assemblage, a combination, a convergence or an intercourse between these distinct but interwoven knowledge forms.

In keeping with Onwu and Mosimege's (2004) observation, roughly a decade later Eze and Ike Nnia (2013) re-echoed Onwu and Mosimege's assertion by stating that IKS is a knowledge system that enables indigenous people to survive, to manage their natural resources and the ecosystems around them such as animals, plants, rivers, seas, natural environment, economic, cultural and political organisation. The knowledge of these elements forms a set of interacting units known as the indigenous "coping systems" (Eze & Ike Nnia, 2013). Eze and Ike Nnia (ibid) further explain that IKS is a convergence between the economic, ecological, political, and social environments within a group with a strong identity, drawing existence from local resources through patterned behaviours that are transferred from one generation to another to enable them to cope with changes in the environment. These patterns are sustained by micro level institutional arrangements vested with different responsibilities that ensure the group's continuous survival (Eze & Ike Nnia, ibid). In other words, there is a well-established institution or body (custodian arrangement) in those communities where these knowledge systems exist that ensures the survival of the people and sustainability of the knowledge forms. Thus, contrary to western perspective that IK and IKS are primitive, unreliable and empirically unverifiable (Semali & Kincheloe, 1999; Mapara, 2009; Eze & Ike Nnia, 2013), in actual fact IK and IKS are properly planned and patterned knowledge systems that sustained and still sustain the holders in different circumstances. It can be seen from the forgoing that IK is an integral

subset of IKS and both concepts have been used interchangeably in many academic discussions.

2.5 Indigenous technology (I-Tech) – an explication

Having defined IK and IKS, it will be appropriate to throw more light on indigenous technology given the critical role it plays in the day-to-day activities of most indigenous people and places (especially in Imo State, Nigeria).

Amara (1987 as cited in Mensah 2006) defines indigenous technology as traditional approaches or methods and skills used to transform locally available materials concerned with the production process into products, either for trade or for family consumption. In addition, Mensah (2006) explains that recent literatures refers indigenous technology as techniques and crafts embedded in local customs and traditions (of indigenous people) and passed from one generation to another. Mensah (2006) emphasised that such technologies are not static but fluid, thus they can be modified in order to improve their efficiency and output. However, according to Menseh (2006) this modification can only be achieved by acquiring technological literacy and capability in school. In this sense, the school should employ contextually relevant or everyday activities (indigenous technology) as a starting point for teaching technology rather than starting with abstract processes and models (Mensah, 2002).

Furthermore, Maluleka, Wilkinson and Gumbo (2007) define indigenous technology as the use of technological knowledge, skills and resources developed and transmitted by indigenous people to their young ones in their cultural settings to manipulate the environment in order to meet their everyday needs and wants. Drawing from the above definitions, it can be contended that indigenous technology are practices, crafts, methods or techniques employed by local or indigenous people to transform locally available resources or raw materials into products and services for personal or community usage and trade. These practices or crafts are rooted in the tradition and customs of that particular indigenous group or people and transferred from one generation to another. In addition, indigenous technology is not book learnt; however it can be enhanced through formal schooling.

2.6 Nigerian basic science and technology curriculum framework – an overview

Scholars such as Emeagwali (2003), Awofala, Olu-Oluwa and Fatade (2012) and Ukeje (1966 cited in Ezeudu, Nkokelonye and Ezeudu, 2013) have been advocating for educational reforms in Nigeria at the level of primary and secondary schools for many decades. As a result, a new Basic Education syllabus (known as Basic-9 Education approaches) was approved by the Nigerian National Council of Education in December 2005. This Basic-9 education syllabus was necessitated by current and emergent changes in the society such as rapid pace of technological development and its effect on the environment, especially in the area of science and technology (Danmole, 2011).

According to Danmole (2011), basic science and technology components occupy a very prominent position in the overall curriculum because topics in science and technology constitute core or compulsory content of the new curriculum from lower Basic through Middle to Upper Basic levels. The ultimate goal and rationale/philosophy of the curriculum was to develop complete citizens that will contribute to national development by inculcating the right values, skills and knowledge. In this respect emphasis on the new basic science and technology curriculum dwelt on the acquisition of technological skills and scientific knowledge with the assumption that development of scientific and technological literate learners will lead to the social-economic transformation of the country. Thus, the content areas for basic science and technology were designed with the above premises in mind.

However, IK was not given adequate consideration in the Nigerian situation, even though IK has become part of the core content areas in many countries like South Africa, Canada, India and Kenya in order to resolve the cultural disparity that exists between learners home and school culture in those countries (Aikenhead & Jegede, 1999). This inattention or deliberate omission of relevant IK practices in the new curriculum implies that the teaching and learning of basic science and technology will remain detached from learners' home culture. Perhaps, this cultural mismatch between students culture and school culture can limit the academic achievements of IK and this means that schools will continue to impart knowledge with little or no reflection on learners' life context. As Ukeje (1966 as cited in Ezeudu, Nkokelonye & Ezeudu, 2013: 79) reasoned "Schools taught children what to think not how to think. Children learnt to memorise but not to digest; and to adopt not to adapt". In other words, the science and technology curriculum and teachers pedagogical practices

in Nigeria is not consistent with learners' ways of knowing. Perhaps, the teachers' classroom practices are in line with the demands of the curriculum. Ukeje (1966 cited in Ezeudu, Nkokelonye & Ezeudu, 2013: 179) further expressed his concerns about the nature of science and technology in Nigeria by asking the following questions.

1. How long shall western education and indigenous education work at cross purposes (in isolation)?
2. What aspects of indigenous education can be integrated with western education?
3. What would have been the fate of Ibo science if western education had not been superimposed on it? (p. 179)

In the light of these points, Ezeudu, Nkokelonye and Ezeudu (2013) posit that secondary school level education should champion the revitalisation of indigenous scientific and technological culture among Nigeria learners. In consideration of the foregoing concerns, it can be concluded that a synergistic relationship rather than a dichotomous relationship between IK and western science and technology will benefit learners more and also contribute to the advancement of basic science and technology. Therefore, basic 7-9 science and technology content areas in Nigeria should by implication of the foregoing be relevant and practicable to learners and students daily experiences or home culture.

2.7 School science and technology and pedagogy in Africa – reason for the heightened interest in IK

According to Jegede (1995), the study of science and technology in Africa is presumably an effective means of scientific literacy, technological advancement and national development. However, its delivery is largely restricted to giving information or facts rather than encouraging and nurturing creative and reflective thinking and personal construction of knowledge. Jegede (1995) as well as Ogunniyi and Ogawa (2008) assert that the teaching of science and technology in African classrooms does not proceed from, or even connect to the learners' sociocultural environment. In keeping with the above assertions, Semali and Kincheloe (1999) contend that the school science and technology curriculum being delivered in African classrooms is not in touch with the socio-cultural realities of the African learners, rather it is a reflection of the colonial culture. In other words, the delivery of science and technology in African classrooms is not synchronised with learners' lived or daily experiences and home culture; it does not take into account or seek to explain learners' daily experiences or interaction with local or indigenous

knowledge (Jegede, 1995). Furthermore, scholars such as Le Grange (2004) maintain that western science and technology have failed to provide solutions to persistent environmental challenges across the globe; even though the majority of these problems were generated by western science and technology. As a result of this, it is pertinent to seek for alternative home-grown (IK) approach(s) in order to curb the worsening environmental issues. Given the foregoing concerns about the abstract delivery of science and technology in schools across Africa, and the failure of science and technology to provide solutions environmental challenges. Cejete (1999), Le Grange (2004), Nel (2005) and Brayboy and Castagno (2008) advocate for a renaissance or re-curricularisation of school science and technology in Africa. It is in this regard that Semali and Kincheloe (1999) and Aikenhead and Jegede, (1999) call for a contextually relevant curriculum and appropriate pedagogical practices that initiate and sustain the interest and performance of indigenous learners in school science and technology across Africa.

According to Aikenhead and Jegede (1999), a science and technology curriculum that recognises students' ways of knowing (such as available in South Africa today) will attract and sustain learners' interest in science and technology. Thus, it can be said that a science and technology curriculum that does not take into consideration learners' worldviews (particularly IK) will be difficult to implement in African classrooms given that learners' everyday/lived experiences are unrecognised (Emeagwali, 2003). It will also be taken to imply that any science and technology curriculum and pedagogy that does not respond to contextual and environmental challenges of the indigenes is irrelevant or unsuitable in that context.

2.8 Teachers' conceptions and incorporation of IK in the classroom

Brayboy and Castagno (2008) highlight vital reasons why educators should engage in culturally responsive schooling for indigenous learners. This includes what learners or students come to school with and what educators want them to leave school with. Therefore, there is a growing need to encourage culturally responsive schooling and to prepare teachers so that they can oversee this type of schooling because learners or students bring different learning styles and cultural practices to the classroom. This is to avoid the incongruity that results when what the learners bring into the classroom and what they are taught and learn in school are not appropriately aligned (Brayboy & Castagno, 2008). In this regard, Gallivan (2014) suggests that teachers must learn and develop novel

instructional methods in order to successfully teach students whose cultural background and lived experiences differs from the school's culture. In this case, the students' cultural background and lived experiences may be used as strengths and learning tools rather than as shortfalls for their learning.

Moving forward, Le Grange (2004 as cited in Nnadozie, 2010) emphasised that effective incorporation or integration of IK in science classrooms can only be achieved if teachers understand what IK and its integration means and have the competence to properly integrate IK in their teaching. Thus, teachers need to be adequately prepared to undertake the incorporation and implementation of such a curriculum.

Importantly, the identity and beliefs of teachers, that is who they are in school and out of school, is the foundation upon which education can be built in each classroom context (Yazzie-Mintz, 2007). This implies that the beliefs and identity of teachers and their conceptions and understandings of IK practices together with their social realities is of critical importance as it plays an essential role in the implementation of a culturally responsive and inclusive science and technology. Hence, the focus of this study is on teachers' conceptions of IK as drawn from their lived experiences and classroom pedagogy.

Scholars such as Kriek and Basson (2008) emphasised that knowing teachers conceptions and perceptions about any curriculum is vital, given that they are the ones to implement it in the classroom. This is in line with the submission of Keys and Brayan (2001 cited in Jones & Carter, 2007) that every aspect of teaching is influenced by complex beliefs and attitudes that teachers hold, including knowledge acquisition and interpretation, defining and selecting instructional tasks and interpreting course content. For instance, a study conducted by Ogunniyi (2000) indicates that teachers are more inclined to scientific worldviews regardless of the fact that they hold certain anthropomorphic conceptions of various natural phenomena. This inclination to scientific worldviews over indigenous beliefs perhaps inadvertently destroys peoples sense of identity and traditional worldviews (Ogunniyi, 2000). Hence, Ogunniyi (2000) suggests that there is need for science teachers to make their learners aware of the difference between school science and their personal beliefs as teachers.

In this light, it is essential to explore teachers' conception and understanding of the curriculum and its content areas. Their conceptions and views about the curriculum and

content together with their personal beliefs will affect the delivery of such a curriculum (both positively and negatively). For instance, if they feel some aspects of the subject are irrelevant to the learners, or if they lack basic understanding of some topics/subjects, they may not teach those aspects even if they are required to do so. Rather they will consider it a waste of time. So, when they develop a negative attitude about certain aspects of the subject implementing it in the classroom becomes a problem. On the other hand, if they feel strongly about certain content areas, then they will teach it with great passion.

In a similar vein, Gallivan (2014) maintains that teachers hold certain conceptions about teaching and learning and these conceptions may impact their choices to implement a culturally relevant education. According to Gallivan (2014), poor and stereotypical conceptions about students and teaching will adversely affect the delivery of a context familiar curriculum framework and performance of indigenous students. This is to say that certain conceptions and beliefs held by teachers in terms of the curriculum or aspects of the curriculum (such as IK) and learners (students) affects their classroom practices. Thus, it can be contended that science and technology can be effectively advanced in Imo State Nigeria by exploring IK in order to understand basic science and technology teachers conceptions of IK.

2.9 Past and present indigenous practices and inventions across Nigeria and beyond – some notable examples

It is significant to note that every tribe or community in Nigeria is gifted with one IK (practice) or another and these practices have contributed and still contribute to national development and global competitiveness (Siyanbola *et al.*, 2012). Remarkable examples of these practices or technologies include the fabrication of talking drums in Oyo (south-west Nigeria), pottery work in Igbo-Ukwu (south-east Nigeria), fabrication of aluminum pottery in Saki (south-west Nigeria), the production of beads in Bida (north-west Nigeria), bronze casting in Benin (south-west Nigeria), soap production in Imo, Abia and Anambra (south-east Nigeria), leather tanning in Sokoto, Zamfara, Kano, Jigawa, Bauchi and Borno states (all in northern Nigeria) (Ozioko, Igwesi & Eke, undated; Emeagwali, 2003; Ezeudu, Nkokeleonye & Adigwe, 2013; Ezeudu, 2013) Other household arts or technologies commonly found in different regions/tribes in Nigeria include mask, drum and figurine carving in Etim Ekpo and Ikot Ekpene Awka Ibom (South-South Nigeria), clothing (textile) in Ibo land (south-east Nigeria), canoe/boat building in Rivers, Bayelsa, Delta,

Akwa-ibom, and Cross River (South-South Nigeria), textile and Indigo dying in Yoruba land (south-west Nigeria), production of local gin from crude palm wine and production of palm wine in Ibo land (south-east, Nigeria). An outline of indigenous practices and innovations in Nigeria will be presented in the section below, starting with indigenous food technology.

2.10 Food technology

Food production or food technology using indigenous methods is a very popular act in Nigeria (Achi, 2005). Processing and preservation of various types of food, cereals and beverages using indigenous methods is still practiced across various tribes in Nigeria. Different tribes are known for the production of certain food products, although there are some commonalities in terms of food intake by diverse ethnic or indigenous groups. Research conducted across different parts of Nigeria shows that there are many indigenous fermented or processed foods in Nigeria with high medicinal and nutritional value such as crops, drinks, cereals, legumes, milk etc. (Iwuoha & Eke, 1996; Aderiye & Layeye, 2003; Achi, 2005; Adebolu, Olodun & Ihunweze, 2007). For example, the Hausa and Fulani tribes in northern Nigeria are known for the production of local drinks such as *Pito* and *Burukutu* while the Ibos in south-east Nigeria are specialists in producing *nkwu ocha or mmanya nkwu* and *mmaya ngwo* (palm wine) using indigenous techniques.

Palm wine is the fermented sap (liquor) of palm tree, either as raphia palm (*mmanya ngwo*) or oil palm (*nkwu ocha/mmanya nkwu*) (Iwuoha & Eke, 1996). The method of producing *mmnanya ngwo* and *mmanya nkwu* (palm wine) is relatively the same. Kuboye (1985) and Uzoagara *et al*. (1990 cited in Iwuoha & Eke, 1996) explain that palm sap is obtained by tapping of inflorescence of the palm trees using a sharp knife. The sap is left to ferment a little time and the fermentation is completed in about two days or less, resulting to a milky suspension of microorganisms in a fermented sap that tastes nice and sour in some cases (Kuboye 1985; Uzoagara *et al*. 1990 as cited in Iwuoha & Eke, 1996). Also, *pito* (cream coloured liquor) and *burukutu* (brown-coloured suspension) are popular drinks in northern Nigeria that are produced traditionally. According Iwuoha and Eke (1996), both drinks are made simultaneously by fermenting a malted or germinated single cereal grain type or a mixture of grains. The drinks are produced through a method that includes soaking the grain for one day, draining of soak water, germinating for two days, sun drying, milling into flour, mixing the flour with water, boiling for three to four hours to form slurry,

settling and decanting, addition of fresh water and reheating. The mixture is left to stand at room temperature for 24 hours. Then more water is added and the mixture is reheated for three hours after which cooling and separation follows. Thereafter, a supernatant and sediment are obtained which are allowed to ferment for one day at room temperature resulting in "*pito*" (top clear supernatant) and "*burukutu*" (a thick brown suspension) (Ekundayo, 1969; Faparusi *et al*. 1990 as cited in Iwuoha & Eke, 1996). It is important to note that the processes of producing these local drinks are very similar to the scientific or industrial methods of wine and beverage production.

Other staple foods (cereals and beverages) that are produced in Nigeria by different ethnic groups using indigenous technology are listed in Table 1 (Iwuoha & Eke, 1996).

Table 1: Nigeria's indigenous foods and their sources
(Iwuoha & Eke, 1996)

Type of foods	Local name	Source of food	Indigenous place/origin
Cereals	Burukutu and pito Ogi/Akamu	Maize sorgum Maize	North, South-East, Mid-west South-east, South-south
Fruits	Agadagidi, Cocoa Cocoa wine	Over-ripe plantain or Banana Cocoa pod pulp	South-west, South-East
Legumes	Ugba Iru (Dawadawa) Ogiri-egusi Ogiri-isi Ogiri-ugu or Ogiri-nwan	African Oil bean seed Soya beans Melon seed Castor oil seeds Fluted pumpkin seeds	South-east Middle belt South-east South-east South-east
Tree sap	Palm wine	Raphia palm or Oil palm seed	South-east, South-south
Tuber	Garri Fufu Lafun Abacha Kokobele	Cassava roots Cassava roots Cassava roots Cassava roots Cocoyam corms	North, South South-east South-west South-east West
Flesh	Afonnama Azu-okpo	Beef tripe Fish	South-east, Mid-west South-east, South-south
Milk	Maishanu and Nono	Cow's Milk	North

According to Iwuoha and Eke (1996), the locations or places listed on the table are the birthplaces or origin for the arts of production and major usage even though commercialisation of the products have widened the spread of the food to other ethnic

groups and overseas. There are many more foods produced by different cultures in Nigeria. In fact, indigenous processed (fermented) foods make up a huge percentage of Nigerians food intake (Achi, 2005). Nonetheless, today there seem to be some concerns about locally made foods and drinks in terms of the production process and preservation. Scholars such as Iwuoha and Eke (1996) and Achi (2005) identified issues such as unhealthy environment, equipment (calabash, baskets, leaves) used in the production and the hygiene of the handlers as major challenges that needs to be conquered. In line with this assertion, Achi (2005) argues that the introduction of imported high technology food products particularly the processed ones, is gradually changing the Nigerian food culture. Ojo (1991 cited in Achi, 2005) maintains that these imported food products are in high demand despite being sold at higher cost, but the fact that their production has benefitted from years of research and development have placed them in higher status and demand than those that are produced locally. In the light of this, there is a need to improve on the techniques/production processes of Nigerian indigenous foods in order to meet the food requirement of the people.

On the contrary, Aderiye and Layeye (2003) reason that Nigeria fermented foods are soaring higher by day. Locally produced foods like "*ugba*" oil bean seed are more palatable and have a longer shelve life if kept properly because the water content has been reduced and organic acids and other chemical compounds produced during fermentation reduce spoilage microorganisms (Aderiye & Layeye, 2003). According to Aderiye and Layeye (2003), the consumer safety of African fermented foods is enhanced or ensured by lactic acid, which creates an unfriendly environment to pathogenic disease causing bacteria such as *Enterobacteriaceae*. Aderiye and Laleye (2003) further emphasised that factors like soaking and cooking treatment which reduces microbial contaminants; salting, where the addition of salt acts as a preservative; and sun drying contribute to the safety and longevity or life span of the food. Whatever may be the case, the forgoing findings (concerns and prospects) of indigenous food science and technology should be given critical attention and schools (starting from primary and secondary) should play a leading role in the reformation agenda.

Moving forward, Ezeudu (2013) explains that the production of soap and cream using resources within the environment is an old act or tradition especially in Ibo land, South-East Nigeria. For many centuries, black native soaps were made through a process that

involves the burning of palm bunches to obtain "*ngu*". The ash from the burnt oil palm bunch is dissolved in water, filtered, and boiled. The resultant solution is mixed with bleached palm oil and the mixture is stirred and allowed to block or cake after which the soap is ready (Ezeudu, 2013). Again, local pomade commonly known as "*Ude Aku*" in south east Nigeria, is produced using the following approach. Palm nuts are collected, washed, and placed in a dry open pot. The pot of palm nuts is heated with high intensity fire for about two to three hours. Extraction by heating is done to collect the black liquid which is placed in a bottle and its liquidities into a cream "*Ude Aku*". *Ude Aku* apart from being rubbed on the body as a cream is also an effective remedy for a number of ailments. *Ude aku* can be taken during convulsions, bronchitis, and other upper respiratory diseases (Ezeudu, 2013). Strangely however, these healthy and economically viable indigenous processes and products have been sidelined today in pursuance of western products (Ezeudu, 2013). It is therefore imperative to revive and sustain these indigenous means of soap and cream making considering that the health benefits are huge. Also, teachers can use the processes involved in the production of these local soaps and creams as lesson exampler in basic science and technology classes.

2.11 Building technology

The Ibo tribe (south-east) and other ethic nationalities in Nigeria showed advanced understanding and mastery of architecture and building technology using indigenous techniques and resources. Locally available resources (building materials) such as clay soil (*Aja-ocha)* for walls, raffia palm leaves (*Akirika*) for roofs, dung for painting the interior walls and floors and bamboo or bitter leaf plant (*achara or oshisi olugbu*) for fencing were skillfully used in building houses many centuries ago (Abdulkareem, 1992). Presently, modern architectural designs and technology have replaced these phenomenal indigenous designs and building materials. Unfortunately, the quest for modernisation and foreign culture has ravaged our indigenous architectural designs (crafts) which are usually in line with the culture, weather and topography (geography) of the communities. Indigenous building materials such as clay soil (*aja-ocha*) has been traded for block/bricks, aluminium have replaced raffia palm leave (*akirika*) while tiles have taken over the place of mud. However, one thing that has never been replaced and perhaps will not be replaced is the natural ventilation and the freshness that comes from using these indigenous materials to build and the traditional value attached to it. Even though our houses and mansions are

decorated today with air conditions (for those that can afford it), yet there is still the absence of absolute freshness enjoyed in indigenous houses (designs). In that respect, rather than outright replacement of these designs and valuable assets, institutions of learning should introduce indigenous architecture or building technology in schools. This context familiar materials and methods of building can be used and should be used as a way of introducing building construction (technology) to learners in the basic 7-9 science and technology stream.

2.12 Agriculture

In agricultural technology, Olaoye (1989), Abdulkareem (1992), Siyanbola *et al*. (2012), Ezeudu, Nkokelonye and Adigwe (2013) highlighted that tools like cutlasses, axes, rakes and hoes were developed and used resourcefully for cultivating the land all over Nigeria. Some tribes that engaged in large scale (commercial) farming like the northern part of Nigeria used animals as beasts to till the land in order to reduce the difficulty in tilling the land with hoe and to increase productivity. Ordinary resources such as leaves and dungs were used as manure during farming to enhance the growth and yield of crops and other farm products. There was also the idea of not cultivating the land annually (i.e. to skip farming in a particular parcel of land for one year) to enable the land to replenish naturally. During this year, manure (dung and some leaves) are deposited on the empty land in order to enrich it and prepare it for the next farming season/year. These ideas contributed immensely to the quantity and quality of farm products produced in Ibo land (eastern Nigeria) in particular, and other parts of the country in general.

In a related manner, some farmers in northern Nigeria devised indigenous ways of knowing when the time is right for farming/planting in each year by observing certain changes in the environment. According to Abdulkareem (1992), the people of Kastina (northern Nigeria) having lived in their communities for many centuries, devised a means of forecasting the weather every year. These people are conversant with the weather pattern of their communities, so it helped them in making key decisions concerning agriculture. Abdulrashid (2013) posits that the weather forecast is a vital component for farmers and pastoralists because they depend on the observation and interpretation of certain occurrences to make decisions about farming. Such occurrences may be seen in trees, the behaviour of some animals, the sky, the direction and intensity of the wind, mountains among others (Abdulrashid, 2013). Abdulrashid (2013) classifies these

occurrences into bio-indicators and non-biotic-indicators. The biotic indicators are the living beings like animals and trees which change their behaviour with change in the environment while the non-biotic-indicators are non-living things like wind and mountains that change in response to the environment. In other words, these indicators help the people living in these communities to decide when to start farming and the types of crops/seeds to plant; and they have been doing this with great precision for many centuries. However, these huge insights and phenomenal achievements remain unrecognised in the schooling system in Nigeria and in in formal educational discussions.

Currently, agricultural practices in Nigeria have taken a new dimension (both positive and negative). Some species of crops/plant, legumes, tubers etc. have suffered extinction (in some parts of the country) caused by human activities and or mechanisation of agriculture. Using machines for clearing and tilling the ground and using fertilisers with harmful chemicals to enhance growth of crops and tubers have further destroyed the land and some indigenous crops etc. Despite the fact that these farming methods contribute to larger output of agricultural products, the consequences on the land or farm are noxious. On the other hand, new strides have been achieved in agriculture using indigenous technology. Some examples include the production of corn shellers, corn threshing machines, grain pre-cleaners, groundnut shellers, cassava peelers etc. (Abdulkareem, 1992). Even though these developments are laudable, there is still so much to be done in the agricultural sector and schools should play a leading role in this. The indigenous and natural approaches to farming highlighted above should not only be strengthened, but they should also be sustained through the school system.

2.13 Metallurgy

Metal work, iron smelting, blacksmithing, goldsmithing (metallurgy) or whatever you may call it is a popular technology (indigenous craft) amongst many tribes in Nigeria. Siyanbola *et al.* (2012) opine that Nigeria is hugely blessed with gifted hands especially in metallurgy and other indigenous technologies. Arguably, the artifacts produced by each tribe is a representation of their needs, religious inclination, cultural heritage or their historical progressions. For instance, the Igun lineage in Benin Edo state, (south-south Nigeria), the Igbo-ukwu community in Anambra (south-east Nigeria), the Nto Edet in community in Etim Ekpo Akwa Ibom (south-south Nigeria) and Saki cluster in Oyo state (south-west Nigeria) are well known for crafting different aesthetic images and household items such

as pots, spoons, axes, ornaments, lamps, chairs, masks and figurines (Siyanbola *et al.*, 2012; Ezeudu, Nkokelonye & Ezeudu, 2013; Okonkwo & Oguamanam, 2013; Siyanbola *et al.*, 2012). The Saki people produced and still produce one of the oldest aluminium pots in Nigeria with the trade mark inscription "*saki*". The Igun linage and the Nto Edet community are experts in carving different sizes and shapes of mask and figurine, while the Igbo-ukwu community produce metal gongs, guns (some of them were used in the Nigeria civil war) and spears (Siyanbola *et al.*, 2012; Okonkwo & Oguamanam, 2013; Ezeudu, Nkokelonye & Adigwe, 2013).

The raw material used in this craft is processed metals (aluminum, zinc, iron ore) obtained locally in the form of scrap from household items and other abandoned metal products. According to Siyanbola *et al*. (2012) and Ezeudu (2013), the process of producing these items involves identification of the right metal (considering the anticipated product), cutting or melting them in an earthen furnace and locally made crucibles using firewood or palm kernel shells as fuel. The smelted metal is poured into the earthen furnace to form the anticipated product. It is worth noting that these crucibles are fabricated by the practitioners themselves and the majority (96.2%) of them are males (Siyanbola *et al.*, 2012). In addition, Okonkwo and Oguamanam (2013) expound that the craftspeople or practitioners (mostly uneducated) do not dream of the particular type of product (like mask and figurine) they are going to carve, rather they conceptualize the object or they are guided by existing products, although some are said to have divine inspiration during which different masks are shown to them. In other words, there may be a metaphysical alliance to this craftwork and perhaps this will determine the type of product that they will be producing. In appropriate consideration, metallurgy, or "blacksmith" (as it is popularly known) is a longstanding activity in most parts of Nigeria. This indigenous technology or craft is dominated by men who are (mostly) conventionally uneducated. Nonetheless, their literacy level has never been a limitation, rather an inspiration. They use a combination of pragmatism, conceptualisation and divine inspiration to turn scrap metals obtained locally into different aesthetic products. Despite this landmark in metallurgy, one wonders why this technology or practice is not enshrined in the Nigerian school basic technology curriculum.

After a critical examination of the forgoing practices and the prospects they can offer learners and students in the world of science and technology, the questions one may ask

are: How adequate or suitable are the content areas of basic science and technology for Nigerian schooling context? Is the basic science and technology currently delivered in school contributing to national development (considering the philosophy and rationale behind the new curriculum) and the promotion of an egalitarian society as stipulated? Whose voices are being heard in the policy (learners or gatekeepers) and whose culture is being promoted through the curriculum? Are the pedagogical practices and assessment strategies appropriate and do they create room for diversity, inclusion as well as creativity on the side of the learners? Whatever may be the answer to these questions, the IK practices outlined above present a suitable platform for basic science and technology teachers to implement a meaningful and culturally relevant schooling in Imo State Nigeria. To reach this milestone requires good understanding of what IK is and how to efficiently integrate it in the classroom.

Moving away from Nigeria, there were many technological inventions that were developed by Africans and used gainfully across Africa and beyond as early as the thirteenth and fourteenth centuries (Van Sertima, 1999). In reminiscence of the ingenuity of Africans, Van Sertima (1999) provides account of how African countries invented and used technological gadgets that were of superior quality than those produced in Western societies in the same period. According to Van Sertima (1999), the ability of Africans to swiftly communicate or transmit information over their huge empires using indigenous methods (technology) was a boon to Africa and a marvel to European travelers. Even though these empires were as huge as the whole of western Europe (Van Sertima, 1999), yet there was swift and proper dissemination of information using indigenous information systems and the people lived harmoniously. Unfortunately, however, these technological discoveries could not spread beyond the centre and were not sustained for posterity

2.14 Beyond Nigeria

Indigenous science and technology (innovations) was and still is common in most indigenous groups or countries across Africa. O' Donoghue (2004) writes of how the Nguni cattle people (tribes) of eastern and southern Africa devised ways of sustaining their lives and the environment by developing and using hoes, axes and fire efficiently. The people devised patterns of hunting and managing wildlife to sustain themselves, their pasture and their cattle. Simply put, the Nguni people knew exactly what to do and how to

do it when they were confronted by different circumstances (whether good or bad) (O' Donoghue, 2004).

Some Europeans travellers such as Peter Schmidt and Donald Avery revealed that Africans living on the western shores of Lake Victoria in Tanzania, Rwanda and Uganda had produced carbon steel as early as 2,000 years ago (Van Sertima, 1999). These Africans achieved this in preheated forced-draft furnaces, a method that was rated technologically more advanced than any developed in Europe until recent times (Van Sertima, 1999). In other places in Africa, a lot of scientific and technological discoveries were recoded. According to Nnadozie (2010), the Zulu tribe in South Africa has an indigenous way of preserving maize which is in line with the scientific process of conserving maize in silos. This act has been perfected over centuries and it has sustained the holders of the knowledge in difficult times.

The Wasukuma people in Tanzania have an indigenous means of naming and classifying the soils. Ngailo and Nortcliff (2007 cited in Nnadozie, 2010) noted that the Wasukuma people developed this technology of classifying the soil based on its colour, texture, consistency and ability to sustain the growth of specific crops and plants. Their soil types such as "*Itogolo*", "*Ikungu*", "*Luseni*", "*Luguru*" and "*Mbunga*" have similar traits with soils classified in western science like "Clay", "Loamy", "Sandy" and "Humus" (Ngailo and Nortcliff, 2007 cited in Nnadozie, 2010). Research according to Van Sertima (1999), Semali and Kincheloe (1999), Emeagwali (2003) and Mapara (2009) shows that countries such as Zimbabwe, Mozambique, Mali, Ghana, South Africa, Egypt, Kenya, Ethiopia etc. recorded great successes in medicine, science and technology long before European/Western countries. The Shona people of Zimbabwe effectively used indigenous plants like *chiparurangoma* (*Borreria dibrachiata*) for the treatment of malaria (Mapara, 2009). Similarly, Emeagwali (2003) opines that the contribution of Africa to the medical profession is laudable. Emeagwali (2003) highlighted that medicinal plants like the *Hoodia* plant (Namibia), African *willow* (South Africa), *iboga* plant (Gabon and Cameroon) have been successfully used to treat sickness such as obesity, malaria, drug addiction and cancer.

Furthermore, Africans were among the pathfinders in what is regarded today as "modern" architectural technology. For instance, the Great Zimbabwe which was the largest building in Africa was built by Africans many years before western imperialism (Van Sertima,

1999; Mapara, 2009). Other epoch buildings by Africans with astonishing features like the University of Timbuktu in Mali and the Egyptian pyramids denote the quality of science and technology of the people, place and time (Van Sertima, 1999). In terms of education, Africans developed their traditional ways of educating their children from a very early age. The use of proverbs, songs and folklore are well proven and recognised as an effective means of education across many tribes in Africa (Mapara, 2009). There is a common saying in Ibo land (Nigeria) that *"ilu ka ndi ibo ji ekwu okwu"* meaning that proverb is the means of communication/education in Ibo land, Nigeria. This implies that songs, folklore and proverbs were effectively used to educate people from an early age. Agreeing with this, Semali and Kincheloe (1999) maintained that oral literacy through music, folklore, stories and proverbs was the main tool for communication and education in ancient Africa. Semali (Semali and Kincheloe, 1999) narrated how his grandmother used stories and proverbs to teach him and his siblings to value words for their meanings and nuances while growing up in Tanzania. Semali (Semali and Kincheloe, 1999), however, lamented that these valuable educational tools have suffered serious onslaught in the hands of the colonial masters. In their obsession with power and insatiable quest for expansion and control, they subjugated the contextual means of education (oral literacy) in Africa and elevated their acclaimed meaningful system of education.

In present day Africa there are many and varied technological inventions developed and available across Africa. According to Emeagwali (2003), the continued existence of the informal sector in Africa took place against the odds. Its existence represents the strong ability for resilience and growth of African IK (AIK) which invariably persists not only at the level of material culture and the natural environment, but also in fields such as business management, banking and hospitality or service (Emeagwali, 2003). Currently, there are numerous indigenous people that engage in the business of making and selling clay-pots, reed chairs, baskets, and other decorated technological products for survival (Maluleka, Wilkinson & Gumbo, 2007). Maluleka Wilkinson and Gumbo (ibid) conclude that creative expression of technology in these products represents indigenous cultures of the people. By implication, the African genius is still alive today as it was centuries ago despite the western onslaught and campaign of calumny against African IK and can thus be used to advance school science and technology.

2.15 Conclusion

This chapter explored IK and IKS and explicated the difference and similarities between the two terms. Also, an overview of basic science and technology curriculum in Nigeria showed that numerous IK practices in Nigeria have been overlooked in the curriculum. This situation was frowned upon by many scholars such as Emeagwali (2003), Eze and Ike Nnia (2013) who called for a re-curriculurisation of basic science and technology in order to accommodate Nigeria's huge IK practice in schools. In addition, this chapter looked at the curriculum and delivery of basic science and technology across Africa. It was noted that there was a disjuncture or mismatch between learners' lived experiences and their classroom experience. The chapter therefore espoused the positions of elite scholars in IK by negotiating a synergy rather a dichotomy between IK and western science and technology for the benefit of African learners

Furthermore, this chapter considered the position of teachers as curriculum implementers. Given that teaching and learning is the core of any educational endeavour, the need to explore teachers' conceptions and understanding about the curriculum and its content areas was emphasised.

As a way of projecting the values of IK and bringing these values to the fore in academic engagements, some notable examples of indigenous technology and science in Nigeria were identified and discussed. The origin, places of practice, inherent values, current status, prospects and challenges of these indigenous craft/practices were highlighted. Also, some indigenous practices (science and technology) of other countries in Africa were discussed.

CHAPTER THREE: THEORETICAL FRAMEWORK

3.1 Introduction

This study is underpinned by post-colonial theory (postcolonialism). Fundamentally, postcolonial theory is a symbolic educational framework that marks the end of political, sociocultural, economic and educational hegemony/domination of the colonial masters over the colonised people, countries and races across the globe. In simple terms postcolonialism is a concept commonly used in social and educational discussions to represent the period coming after the end of western colonialism (Childs, Williams R. P. & Williams P., 1997; Tikly, 1999; Mapara, 2009). Beyond representing an era, postcolonial theory (postcolonialism) has been interpreted and applied in different ways and context in educational research. For instance, the theory has led to the advocacy for culturally relevant and practicable curriculum in Africa and other colonised places (Mapara, 2009). This chapter will therefore embark on a critical exploration of postcolonial theory which serves as the theoretical framework underpinning this research study. Firstly, the historical background of postcolonial theory will be explored. Afterwards, the emergence of postcolonial theory in educational research will be reviewed and the leading proponents and their various perspectives will be outlined. Equally, the use of postcolonial theory in educational research and its application in research in school science and technology education will be discussed. The penultimate part of this chapter will consider the application or relevance of postcolonial theory to this research whilst in the final part I conclude the chapter.

3.2 Historical background of postcolonial theory (Tikly, 1999)

The emergence of postcolonial theory can be traced to the period when most colonised countries/places around the world gained independence from the shackles of their respective colonial masters (Parsons & Harding, 2011). According to Childs, Williams R. P. & Williams P. (1997), the end of colonial reign and control began in the late 1950s and reached its peak in the 1960s; this period marked a historical moment as country after country gained independence from their colonial masters. Different parts of the world that were hugely impacted by colonisation such as Africa, Latin America and Asia (Parsons & Harding, 2011) gained their independence within this period; nonetheless, the effects of

colonisation are still evident in those place to date. However, the fact that many countries now live in the world formed by decolonisation is enough justification for the emergence and use of the term postcolonialism in educational research (Childs, Williams R. P. & Williams P. 1997). Postcolonial theory is therefore a tool that captures and explains the events that took place in this era and how they occurred, with the aim of emancipating and empowering the formerly colonised nations and people educationally and otherwise. It is in this light that Tikly (1999) argues that postcolonial theory is not only used to describe an era (colonialism and postcolonialism) and certain developments that occurred in that era, but it also represents an epistemological shift in the way this era and the events are described and interpreted. In addition, postcolonial theory identifies the challenges in establishing a new identity (amongst the colonised) different from, or not influenced by, the colonist philosophy (Parsons & Harding, 2011).

Contrary to the foregoing, McKinley (2007) espoused the views of Bhaba (1994) that postcolonial discussions should not be limited or attributed to a point in history (before and after); rather it can be used to mean "beyond", where "beyond" implies that limitations and borders created by colonisation have become blurred. For instance, there is close contact and peaceful coexistence/intermingling between the colonised and colonisers in many countries across the world today (McKinley, 2007). Consequently, blurring boundaries/borders takes the postcolonial dialogue beyond the "them and us" (coloniser/colonised) positions established in postcolonial discourses (McKinley, 2007). Thus, it can be deduced from the above that postcolonial direction was created when most colonial countries became independent. The theory however goes beyond the popular conceptualisation of -"before and after" or "them and us". It involves a movement and process of "decolonisation" (processes and struggles) in order to establish a new identity beyond the "them and us" or "before and after".

It stands to reason that "decolonisation" in this case represents a process of mental reorientation or repositioning. In this regard Wane (2006) posits that decolonisation is an intellectual process that painstakingly and persistently transfers the independence of formerly colonised people and places into their minds. The main focus of the decolonisation process is the deconstruction of obsolete perceptions and attitudes of power and oppression that were established during the colonial era. Therefore, decolonisation involves the re-evaluation of old-fashioned perceptions about knowledge and power. While

the formerly colonised had to learn how to put their acquired independence into practice, the colonial powers had to accept the loss of power and total control over the colonised (Parsons & Harding, 2011). By implication, decolonisation is a microcosm of postcolonial theory and it is not limited to the colonised people alone. It also affects the colonial hierarchies, given that both sides need to deal with their new status/designation different from suppressed and suppressor. Hence, decolonisation is a psychological process of filtering or re-awaking the mind in order to deal with present realities (change), while postcolonial theory is the educational lens that stimulates and analyses this process.

3.3 Emergence of postcolonial theory in educational discussions

The leading proponents or pioneers of postcolonial theory within the academy include Grayatri Spivak, Franz Fanon, Edward Said and Homi Bhabha. According to Parsons & Harding (2011), these postcolonial elites sought to address the vast and dreadful social and mental suffering, exploitation, abuse, violence and enslavement meted out on the powerless victims of colonisation around the world. As Smith (2007 cited in Parsons & Harding, 2011) explained, postcolonialism is an emancipatory crusade to challenge the supremacy of the dominant Western perspective in order to empower the subjugated and marginalised peoples ("Others") of the world. The theory challenges authoritarian and domineering western ideologies and practices that denigrate and dismiss local/indigenous belief, culture and practices as uninformed, unverifiable, irrational and barbaric (Dussel 2000 cited in Parsons & Harding, 2011). Agreeing to this, Dirlik (1994) reasoned that postcolonialism is a representation of the subjugated voices demanding a total abolishment of the distinction or divide in the global system between "centre and periphery" (constructed otherness) that are the legacies of colonialist ways of thinking in order to embrace societies globally in their heterogeneity of knowledge/epistemology. Thus, it can be said that the ontological direction of postcolonial theory/postcolonialism is to establish an egalitarian society void of injustices and psychological enslavement.

Despite this, most areas like Africa that were massively impacted by colonisation are still influenced physically and psychologically by Western perspectives. The way things are done or should be done (schooling, language, marriage, food, shelter etc.) in these places are mostly borrowed from or determined by Western perspectives (McKinley, 2007; Mapara, 2009; Parsons & Harding, 2011). For instance, public institutions such as schools, churches and governmental organisations still promote the ideologies and culture of the

colonial masters. Thus, the true identities of most colonised people are masked by that of the colonial masters. Most colonised people were cajoled into abandoning their worldviews/identity and adopting that of their colonial masters as superior and reliable. As Fanon (cited in Mapara, 2009) hinted, colonialism promoted western colonial superiority over non-western colonised people and this resulted in a sense of division and alienation in the self-identity of the colonised. Fanon (cited in Mapara, 2009) further emphasised that the proliferation or propagation and promotion of Western history, language, culture and belief system as universal and superior to the knowledge systems of the colonised lead to a strong sense of inferiority in most colonised countries (places). In this respect, the promotion of western identity/worldview and subjugation of indigenous cultures and belief created serious identity crises in the minds of many colonised people. Most colonised people/places opted for the identity of the coloniser and adopted their knowledge systems/worldviews as their own.

Based on the foregoing, McKinley (2007) surmised that colonisation did not really stop when power was handed over to the colonised countries and races, so it may be a hasty conclusion to say that postcolonialism represents or implies an end to the colonial era. As a result of this, Said (1994) and Mbembe (2001) as cited in Osagie & Buzinde (2011) posit that it is premature to speak of postcolonialism, which signifies the end of colonialism, when the latter has simply been replaced by neocolonialism. That notwithstanding, Osagie & Buzinde (2011) maintain that the emergence of postcolonial theory in education is justifiable given that many scholars are adopting the theory as a suitable framework to examine identity and representation as well as to study cultural, environmental and political encounters in the formerly colonised nations.

3.4 Postcolonial theory in science and technology educational research

In the educational milieu, especially science and technology research, postcolonial theory has gained visible interest and popularity over the years. Many reforms in terms of content/epistemology and pedagogy in school science and technology are anchored in postcolonial theory (Carter, 2008). This is because the legacies of colonisation are still evident in many countries, such as employing or adopting western instructional arrangements and languages for local schooling systems (Mapara, 2009). As a result of this, Lash and Featherstone (cited in Carter 2006, p. 821) maintain that postcolonialism offers vital theoretical insights to science and technology education concerning the

recognition and acceptance of diversity and redistributive justice relevant to the new complexities of the modern global world. By implication, postcolonial theory argues for a science and technology education that recognises diversity of epistemology because we live in a diversified world with learners/students that are socially heterogeneous.

In keeping with the above assertion, Mapara (2009) argues that the majority of science educational reforms and research – particularly those targeting areas/countries that suffered western (science and technology) expansionism to the detriment of indigenous ways of knowing/culture – have embraced post-colonialism as a suitable framework to underpin their educational reformation agenda. In the same vein, Carter (2006) argues that postcolonialism is a unique framework with the potential to lead global efforts in science educational reforms, especially reforms related to cultural diversity. Hence, it can be argued that postcolonial theory is a suitable framework that can guide the epistemological and pedagogical reformation movement in school science and technology because it offers a portal to a science and technology education that recognises multiple epistemologies. It is in this regard that McKinley (2007) concludes that postcolonialism conceptualised to mean "beyond" suggests that boundaries/barriers and divisions created by colonialism should become completely blurred. Accordingly, Martin (2007) as cited in Naidoo (2010) suggests that postcolonial theory applied in education of those countries that experienced colonialism should go beyond dislodging or disrupting western science/technology and work towards "multiculturalism", engage multiple ways of knowing, and ensure that curriculum and practice are not only relevant, but also appropriate to specific cultural backgrounds. This implies that postcolonial theory is designed to walk towards a harmonious bearing in science and technology education rather than promoting the "Western verses Indigenous" or "Colonised against Coloniser" dichotomy.

The notion of multiculturalism as explained by Zazu (2008) deals with developing and implementing educational processes (teaching and learning) that considers the diversity of learners/students cultural experiences. According Cejete (2008 cited in Zazu, 2008), a strong nexus exist between culture, environment and education, and indigenous people have a strong relationship with their environment. Thus, multiculturalism advocates for the rejection of dichotomisation of knowledge forms, and maintains that all forms of knowledge within learners' culture (Indigenous and Western) should be given equal

consideration in order to make learning contextually relevant (Zazu, 2008). Closely related to multiculturalism is Beck's (1992) idea of "inter-epistemological dialogue". Beck (ibid) explains that inter-epistemological dialogue is a form of reflexive learning that can align different forms of knowledge (scientific and indigenous) in the learning process. What this means is that plurality of knowledge is encouraged in the teaching and learning processes. Such a learning process does not marginalise or reject one form of knowledge in order to uphold/uplift the other. In this way, learning will be more relevant and suitable to learners from diverse backgrounds.

In concurring with the preceding insights, Nel (2005) maintains that discussions around IK/IKS in postcolonial Africa should carve their own space in order to critique and make their own anticipated valuable contributions. This is because occupying the popular space of the past, thus focusing on opposition and rejection of imperial systems, will only result in a space of fixed ideas about race, ethnocentrism, culture and identity. This is to say that IK and postcolonial discourses in Africa should go beyond the space of rejection and opposition and occupy a more relevant space so as to make more relevant contributions to the educational system. As Fanon 1986 (cited in Nel, 2005) suggested, IKS discussion in postcolonial Africa should occupy a space "beyond" the past, present and future, thus a border space. This space should be negotiating rather than negating/opposing in order to achieve new forms of understanding and levels of struggle that open novel "hybridities" (prospects) between past and present realities (Nel, 2005). Nel (ibid) went on to argue that IKS/postcolonial discussions anchored on ethnocentrism, black consciousness, and Pan-Africanism in essentialist dimension will hamper the progress of the proposed "beyond space" to fixity and the consequences of this will be catastrophic. This means that IKS and postcolonial discussion across Africa should not be centred on displacement, enslavement, colonial hegemony and suppression rather it should inhabit the space of rediscovering, re-enacting and reclaiming lost cultures and ways of knowing (Nel, 2005). By implication, postcolonial theory should work towards changing the long standing "Western" and "Indigenous" or "Colonised" and "Coloniser" dichotomy.

The above perspective is in concordance with the views of Mapara (2009) that postcolonial theory is not just about the formerly colonised (periphery) writing back to the centre, but it is also about the formerly colonised writing back to the centre and

highlighting their past achievements and advancements. Moving forward, Mapara (2009) stated that IKS highlights the fact that postcolonial theory not only emphasises the lost knowledge systems or past achievements of the formally colonised people, but it also underlines the enduring quality of some of their knowledge systems and beliefs. Again, it represents an effort to straighten the records about education, history, philosophy, architecture, language, science and technology of the formerly colonised and to remove the tag of being called "others". Drawing from the above views, it can be seem that postcolonial theory and IK systems are intertwined and their main agenda is not to dislodge or negate Western perspective. Rather, the focus is to negotiate and navigate through its own space ("border space") in educational discourses. This space goes beyond black consciousness, ethnocentricity and negation. It is a space of repositioning, rediscovering and advancement of novel educational contents and pedagogies in formerly colonised places/nations, especially Africa. This space embraces multiculturalism in formal educational processes and advocates for multiple epistemologies and inter-epistemological dialogue (Zazu, 2008) in science and technology education across Africa.

3.5 The relevance/application of postcolonial theory to this study

Postcolonial theory as discussed above has been in the forefront of educational reforms of the "Third World Countries". In Africa, many countries (example South Africa) have intensified their efforts towards culturally relevant and appropriate schooling, in a bid to make the teaching and learning processes in these countries meaningful and practicable. Looking at the trend of these reforms (particularly in the area of school science and technology), postcolonial theory is considered most suitable to guide this study given that the framework is leading the crusade for multiple epistemologies or multiculturalism particularly in Africa. More so, the theory calls for such pedagogical practices (novel pedagogy) that recognise diversity in the classroom and it is on these premises that this research study is foregrounded. The study is arguing for school science and technology educational reforms by exploring the conceptions of teachers as curriculum implementers. Therefore postcolonial theory as a key player in the advocacy for culturally relevant schooling in Africa is appropriately positioned to guide this study.

The need to explore teachers' perception of and role in the delivery of culturally appropriate and sensitive curriculum cannot be over emphasised. As Jegede (1999)

explained, teachers as curriculum implementers are "cultural brokers". In this regard, they are responsible for bridging the gap that may exists between learners' daily experiences and school experience. Therefore the onus is upon them as cultural brokers to guide the movement of students between home and science and technology cultures. Accordingly, Jegede (1999) emphasised that for students to move effectively and successfully from their daily experience to school science and technology the teachers must be appropriately equipped to help them. This is to say that the successful movement of students between both worlds depends on their teachers.

Furthermore, Jegede (1999) highlighted that teacher as cultural brokers require that appropriate pedagogical strategies should be employed in order not to alienate the learners/students from the school science and technology culture. In concurring with the above view, Parsons and Harding (2011) stated that the contributions of elite postcolonial theorists in postcolonial discourses compels teachers to critically reflect on the continuous, often innocuous acts of inequality, oppression, exclusion and stereotype they carry out in the classroom. How, through their choice of texts/content, through their recollection and presentation of history, their view on other cultures, the way they regard, and construct some kinds of knowledge are they promoting the myth of inferior worlds, inferior races and inferior ways of being/knowing? In this vein, Jegede (1999) concludes that teachers need to have a good understanding of learners' cultures/history and be willing to integrate that understanding into their teaching. Therefore, looking at the sensitive position occupied by teachers in the delivering of contextualised curriculum, their conceptions and beliefs about content and pedagogy need to be explored and interpreted. Hence, postcolonial theory being a reformation framework/tool that deals with culture and diversity of knowledge will be used to understand and interpret (analyse) the data generated from teachers based on their conceptions of IK (IK) as drawn from their lived experiences and classroom practices.

3.6 Conclusion

This chapter discussed the theoretical framework guiding this study. Postcolonial theory underlines the need to adopt multiple epistemologies, diversity or multiculturalism in schools across the formerly colonised countries and places. As a reformation tool, postcolonial theory argues that a culturally relevant curriculum and pedagogy will be of

great benefit to indigenous learners undertaking science and technology subjects in schools. Among the things discussed in this chapter is the historical background of postcolonial theory. A look at the historical antecedents showed that the end of the colonial era and independence of the formerly colonised places gave rise to postcolonial theory and discussions. Furthermore, the emergence of postcolonial theory in educational discussions was explored. Under this heading, the elites (key proponents) were listed and their perspectives were deliberated. Again, this chapter looked at the application of postcolonial theory in science and technology education research. It was emphasised that postcolonial theory and IKS are intertwined and their main agenda is not to dislodge or negate Western science. Rather, to rediscover and re-enact past achievements. Thus, concepts such as "multiculturalism", "inter-epistemological dialogue" and "border space" (Naidoo, 2010; Nel, 2005; Zazu, 2008; and Beck, 1992) and their relationship with postcolonial theory were explained. Finally, the relevance/application of postcolonial theory to this study was discussed.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

This chapter presents the methodological underpinnings of this research study. The chapter offers a detailed description and explanation of the choice of paradigm, type of research and research design. Furthermore, the chapter describes the types of instruments and methods used for data collection and analysis. The sampling techniques employed and the reasons for choosing these styles are presented. Steps taken to ensure the validity and credibility of the research are highlighted. The efforts made towards overcoming limitations encountered in this study and ethical issues are explained.

4.2 Research paradigm

This research study is underpinned by the interpretivist paradigm. According to Cohen, Manion and Morrison (2011), the interpretivist paradigm aims to understand and offer a detailed interpretation of the lived experiences and actions of participants in a study. Accordingly, the interpretivist researcher seeks to understand and describe how people make sense of their worlds and how they make meanings of their actions and inactions. Agreeing to this, Denzin and Lincoln (2011) contend that from an interpretivist perspective, human actions have meanings which are determinable by a researcher.

Furthermore, Maree (2013) contends that the interpretivist researcher operates under the assumption that access to reality (given or socially constructed) is only through social constructions like language (including text and symbols), consciousness and shared meanings. Thus, interpretative studies aim to understand phenomenon through the meanings people assign to them (Maree, 2013).

With regard to the foregoing, Maree (2013) explains that the interpretivist paradigm foregrounds the assumptions that human life can only be understood from within. Therefore, interpretivist paradigm focuses on people's subjective experiences, on how people construct the social world by sharing meanings, and how they interact/relate with each other. Also, Maree (2013) explains that the interpretivist paradigm assumes that reality is not objectively determined, rather it is socially constructed. In that sense, placing people in their social contexts offers a greater chance to uncover the perceptions they have

of their own activities. This implies that the uniqueness of a particular context is important to understand and interpret the meanings constructed (Hussey & Hussey, 1997 cited in Maree, 2013). The implication of the forgoing is that there is a need to examine/explore situations through the lens (eyes) of participants rather than the researcher. Again, gaining an understanding of peoples subjective (within) experiences is a first step in qualitative research. This enables the researcher to understand and interpret the perceptions, conceptions, motives/intentions and beliefs of the participants from the inside (within) and the social context. Hence, careful consideration was given to choosing the interpretivist paradigm to guide this study, especially when considered in the light of the need to explore or understand situations from "within" or through respondent's lenses (context and human interactions within the social environment). The interpretivist paradigm is therefore appropriately positioned to uncover and interpret the subjective experiences of the basic 7-9 science and technology teachers' conceptions of IK as they interact with the social world and with each other. The ontological position of the interpretative paradigm and post-colonial theory directs this study to adopt a qualitative case study method in order to explore basic 7-9 science and technology teachers' conceptions of IK as drawn from their lived experience and classroom practices in Imo state, Nigeria.

4.3 Case study

Fundamentally, the qualitative case study research approach aims to explore in order to understand things in detail (Creswell, 2013). The case may be some aspects of the social life of a person or group of persons, an organisation or a phenomenon and it usually generates words, rather than numbers as data for analysis (Lapan, 2012). According to Creswell (2013), a case study research approach is an empirical inquiry approach that investigates a phenomenon within its real-life context. The method allows participants to freely share their ideas, views, perceptions and experiences in their natural settings, making it possible for the participants to provide in-depth information/data (Cohen, Manion & Morrison, 2011). In other words, a case study method is very suitable and useful when a researcher is seeking for in-depth understanding of a specific event, process, organisation or particular group/groups of people in a particular place.

Furthermore, Cohen, Manion and Morrison (2011) argue that a qualitative case study provides a unique example of real people in real situations and also explains causes and effects in their real context, given that context plays a huge role in determining both causes

and effects, and in-depth understanding is needed to do justice to a situation. Cohen (ibid) went on to explain that contexts are distinct and dynamic, thus case studies investigate and report the real-life, complex dynamic and evolving interactions of events, human relationship and other issues in a unique instance. Simons (2001) as cited in Thomas, (2011) contends that case study involves an in-depth exploration from different perspectives of the complexity and distinctiveness of a particular situation, project, institution, program or system in a real life context. What can be drawn from the foregoing perspectives is that context (real-life context) is a major factor in case study research methodology, because it gives the researcher the opportunity of interacting with the participants in their natural setting/context, thereby leading to in-depth understanding and interpretation of the phenomenon/case under investigation.

Similarly, Creswell (2013) opines that a case study is an in-depth exploration of a bounded system. Explaining further, Creswell (ibid, p 462) highlighted that case study is a qualitative approach in which the researcher explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over a period of time, using in-depth data collection that involves various sources of information such as observation, interviews, documents, reports etc. This system could be a person, group of persons, activities, events or processes. In concurring with this, Lapan (2012) asserts that one of the unique features of the case study approach is the exploration of something with clear limits or boundaries. Lapan (ibid) further explains that the case study researcher clearly and carefully specifies what elements of the case will be studied, that is, which portion of the program or the phenomenon is to be the focus of the investigation. The bounding of the case includes classifying the aspects to be studied using research question, time frame, and physical location (Lapan, 2012). In this light, this research study which investigates basic science and technology teachers' conceptions of IK is explored in the bound system of basic 7-9 science and technology teacher in Imo state Nigeria.

The hallmark of case study approach, according to Lapan (2012) and Cohen, Manion and Morrison (2013), is that case study methodology provides thick descriptions of participants lived experiences of, thoughts about, and feelings for, a situation using multiple data sources. It is descriptive and detailed with a narrow focus, and combines subjective and objective data. In addition, Hitchcock and Hughes (1995) and Verschuren (2013) as cited in Cohen, Manion and Morrison (2013) hinted that the case study approach is particularly

suitable when the researcher has minimal control over events, that is to say, when behaviours cannot be controlled or manipulated. They suggests that the strengths of the case study approach lies in the fact that it is concerned with rich and explicit descriptions of events relevant to the case; it focuses on individual actors or group of actors and seeks for deep understanding of their perceptions of events; and the researcher is integrally involved in the case since the case study may be linked to the personality of the researcher. Thus, the latter characteristics of the case study approach underlines the researcher's reason for the choice of this approach, given that the researcher is integrally involved in the case under investigation as a result of the researcher's learning experiences while growing up in the context of this study.

Drawing from the foregoing insights, Cohen, Manion and Morrison (2013) and Maree (2013) conclude that the case study approach seeks to answer the crucial 'what', 'how' or 'why' of the phenomenon under investigation and also provides a detailed explanation of the phenomenon being explored by focusing on specific instances in a bounded system. It can thus be argued from the above perspectives that case study research approach allows for in-depth, thick rich descriptions that will generate words, vivid descriptions, and insightful personal comments which will facilitate understanding of the phenomenon under investigation within a particular context. The phenomenon under investigation for this research is basic 7-9 science and technology teachers' conceptions of IK.

The choice of a case study research methodology arose out of the researcher's desire to probe in order to gain an in-depth understanding of the phenomena. The method emphasises the use of various sources of data in the collection of data. Therefore, this research study adopted the case study method, because multiple sources of data are used in generating the data, namely, narratives and three focus group interviews. Also, the methodology provides the researcher an opportunity to interview the basic 7-9 science and technology teachers' in the real context where the phenomenon exists which helps in gaining deeper understanding of the phenomenon under investigation. In exploring basic 7-9 science and technology teachers' conception of IK, understanding aspects of their social life is considered necessary. It is thus considered that in order to have this understanding, it is necessary to find out how they experience daily living and teaching in their immediate environment and how they experience transitions and flux in their locality as part of their teaching, as well as what barriers exist in their experience of navigating between their

indigenous worldviews and modern science and technology worldviews etc. Such enquiries can only be achieved using methods such as a qualitative case study which will generate data for analysis as words and expressions rather than numbers.

Brickci and Green (2007) and Maree (2013) pointed out that qualitative case study research approach has many criticism and observed flaws, including its dependence on a single case which makes it incapable of generating generalisable conclusions; the samples are usually small and not often necessarily representative of the broader population so it is difficult to know how far one can generalise the result; and it is difficult to tell how far the findings are biased by the researcher's own opinions.

However, considering that this research work engages a phenomena in ways aimed at understanding the perspectives of the participants to the given phenomena, exploring the meaning they give to it and seeking in-depth understanding of the context/situation and narratives of the basic 7-9 science and technology teachers with respect to their conceptions of IK, a qualitative approach even with its limitations is still considered the best method to be adopted for the work. As Maree (2013) maintained, a qualitative case study approach is crucial as a first instance research in terms of gaining insights and deep understandings of the dynamics of a particular situation (case). There are different types of case studies; these will be discussed in the section below.

4.4 Classification of case study methods

According to Creswell (2013) and Cohen, Manion and Morrison (2013, p. 291) there are different categories or types of case study approach which a researcher can choose from. These categories are distinguished by the size of the bounded case, that is whether the case involves one individual, many individuals, a group of individuals, a process, an institution or an activity. Also, these categories of case study are distinguished by the intention and purpose of the study (Stake, 2000; Creswell, 2013). In this regard, Stake (2000), Lapan (2012), Creswell (2013) as well as Cohen, Manion and Morrison,. (2013, p. 291) identified the following categories of case studies:

- **Intrinsic case study:** These are studies undertaken in order to understand the particular case at hand (Cohen, Manion & Morrison, 2013, p. 291). According to Lapan (2012), an intrinsic case study focuses on the case being studied, answering questions about that entity or object in order to convey the illuminated operations to

its participants and stakeholders. Here, the purpose is not to understand some abstract generic phenomenon, but to develop a detailed understanding of case at hand. In other words intrinsic case study focuses on developing a deep insight of a particular case.

- **Instrumental case study:** This examines a particular case or instance to build new theories or to compare findings to new ones for corroboration or to question their validity (Lapan, 2012). The case here is of secondary interest, which is facilitating of theory.

- **Collective case study:** This involves studying a number of cases (multiple case studies) jointly in order to investigate a phenomenon (Creswell, 2013). This method is believed to offer better understanding of the phenomenon/case.

In another classification of case study research approaches, Yin (1994 cited in Cohen, Manion and Morrison, 2011, p. 291) and Robson (1993) identified three categories of case studies with regards to their outcomes. These include:

- **Exploratory case study**: This serves as a suitable means of eliciting information in order to seek new insights and clarify one's understanding of a process or problem. This approach also serves as a pilot to other studies or research questions. This implies that the exploratory approach provides new and detailed information or insight about a problem or a process (phenomenon) through the research findings, which can perhaps inform policy or serve as the background for further research.

- **Descriptive case study:** This type of case study focuses on providing narrative accounts.

- **Explanatory case study:** This deals with hypothesis testing.

In critical consideration of the above categories or types of case studies, I chose the exploratory case research study methodology. The choice of exploratory case study method is based on the purpose or intent of the study which is to explore basic 7-9 science and technology teachers' conceptions of IK. This approach aligns perfectly with the methods of generating data for this research, that is narratives/stories and three focus group interviews with teachers of basic 7-9 science and technology. In the next section, I will present the research design for this case study.

4.5 Research design

In this section I discuss the location of the study, gaining access, sampling, ethical consideration, data and analysis collection plan etc.

4.5.1 Location of study

This study is located within Owerri Metropolis, Imo state (South East) in Nigeria. I was born and brought up in Imo state and completed both my primary and secondary school education here. I also speak the local Igbo language of this region and I am extremely familiar with traditional beliefs and IK and practices in the state. Imo State is about 12,689 square kilometers with 2,938,708 people living in the state. There are 27 local governments in Imo state of which Owerri municipality/metropolis is one. There are 10 basic (secondary) schools, located within Owerri Metropolis, Imo State,

and we have an average of 20 basic 7-9 science and technology teachers at these 10 schools. The Nigerian secondary school level is divided into two – the senior secondary/upper basic school level and the junior secondary/lower basic school level. The interest of this study is in the junior secondary schools levels, particularly with teachers of basic 7-9 science and technology. It was my original intention to have all 20 basic 7-9 science and technology teachers participate in this study, however at the time of data collection many schools in the Owerri metropolis were closed for holiday due to the Ebola scare in Nigeria. Only three schools were open in the Owerri region, hence only seven basic 7-9 science and technology teachers participated in this study.

4.5.2 Gaining access

Gaining access means dealing with various gatekeepers at each stage of the research. Formal permission to conduct research was obtained from UKZN's research office. In addition, permission/informed consent was obtained from the schools where this research was conducted within Owerri metropolis, Imo State Nigeria. Permission was also obtained from basic 7-9 technology and science teachers' during each phase of data capturing. Whilst collecting data I realised that gaining access is an iterative process for each level of data collection.

4.5.3 Purposive and convenience sampling

Sampling involves making decisions about the settings/contexts, people and events to be observed. Hence, two sampling methods were employed for this research, namely purposive sampling and convenience sampling. In purposive sampling, according to Kumar (2011), participants are selected specifically and systematically because they are most likely to generate the data useful to the research. Convenience sampling involves choosing participants that are available or accessible to the researcher (Cohen, Manion & Morrison, 2011).

Convenience sampling was used as the seven teachers that participated in the research were chosen because they were accessible (near) to the researcher, that is to say, the teachers lived within Owerri metropolis where this study was carried out and their schools were open at the time of data collection.

In terms of purposive sampling, as explained above, the teachers that participated in the three phases of this study were selected because they were all teaching of basic science and technology at the basic 7-9 stream.

4.5.4 Ethical considerations

Prior informed consent or permission (Appendix X) was obtained from the school principals where the research was conducted. Also, the teachers that granted their permission by signing the informed consent letter (Appendix X) after the nature of the research were explained to them. Furthermore, all participants in the study were assured of the anonymity of their identity before and after the data collection to enable them partake willingly and freely in the research. Again, this was done to guarantee strict adherence to the University's research ethical standards.

4.5.5 Data collection plan

To answer the critical questions for this research, data was collected in three phase

> ➢ **Phase One**

Phase one answered the Research Question 1, namely:

1. *What are the conceptions of basic 7-9 science and technology teachers' of IK in Imo State, Nigeria as drawn from their narratives about IK?*

The instrument used to generate data for this research question was narratives/stories and focus group interviews. Seven teachers of basic 7-9 science and technology teachers shared their stories based on their experience of IK and afterwards five teachers out of the seven opted to participate in the focus group. This was because of the compulsory holiday in schools caused by the Ebola disease outbreak in some Western African countries, of which Nigeria (the location of this study) was among them.

> ➢ **Phase Two**

This phase aimed to answer Research Question 2 (a):
1. *Are these conceptions enacted in the classroom?*
   (a) *If so, how are they being enacted and what informs their enactment?*

Three teachers who enacted (integrate) their IK experiences were engaged in a focus group discussion in order to answer this research question. Sampling was therefore purposive.

> ➢ **Phase Three**

This phase aimed to answer Research Question 2 (b):
2. *Are these conceptions enacted in the classroom?*
   (b) *If not, what informs their practice?*

Two teachers participated in this third phase as they did not enact their IK experiences in their teaching of basic 7-9 science and technology (so they were selected purposively)

4.6 Data collection and instruments

The instruments used in this research study are narrative/stories and three focus group interviews. The instruments were piloted with members of the research group; this led to

restructuring/reframing of some of the questions. Also, because of closure of schools as a result of Ebola outbreak in Nigeria, the instruments were further reframed as the initial plans to carry out observations and pre-observations interviews could not hold.

The three phases of this study were conducted amongst teachers of basic 7-9 science and technology teaching in three schools within Owerri metropolises, in Imo State Nigeria. The first three teachers teach in the same school, the second three also teach in one school while one educator teaches in a different school.

4.6.1 Narratives (story telling)

Narratives/story telling was the first technique used to generate data for this study in relation to Research Question 1. According to Lapan *et al*. (2012), narrative is a qualitative research approach that seeks ways to understand and present experiences of individuals through the stories they live and tell. As a research approach, narrative critically analysis social and cultural context of human experience through stories (Lapan *et al*., 2012, p. 215). In this study, the researcher started by sharing his own stories about his personal experiences of and engagements with IK while growing up in Imo state, Nigeria. Afterwards, the participants (seven) shared their own stories with regards to their experiences of IK.

4.6.2 Focus group

Williams and Katz (2001) explains that a focus group is a small gathering of people with common interest or characteristics, assembled by the interviewer (researcher) in a comfortable atmosphere where people can share their opinion, ideas or experiences with the purpose of gaining information about a particular issue. Similarly, de Vos, Strydom, Fouche, and Delport (2011, p. 360) pointed out that focus group interviews are avenues through which people with certain common characteristics/traits share their understanding or feelings about an issue, product or services in a tolerant environment. Going by these explanations, focus group interviews were held with five participants in order to gain deeper insight into their conceptions of IK and how it impacts their teaching of basic science and technology. Afterwards, the five participants were divided into two groups based on their responses in the first focus group section. Three participants out of the five participants who had enacted their IK experiences were interviewed in another focus group arrangement. This was followed by another focus group discussion (interview) who had

not enacted their IK experiences. These focus group interviews were designed to answer the critical Research Question 2. The focus group interviews were audio and video recorded. The video recording captured the non-verbal data such as facial expression, body language that would not have been captured in an audio recording. The focus group interviews allowed the researcher to carry out in-depth probing and gave the researcher a grounded understanding of not only the participant's conception and experiences of IK but equally it helped me understand how they dealt with probable conflict between IK and conventional/western basic 7-9 science and technology and how both worldviews can be integrated to foster effective teaching and learning of science and technology in Nigerian schools.

4.7 Data analysis

According to Cohen, Manion and Morrison (2011) qualitative data involves organizing, accounting for and explaining data in terms of the participants' conception of the phenomenon being explored, noting patterns, themes and categories and regularities. Lapan *et al*. (2012) pointed out that the first level of data analysis involves classifying or coding qualitative data from interviews and other sources. This implies pulling the data apart to examine them in their smallest components to enhance understanding and interpretation of the data.

The qualitative data were read many times in order to gain deeper insight and to identify the key ideas in the data. Subsequently, the data (stories and focus group discussions) were organised and sorted into codes (inductive coding) or categories to bring out the themes. The themes that emerged from the data are given critical analysis and discussion in the following chapters.

4.8 Validity and credibility

Validity and credibility are key ways of ensuring the authenticity or reliability of a research. To ensure credibility and dependability/trustworthiness in this work there was a detailed description of settings, participants and themes that was used in this study. Also, triangulation (Lapan *et al*., 2012, p. 265) was employed by using different sources of data collection (narratives and focus group interviews) in order to ensure credibility and validity for this study.

Furthermore, Lapan *et al*. (2012) maintain that validity and credibility of research can be ensured by undertaking an external review and interpretations of the findings. By implication, it is important for other researchers in the field to carry out a critical review of the findings of a research to ensure its credibility. Bearing this in mind, the findings from this research study was critiqued by my supervisors and other researchers in the field to ensure that the findings are accurate and credible.

4.9 Triangulation

Triangulation is a process used to ensure validity in a research. According to Creswell and Miller (2000) triangulation is used to increase credibility and check dependability by sourcing for information from different sources to forms themes for the study. In this study data was generated via narratives and focus group interviews.

4.10 Rigour

The results of the data collected and analysed and the findings of this research were critiqued by other academics and researchers in this field of study. This is to ensure the soundness, accuracy of the findings and conclusions reached as emphasised by Long and Johnson (2000).

4.11 Limitations

The major limitation encountered in this research study was the closure of schools at the time when this study was conducted due to the Ebola virus outbreak. As a result of this, the last stages of data collection which include pre-observation, teaching observation and post-observation interviews with the participants were not carried out. This also affected the sample size, as the expected numbers of participants could not be reached and the number of participants that partook in the first part of the study (narratives) reduced by two. Also, reaching the participants on the scheduled dates was difficult as some of them did not pitch at the agreed time or did not pitch at all on the scheduled date/day. To tackle these setbacks, the research rescheduled the date of the interviews with the participants that did not show up. Also the research instruments were rephrased to enable me to answer the critical research questions given that there was nothing the researcher could do about the compulsory closure of schools.

4.12 Conclusion

This chapter discussed the research methodology that guided this study. Firstly, the chapter explained the choice of paradigm and the type of research as well as the rationale for employing these approaches. Furthermore, the research design, sample techniques, method of data collection and analysis were presented. In addition, this chapter offered explanations on the efforts made to ensure credibility and validity of this research. Also in this chapter, ethical issues and limitations of this research was deliberated. The next chapter will offer an analysis of the data collected in response to the research questions for this study.

CHAPTER FIVE: PRESENTATION OF THE ANALYSIS OF RESEARCH QUESTION 1

5.1 Introduction

This chapter presents the analysis of the Research Question 1: *"What are basic 7-9 science and technology teachers conceptions of IK as drawn from their narratives about IK"?*. This question was answered through the use of two data sources, namely, narratives and focus group interviews. The narratives provided by the basic 7-9 science and technology teachers were based on their lived experiences and classroom practices of IK. The focus group discussion aimed to gain a deeper insight into their conceptions of IK. The different data sources illuminated different IK practices carried out by these teachers. The analysis of the Research Question 1was premised on these identified IK practices. In this regard, five conceptions were brought to the fore. What is interesting to point out was that embedded in the five conceptions foregrounded, were five key qualifying components. The chapter is therefore divided into three parts. The first part presents the five conceptions together with the respective qualifying components. This is followed by a summary and a brief discussion on the findings of Research Question 1. The last part concludes the chapter by highlighting the key issues that were foregrounded in the analysis paving a way for the next chapter.

5.2 Analysis of Research Question 1

Before I provide an analysis of the kinds of conceptions that were unearthed in this study, I want to first outline the five IK practices that came to the fore from the narratives:

- Processing
  - Processing of cassava tuber:
    - Grinding and fermentation – to make *garri*;
    - Peeling and soaking in water leading to fermentation – to make *fufu.*
  - Processing of palm fruit:
    - Oil extraction using hot stone/metal rod.
  - Processing of raffia palm leaves:
    - Weaving of basket (*ngiga*) and handbags (*akpa*).
  - Processing of raffia palm core:

- Fermentation of the wine made from the core to produce local gin (*kai-kai or mwaetete*).
  - o Processing of scent leaf:
    - grinding and extracting the liquid content (*nchuawuta*)
  - o Processing of roots:
    - Grinding the roots (*mgborogwu*) and steeping them in water to make an infusion.
- Catalysing: speeding up fermentation through the use of an iron nail.
- Neutralising: using kerosene as a neutralizing agent for unpleasant smells.
- Setting: positioning of nodes of yam cuttings to capture maximum sunlight to promote germination
- Saponification: using palm leaves to produce soap and lotions.

The above practices were used as a premise from which to address Research Question 1.

With regard to Research Question 1, "*What are basic 7-9 science and technology teachers' conceptions of IK as drawn from their narratives about IK*"? the following five conceptions were foregrounded:

Conception 1: IK as informally learnt knowledge.

Conception 2: IK as Relational knowledge.

Conception 3: IK as Traditional knowledge.

Conception 4: IK as Technological knowledge that is scientifically based.

Conception 5: IK as Lost knowledge.

As mentioned in the introduction, embedded in the above five conceptions of what IK is, were five key qualifying components. These five qualifiers related to what I termed: the "what"; the "how"; the "where" the "who" and the "when" aspects of basic 7-9 science and technology teachers' IK conceptions. The "what" aspect focused on what constitutes the knowledge. The "how" aspect highlighted the process of acquiring these knowledge forms. The "where" aspect pointed to the source of the knowledge and the "who" aspect referred to the holders of the knowledge forms. Equally important in their conceptions, was the "when" aspect, which alluded to the time or era at which these knowledge forms were acquired. Thus, the conceptions of IK of basic 7-9 science and technology teachers can be argued to encapsulate the properties, the process, the place, the holder and the time of

knowledge acquisition. In the following section, I unpack each of the conceptions identified. This is then followed by a brief analysis of the conception.

5.2.1 Analysis of Conception 1: IK as informally learnt knowledge

A critical examination of the narratives provided by the teachers' points to the fact that they associate or describe IK as *informal* knowledge acquired in an *informal* context. They emphasised the fact that the knowledge is learnt casually or informally without attaching much importance to it. In other words, their understanding of IK has to do with the knowledge they acquired outside the formal school setting as reflected in the excerpts below.

> P3: *These are informal knowledge acquired informally … acquired outside the four walls of the classroom, there is no exam to it but it helps us in our day to day activities, they are IK.* (Appendix I)

> P1: *I think IK means the things you learn casually. "Acquired at home, outside the classroom, you just learn them casually without attaching any importance to them, maybe you see people doing it or you see your mother or father doing it you learn it and maybe at the end of the day, no examination on it.* (Appendix I)

It is interesting to note that both excerpts draw our attention to the "non-examinable" aspect of this informally acquired knowledge. While participant 3 conceived IK as "knowledge acquired informally", "outside the four walls of the classroom", participant 1 points to the notion of IK being acquired informally, by using the word "casually learnt at home". In other words, IK is acquired "at home" from "your parents" when you "see" (when you observe) them doing things. It is therefore clear that IK is conceived as "informal knowledge or casual knowledge" (borrowing the words of participant 1) acquired at a particular locale "at home" from "your mother or father", when you "see" (that is when you observe) them doing things.

Furthermore, with respect to the qualification of the conceptions, four of the five key qualifying components of IK conceptions are revealed in the excerpts above. These are:

- the "what" (IK conception)
- the "where" (its source)

- the "who" (its holder) and
- the "how" (process of acquisition).

The above conceptions in terms of the nature and qualifying components were reaffirmed by participant 3 as can be seen in the excerpts below.

> P3: *Observation, there is no test attached to it, is mainly practical… Because when we watch our parents fry garri (fermented cassava) for instance, we learn from that. Eh when we see them do these things practically we also learn. There is no formal, the most* important *thing there is that you learn it outside the classroom.* (Appendix M)

It can be seen that the informal nature of IK as conceived by the participants and the qualifying components such as the "how" (process of acquisition), the "who" (holders of the knowledge) was again emphasised in the above excerpt. The participant pointed out these qualifying components using the following words "Observation, there is no test attached to it", when we 'watch our parents" we learn. The most important thing is that "you learn it outside the classroom".

It can be said from forgoing expressions that IK is an informal type of knowledge in contrast with western knowledge that is described as formal knowledge. Also, it would seem the "in-formalness" or "casualness" of IK is associated with the contexts "where", "who" and "how" the knowledge is acquired and the lack of any formal assessment (no exam). In other words, these practices or knowledge are learned and acquired willingly at home or in the community, without any form of pressure to demonstrate performance, which lies at the heart of all formal exams.

These explanations are consistent with the views of researchers such as Agrawal (1995) in terms of the distinction between IK and conventional/western science and technology. According to Agrawal (1995), western science and technology is guided by empirical evidence and measurement or testing of hypothesis in a formal setting. In other words, one cannot completely acquire western science and technology outside formal schooling arrangement like in the case of IK. Also, western science and technology requires rigorous laboratory research and classroom examination before it can be acquired and proven, while on the other hand IK does not require formal examination to be proven and accepted. Rather other informal ways of testing or examination may be employed, such as planting

of crops and seeds in a given space and time with the guidance or supervision of a more experienced practitioner in that particular indigenous practice.

It is equally significant to note that the above perspectives concurs with the views of other scholars such as Takawira (2002 cited in Zazu, 2008) and Mapara (2009) who argue that IK is an informal or local (home grown) based knowledge that exist specifically in a given context (outside the school environment). This knowledge, according to Onwu and Mosimege (2004), reflects the relationship that exist amongst the people (children and elders) and the environment as well as the norms of the community. Therefore, the understandings and explanations of the teachers with regards to what makes up IK are consistent with the views of other scholars across the globe.

5.2.2 Analysis of Conception 2: IK as relational knowledge

It is interesting to note that the participants' links IK to a form of knowledge related to or intertwined with conventional knowledge (western science and technology). In the explanation provide by the teachers, they pointed out that IK is a type of knowledge that can be related or integrated into western knowledge. It can thus be said that IK is not far removed from western science and technology, rather both worldviews works interchangeably and interactively. In this regard an understanding of IK facilitates the acquisition and application of western science and technology. Looking at the responses provided by the teacher, it can be noted that the qualifying components of IK such as the "who" (holders of the knowledge), the where (source of knowledge) were emphasised as can be seen in the excerpts below.

> P4: *I think is relating local way of doing things into a modern way of learning…. That is, in the sense that our local way of life at home, maybe the way we ferment things, assume you want to teach fermentation you are trying to relate it to the way we do things in our house, how our mothers ferment their own food, try to relate it to the modern way of teaching in the class.* (Appendix I)

It is clear from the above expression that the participant conceives of IK as relational knowledge and also highlighted the "where" (source) and the "who" (holders) of the knowledge by using the following words "you are trying to relate it to the way we do things in our house, how our mothers ferment things". Affirming the above perspective,

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Participant 2 emphasised that IK is knowledge "we go up with and mix with the ones we learn in school". In other words, this knowledge is relational.

> P2:   *It is the knowledge we acquired from our parents at home and we go on with it until we come to school, and when we come to school that knowledge we may not drop, we go up with it and mix it with the ones we learn from school.* (Appendix N)

Again, embedded in the above conception are the "where" (source of IK) and the "who" (holders of IK). The participant explained that "the knowledge is acquired from our parents at home".

It can be seen from the above expressions that the participants conceive IK as a relational knowledge. That is to say that IK is a form of knowledge that can be related to other forms (formal) of knowledge such as western knowledge. It can also be deduced from the views of the teachers that IK is socially constructed, and is shaped by many relations or connection within the local environment and the school setting. This means IK it is a derivative of the experiences and ways of knowing of the people in the local environment in ration to other forms of knowledge and when individuals from the local environment move they move with the IK gained. In other words, IK is not static; it is transferable and can be linked to "another setting" which is inhabited by these individuals (Onwu & Mosimege, 2004). So IK is a relational knowledge. By implication, it is a type of knowledge that a child or children and teachers brings into the classroom (school). Perhaps these IK facilitate the acquisition and understanding of other forms of knowledge such as western knowledge. In consideration of the above responses given by the teachers, it can be said that they conceive IK as a relational form of knowledge. These conceptions underline the assertion made by Ogunniyi and Ogawa (2008) that an understanding of what students and teachers bring to the class is critical in positioning the teaching and learning activities within a meaningful context.

5.2.3 Analysis of Conception 3: IK as traditional knowledge

Traditional knowledge may be described as a knowledge form embedded in the culture or traditions of the people living within a particular community. According to Onwu and Mosimege (2004), such knowledge is unique to a given culture or community and have developed as that culture evolves over generations. Hence, traditional knowledge (also

identified as IK) is known and applied by the people living and operating within a particular culture and is handed down from one generation to another.

It is significant to note that the conceptions held by the participants concurs with the views held by some advocates and proponents of IK such as Lilemba and Matemba (2014) who argues that IK is the traditional knowledge of the people living within community. The expression "I define it as traditional knowledge passed from generation to generation" implies that the participant conceives IK as knowledge associated with the tradition and beliefs of the people living within a particular community and that this knowledge is intergeneration as illuminated in the excerpt below.

> P5: *I define it as the traditional knowledge that is passed from generation to generation. The knowledge is passed through oral teaching and some practical work.* (Appendix I)

In consideration of the above excerpt, it can be said that this participant's conception of IK is that of a knowledge embedded in the traditions and beliefs of the people living within a particular community. By implication, IK is the traditions and beliefs of the community and its inhabitants. Also revealed in his conceptions is the "how" (process of acquiring IK). The participant revealed that "the knowledge is passed down from generation to generation" thereby echoing the long held perceptions of scholars such as Semali and Kincheloe (1999), Onwu and Mosimege (2004) that IK is intergenerational. Therefore, it can be concluded from the above response that the traditions of a community are their IK and vice versa. Such knowledge is transferred to the younger generations by the elders as a way of preserving them.

Agreeing to the preceding perspective, participant 3 believes that there is a strong nexus between IK and traditions of the people in their community. His expression also identified some old men in the community as the holders (the "who") of the knowledge.

> P3: *Even some of the local old men here believe that any particular land the nchuanwunta (saint leaf) is planted is a blessed land. It is going to make some other important crops grow on that land. So by tradition you are not supposed to uproot the nchuanwunta leaf from the land so that it will help other plants grow.* (Appendix M)

It can be seen from the above expression that "by tradition" people know what they are allowed to do and what they are not supposed to do. Also "some of the old men" in the community are the "holders" of this knowledge which is one of the key qualifying components (the "who" aspect) embedded in their conceptions of IK. It can therefore be said that IK is the tradition of the people living within the community. The knowledge is symbolic and helps the people in making keys decisions within the community. When considered, the forgoing is in line with the perspective that IK is a way of knowing and living of people living within a community (Lilemba & Matemba, 2014).

Similarly, participant 2 in her explanation of IK and its source made the comments below.

> P1:   *Apart from listening to your parents, you are guided. You are guided because even when you watch them do those things, if you are doing your own and you not doing it well you will be corrected. Like teaching a child how to sweep the house, if the child sweeps it anyhow the mother or father or an elderly person will call the child back and say lift up the chairs and stools, and all those things and sweep under.* (Appendix L)

It is apparent from the above excerpt that, the "how" (process of acquisition), the "where´ (source of IK), the "when" (the era or time) and the "who" (its holders) components are revealed in the above expression. Thus, IK is acquired through "guidance" from an experienced practitioner (holders) of the knowledge. In that regard, the participant points to the "mother", "father" or an "elder" as the knowledge holders. The "home" or "house" if I may use the words of the participants is the source of the knowledge. Furthermore, the knowledge is acquired when the person is a "child" and "guidance and listening" are the processes of acquisition. The above excerpts also indicate that IK or traditional knowledge as conceived by the participants presents a platform for enculturation of younger people through guidance (observation).

In appropriate consideration, the views of the participants agrees with the perceptions of Maluleka, Wilkinson and Gumbo (2007) that IK is a knowledge form entrenched in the tradition of the people living within a particular locale. This is also in concordance with Mapara (2009) who argues that IK is associated with other names such as traditional knowledge, local knowledge and native knowledge and these forms of knowledge is transferred from one generation to another generation. Such knowledge according to Onwu and Mosimege (2004) is transferred from one person to another through oral

communication and guidance (apprenticeship). It can therefore be concluded that IK is a traditional, native or local form of knowledge developed and used by the people living within that community and handed down from one generation to another through oral communication and guided practice to ensure the sustenance of the people and the environment.

5.2.4 Analysis of Conception 4: IK as technological knowledge that is scientifically based

The assertion that IK can deliver in a similar way like western science and technology was espoused by the participants who proffered that IK is scientific in nature. This can be seen in the excerpts below.

> P1: *If I want to prepare fufu (fermented cassava), instead of leaving it to stay for four days and be smelly, what I will do is to grind it as if I want to use it for garri (processed cassava). After grinding it, I will not squeeze out the water the way we do for garri, rather I will cover it and sprinkle more water and allow it to stay for two days instead of the normal four days. You know because you have increased the surface area for the reaction, so within those two days it will be like you have fermented it up to the normal four days and the smell will not be there. So that one is science, because you have increased the reaction, you know the surface area, so it reacts, it ferments and the smell will not be there.* (Appendix M)

The above expression implies that the participant associates IK with "science". In her elucidation of the local process of fermentation, she explained that reaction takes place when the surface area is increased. This local process is in line with scientific process of achieving fermentation. The participant did not "squeeze out the water", because scientifically, water is needed for hydrolysis (breaking down) of glycoside. Yet again, participant1 associated the "what" (conception of IK) and the "where" (source of the knowledge) to science and technology as can be seen in the excerpt below.

> P1: *Again all these egwusi or mgbam (processed melon) that we do at home, I don't know if you do it in your area. Here after preparing it, they will wrap it in the leaves and then cook it and you can eat it. But in my husband's place (Ngwa), they don't cook it, they will roast it. After making the paste*

with salt, pepper and everything you want to put in it. They will put it in the ngiga (local basket), and hang it over the fire place and it will roast. It will come out very sweet and preserved too, so you won't spend extra money trying to cook it. That smoke coming from the fire place will roast it and give it a nice smell. (Appendix M)

It can be deduced from the expression of the participant that she conceives IK as a form of knowledge that is technologically inclined and scientific grounded, for example, using the *ngiga* (local basket) to prepare and preserve *egwusi* (processed melon) is very similar to the modern food processing technology that involves using electric or gas cooker to grill and preserve some food items and meat.

When considered critically, there are enzymes such as bromelain and papain in the leaves used in wrapping the melon which softens the *egwusi* or *mgbam* (melon) and speeds up the cooking time. These enzymes are like tenderizers (softeners). Also roasting the melon with salt in the fire place increases the surface temperature and also preserves it from spoilage microorganism. This also gives room for caramelisation (oxidation process of sugar) and gives the melon a sweeter taste and aroma; in the words of the participant, 'it will come out very sweet and preserved too". These explanation are familiar with the opinions held by scholars like Eze & Ike Nnia (2013) that IK or IK system is intertwined with science and technology. In other words IK is a form of knowledge that is scientifically based and technologically applied.

Again, IK was identified as a knowledge form that involves "making" (innovation) of things to sustenance and survival. This viewpoint is captured in the excerpt below.

> P3:   *From my understanding, it is about the things we witnessed and our local ways those days of making small things we can use to help ourselves.* (Appendix I)

It can be deduced from the above expression that IK is conceived as a knowledge used in providing solution (*making small things to help ourselves)* to contextual problems and for sustainability. This is to say that IK it is a knowledge that involves "making", (application) doing, or solving problems which lies at the heart of modern technology.

In furtherance, Participant 3 affirms the points made by Semali and Kincheloe (1999) and Lilemba and Matemba (2014) who argue that IK is a tested and trusted "traditional

science" as against western perspective that IK is barbaric, primitive unverifiable. His position is reflected in the excerpt below.

> P3: *"On many occasions when a child or children have convulsion you will see the old women or men rush into the bush and get one or two leaves, but as a person who doesn't know the leaves too well, I don't know how they are able to know the particular leaves that can cure so many diseases like convulsions. To some people it looks like magic but to me, I believe that there is certain evidence of science there. Although they are not able to test the particular ingredient curing those sickness, but there is always a leaf that cures those sickness.* (Appendix M)

It can be deduced from the above except that both the "what" (conception of IK) and the "who" (its holders) aspects of IK are revealed. With regards to the "what" the participant disparaged the views that IK is "magic" and said "there is certain evidence of science there". He also linked the holders of IK to "old women and men". Agreeing to the above expressions, participant 1 espoused the nexus between IK and western science by using these words, "there is a lot of relationship between science and IK" as seen in the excerpt below.

> P1: *You know there is a lot of relationship between science and IK, but you cannot know except through this kind of research.* (Appendix I)

In consideration of the above expression, the participants are aware of the relationship between modern science and technology, but perhaps, this nexus is yet to be fully explored by scholars and educators. Having said that, negotiating a synergic front between these worldviews through educational policies and researches such as this will be of great benefit to indigenous learners and students, while the neglecting the relationship will widen the dichotomy between both worldviews.

In the same regard, participant 5 conceived that IK is a technological knowledge that is scientifically based. Comparing the "local technology involved" in the "production of local gin (*nwaetete*)" and other indigenous food products with that involved in the " industrial production of whisky", the participant maintained that the "technologies are the same". His expression is as seen in the excerpt below.

P5:   *For instance in food processing, let's say processing of gins. I know in your place there is a place we call Amumara, when I was young, the place was known for producing local gin (Nwaetete). Now, local technology is involved, is almost the same process with the production of whisky and the rest of them.* (Appendix I)

Another key qualifying component which I termed the 'when" aspect (the time or era of acquiring IK) was made know in his explanation. By using the words "when I was growing", the participant revealed the "time or era" (when) of acquiring IK. It is therefore interesting to note that the conception of this participant is consistent with the position of researchers such as Van Sertima (1999), Onwu and Mosimege (2004), Leewee (2004 cited in Nel, 2005) and Eze and Ike Nnia (2013) who emphasise that IK is an inclusive type of knowledge that covers technologies and practices that have been used and are still used by indigenous people for survival within their environment. These researchers maintains that IK can deliver at the same level with western science and technology, given that the processes and products involved in both system are similar.

More so, the previous views were again emphasised by participant 7 who said he grew up to "see his father do a lot of things technologically". His conception is illuminated in the following quotes:

P7:   *I grew up to see my dad do a lot of things technologically… Like weaving of bags with bamboo leaves. After weaving, he will fold it and use a needle to sew it into a fanciful bag and he was making money out of it … Also my mother was into soap making using palm frond from palm tree. After harvesting the palm kernel, she will burn the palm frond into ashes. The ashes will be left to dry for a long time and it will be mixed with oil, and then the soap is ready. The soap is used for washing and bathing. Traditionally, it is used to cure rashes.* (Appendix M)

From a science perspective, palm frond has potash or sodium and when it is burnt the potash is transformed to oxides (potassium) or sodium. When oil is added, reaction occurs to produce hydroxides (red colour is due to oil). The soap produced in this reaction cures rashes due to the high potassium content. It can be seen that this process of soap making is science oriented and similar to the processes applied in making soaps in factories. It is

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therefore significant to say that IK is conceived as a technological knowledge that is scientifically based given that such knowledge has been tested and trusted over time.

Drawing from the above excerpt, the "what" (conception of IK), the "when" (era or time of acquisition of IK), the "how" (process of acquiring IK) and the "who" (holders of IK) aspects of IK are revealed. These are reflected in the statement 'I grew up to see my dad do a lot of things technologically". Therefore, it can be said that IK is conceived as a "technological" knowledge, the era or time of acquiring it is "when growing up", the process of acquiring it is by "seeing" (observation) and finally the holder of the knowledge is "dad" (fathers).

It can be concluded that the participants conceive IK as a technological knowledge with science base. They emphasised that IK is used in "doing and making" products and services for sustenance and adaptability within the community. Furthermore, their conceptions revealed how this knowledge is acquired, who is acquired from and where it is acquired. Interestingly, these conceptions are not removed from the opinions of scholars in within the academy about IK/IKS.

5.3 IK as lost knowledge

Despite acknowledging IK as a form knowledge that is applied on daily basis, the participants expressed concerns that IK is diminishing (being lost) as a result of poor documentation and lack of interest. The participants reasoned along the same line as Van Sertima (1999) and Semali and Kincheloe (1999) who stated that western knowledge or modern technology has taken over the IK in communities. These concerns can be seen in the quote below.

P7   *… All these things are local technology and when I went on transfer from Imo state to Abia state I saw all these things there, and they make more money with it. Some of them don't do anything else apart from that (it is there occupation), making and weaving and they make money out of it…… So what am saying is that it looks like we have forgotten about all those indigenous technologies and went into the ones we may see as modern technology. I feel we should also come back to those things and begin to encourage them, people should practice them.* (Appendix M)

Participant 7 explained that the desire to acquire modern science and technology have led to the loss of valuable IK forms and practices and maintains that "it looks like we have forgotten all those indigenous technologies and went into the ones we see as modern technology". While today, western agenda by way of western education and industrialisation and modernisation has led to neglect and lack of interest in IK forms and practices. In the same vein, Participant 1 linked IK to lost knowledge by using these words "most of these science were practiced, but without any documentation".

> P1: *Because our ancient people did not go to school, so they can't write down anything. But actually, these things, most of the science were practiced, but without any documentation, do you understand it now?* (Appendix I)

The participant acknowledges that IK has been in practice for long, but lack of documentation of scientific discoveries as a result of lack of formal education on the side of the ancient people has led to the loss of some valuable IK practices. Also revealed in the participant conception of IK are the holders (who) of the knowledge "ancient people". Moving forward, it is important to state that educational research contribute immensely in invigorating IK and also help in the documentation and preservation of the legacies of the ancient people in the area of indigenous science and technology. Just like participant 1 pointed out: "*You know there is a lot of relationship between science and IK, but you cannot know except through this kind of research*". It is thus critical to note that the participants acknowledged the importance of such educational research in preserving and projecting IK to the fore.

Nonetheless, it is significant to say that the participants recognises the fact that IK is gradually going into extinction in the communities as a result of what one of the participants referred to as "quest for modern technology". Remarkably, some researchers like Van Sertima (1999) shared similar sentiments over a decade ago. In his words,

> It is important to understand this, if we are to comprehend how a science or technology may rise and fall with civilisation, why the destruction of a centre could lead to the almost instant evaporation or disappearance of a center of centuries of knowledge and technical skill (Van Sertima, 1999, p.16).

Interestingly, the above concerns was sustained after a decade by Quigley (2009) who argues that educators are determined to explore traditional belief systems in order to bring

them to the fore, but the youths (students) of many indigenous groups are becoming cynical in their own indigenous practices or culture and these has contributed to the loss of these valuable practices. This negative view is as a result of lack of value placed on these indigenous practices by Western perspectives (Quigley, 2009). It is evident that the expression of the teachers about IK indicates that they understand it as a body of knowledge that has been lost to intrusion of western technological developments which are unsustainable in most case. Likewise, lack of documentation of discoveries of the ancient people and apathy on the side of the younger generation contributes to chances of IK becoming lost knowledge and going into extinction.

5.4 Conclusion

In exploring basic science and technology teachers' conceptions of IK as drawn from their narrative about IK, five key categories or findings were identified which answered Research Question 1 of this study namely, IK as informally learnt knowledge, IK as Relational knowledge, IK as Traditional knowledge, IK as Technological knowledge that is scientifically based and lastly, IK as Lost knowledge. Furthermore, embedded in the conceptions held by the teachers are five key qualifying components related to what I termed as the "what"; the "how"; the "where" the "who" and the "when" aspects of their IK conceptions.

Firstly, the participants emphasised that IK is an informal knowledge that exists outside the school setting or classroom contexts. In other words the knowledge is not book learnt. According to the participants, this type of knowledge is relational given that the learners bring them into formal school arrangements and mix them with what they learn in school. Perhaps, IK lays the foundation for the acquisition of western knowledge. Also, it was deduced from the teachers' responses that they conceive IK as traditional knowledge. The teachers explained that their tradition serves as a guide to decision making in the community and is therefore there way of knowing and living. Furthermore, the teachers through their expressions supported the view that IK is technologically inclined and have a scientific base. They pointed out instances where IK delivered at the same level with western science and technology. More so, the teachers expressed concerns that IK is gradually going extinct (lost knowledge) as a result of poor documentation and lack of interest in IK and the quest to acquire western knowledge. That implies that IK is also conceived as a lost knowledge.

Moving forward, the five key qualifying components embedded in their conception of IK which are the "what" (conception of IK), the "where" (source of IK), the "how" (process of acquiring IK), the "when" (time or era of acquiring IK) and lastly the "who" (holders of IK) were discussed in this chapter. With regards to the "how", the participants emphasised that this knowledge or sets of knowledge can only be acquired through observation, guided practice (apprenticeship) and oral teaching and there is no form of assessment (examination & test) attached to it. By implication, the teachers believe that IK is not book learnt rather is a type of knowledge that is developed and used by the community informally. It was also noted from the participants responses that the grandmother and grandfather, parents, elders and peers in some cases are the "holders" (who) of IK and perfection comes with guidance from these elites in practice. In that regard, IK is usually handed down from one generation of practitioners to another generation as one of the participants explicitly pointed out. Yet again, the participant identified the home or the community as the source (which is regarded as the where) of IK. Lastly, it was noted that IK is acquired at an early age or childhood (while growing), which is alluded to the "when" component of their conception.

In summary, the findings for Research Question 1 are that the basic 7-9 science and technology participants conceive IK as follows:

- Informally learnt things.
- Relational knowledge.
- Traditional knowledge.
- Technological knowledge that is scientifically based.
- Lost knowledge.

The next chapter will focus on the analysis of research question 2.

CHAPTER 6: PRESENTATION OF THE ANALYSIS OF RESEARCH QUESTION 2

6.1 Introduction

In this chapter, an analysis of Research Question 2: *"Are these conceptions enacted in the classroom? If so, how are they being enacted and what informs their enactment? If not, what informs their practice?"* is presented. Research Question 2 was answered through the use of three focus group interviews. The focus group discussions aimed to find out whether the teachers enact their IK conceptions in their teaching, how they are being enacted and what informs their enactment. For the teachers that do not enact their IK conceptions in their teaching, the discussion was aimed at understanding what informs their current teaching practices. Hence, this chapter will, firstly, consider "whether" the five conceptions held by the teachers in chapter five are enacted in their teaching practices and "how" they are being enacted. Furthermore, the chapter will establish "what" factors inform their enactment. Lastly, the chapter will determine what factors determine the participants' teaching practices, if they are not underpinned by their IK conceptions.

This chapter is therefore divided into three key sections. The first section will present the analysis and discussion on the findings for Research Question 2 (a) *"Are these conceptions enacted in the classroom? If so, how are they being enacted and what informs their enactment"?* The second section will present the analysis and discussion on the findings for the second part of research question 2 (b) *"Are these conceptions enacted in the classroom? If not, what informs their practice?"* The last part concludes the chapter by highlighting the key issues that were foregrounded in the analysis, which paves the way for the next chapter

6.2 Analysis of Research Question 2

As pointed out in the methodology chapter, out of the seven teachers who participated in Phase One of data capture of Research Question 1, only five teachers' (P1-P5) consented to participated in Phase Two of data collection for Research Question 2. Two participants (P6 & P7) excused themselves from the research process. With regard to *enacted and what informs their enactment? If not, what informs their practice?"* the analysis is presented to sub-questions 2 (a) and 2 (b):

- Research Question 2 (a): *Are these conceptions enacted in the classroom? If so, how are they being enacted and what informs their enactment?*

- Research Question 2 (b):: *Are these conceptions enacted in the classroom? If not, what informs their practice?*

6.2.1 Research Question 2: Are these conceptions enacted in the classroom?

In this section, I will present the findings with regards to Research Question 2 in tabular form (see Table 2). The section focuses on the "How" and 'What" factors that are foregrounded in the teachers' enactment of their IK conceptions in the classroom. Afterwards, I will present the findings and analysis each of them separately and then conclude the first section.

With regard to establishing whether the participants enact any of the five conceptions identified in Research Question 1, three out of the five teachers responded positively. Furthermore, the analysis revealed that only two out of the five conceptions identified were enacted as can be seen in Table 2 below.

Table 2: Participants that enact their IK conceptions in their teaching

Conceptions	Yes			Maybe	No	
1. **IK as informal knowledge**						
2. **IK as relational knowledge**	P2	P4	P5		P1	P3
3. **IK as traditional knowledge**						
4. **IK as technological knowledge that is scientifically based**	P2	P4	P5		P1	P3
5. **IK as lost knowledge**						

In the following section, I provide a brief discussion on each enacted conception.

6.2.1.1 IK as relational knowledge: Relating school knowledge to lived experience

The participants accepted that they enact their conceptions of IK in their pedagogical activities and explained that they use some activities the learners are familiar with to explain concepts in the classroom. Participant 4 explained "how" (the process of enactment of IK conceptions) she enacts her IK conceptions by using these words "you try to relate it

to what you are teaching them in school". She emphasised that relating learners' day to day activities to what they are learning is important because it grabs their attention.

> P4:   *Yes, because it is day to day activities, you try to relate it to what you are teaching them in school. So when you bring those things more closer, it will draw their attention to that area of concentration.* (Appendix K)

With regards to "what" (reason for enactment of IK conceptions) informs the enactment of IK, she explained that "it draws their attention to that area of concentration". Agreeing to this, Participant 2 asserts that some of the learners lack basic understanding of some of the terms (concepts) in basic science and technology, therefore bringing the terms closer to home (contextualizing teaching) will facilitate their understanding and also bridge the gap between western knowledge and IK. This can be seen in the excerpt below.

> P2:   *At times some of them don't understand some of the terms, but if you go down bring it home and relate it with the activities they do at home, they will understand very well. Although there are time constraints, but whenever you teach and bring the topic home, they will understand it very well.* (Appendix K)

As observed from the above excerpt, the participant explained that learners struggle to understand some of the western science and technology terms but "if go down and bring it home and relate it with activities they do at home" the student will understand very well. In other words, the teachers enact their IK conceptions by contextualizing teaching and learning activities (relating school knowledge to learners lived experiences). This alludes to the "how" aspect of enacting their IK conceptions. In terms of "what" (which is the process of enactment) informs their enactment, Participant 2 explained this by using this statement "whenever you teach and bring the topic home, they will understand it very well".

The opinion of these teachers are similar to those of Brayboy and Castagno (2008) who argue that effective learning of basic school science and technology can be achieved if teachers embrace and implement culturally relevant schooling especially in formally colonised countries and places. Thus, the participants' understandings and explanations are in line with current discussions across the globe related to decolonisation and contextualizing of the teaching and learning of school science and technology. In addition,

these explanations imply that they link (relate) their teaching of basic science and technology to learners' IK and practices in order to facilitate their understanding of conventional science and technology.

6.2.1.2 IK as technological knowledge that is scientifically based: contextual problem solving

The teachers acknowledged that the methods used in enacting their IK in the classroom gives room for problem solving (contextually and in the school settings). These methods of enactment could be in the form of improvisation, indigenous technology, oral teaching and reference points.

> P5:   *They are very important. In the first place, they help to solve problems locally and in school.* (Appendix K)

Furthermore, Participant 5 emphasised that he exposes learners to both worldviews (IK and science and technology culture). This is very typical of teachers as cultural brokers (Stears, 1995 cited in Aikenhead & Jegede, 1999).

> P5:   *First of all I will tell them, this is how a local house is made, but this is how developed buildings like bungalows, detached buildings, skyscrapers and these ones seen in developed countries that are made of bricks are made. While our local ones are made with local materials. I will first introduce the indigenous method of making a house with local materials and afterwards I will teach the modern method of building houses.* (Appendix K)

It can be deduced from the above expression that the teacher exposes the learners to indigenous local (contextual) methods first before introducing them to modern approaches of doing things. Importantly, the teacher exposes the learners to both methods of problem solving, starting with the indigenous methods in order to make understanding of western methods possible.

This approach is concordance with the Snively (1995 cited in Aikenhead & Jegede, 1999) who proposes 15 teaching strategies or methods for teachers as cultural brokers. Snively (ibid) contends that teachers must adopt teaching approaches that emphasise solving science and technology problems, contextual problems, resource management and

sustainable development. In other words, teachers as cultural brokers should adopt strategies that will inculcate such problem solving skills in the learners.

In exploring how the above two conceptions were enacted and the reasons therefore, the following section presents the findings on the variation of the categories that emerged.

6.2.2 Research Question 2 (a): If so, how are they being enacted and what informs their enactment?

As mentioned in the previous section, the analysis revealed that only two conceptions were enacted, namely: IK as relational knowledge and IK as technological knowledge that is scientifically based. In the following section I discuss first the process (how) of enactment of the above two conceptions, followed by the reasons that were given by the participants for their enactment.

With respect to the conception of IK as relational knowledge, the following three categories were established:

- Practical work.
- Hands on experience.
- Guided discovery.

With respect to the conception of IK as technological knowledge that is scientifically based three categories were established as follows:

- Improvisation.
- The use of indigenous technology as reference points.
- Oral presentation.

With regards to "what informs the participant's enactment of their IK conceptions", the following factors were revealed:

- To link local knowledge to western and school knowledge.
- To facilitate understanding.
- To understanding how local knowledge should be applied or developed.
- Avenues for enculturation.

6.2.2.1 Analysis of IK as relational knowledge: Relating school knowledge to lived experience

➢ *Practical work*

Still on "how" (process of enacting IK conceptions) the teachers enact their IK conceptions and "what" (reasons for enactment) informs their enactment, the participants said they expose their students to "practical skills whereby they practice what they have been taught". This viewpoint is reflected in the quotation below.

> P5: *After explanations and teachings have taken place. They are exposed to practical skills, whereby they practice what they have been taught.* (Appendix K)

The above view was espoused by Participant 2 as seen in the excerpt below:

> P2: *We do practical depending on the topic. Like when we did household cleaning agents, I told them to bring eggshell and we dried and squeezed it there, and sieved it.* (Appendix K)

The explanations offered by the participants shows that they engage the learners in practical work using locally available resources. Therefore, it can be said that the process (how) of enacting their IK conceptions is by the use of practical work depending on the topic being taught.

➢ *Hands on experiences*

The teachers explained that the learners are given hands on activities such as weaving with needles and farming with local farm implements and this explains "how" they enact their IK conceptions in the classroom. The following statements were made by the teachers:

> P4: *When I taught them house help and craft we did the practical in the class. So many of them came with things like threads, needle and knots so we practiced in the class.* (Appendix K)

Affirming the above perspective, Participant 2 explained that she takes the "learners to the farm and they will use the farm implements and do the farming". The above explanation can be seen in the quote below.

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P2:   *If its farming like I said before, I will take them to the farm and they will use the implements which I have brought and do the farming. Implements like hoes and machetes and all the rest of them. We use machete to cut the grasses, the sickle to work on the soil, the shovel to dig the soil.* (Appendix K)

It is evident from the above explanations that the teachers expose the learners to hands on experiences (activities). Perhaps the learners are already familiar with such activities like clearing and cultivating the soil. This approach is consistent with Snively's (1995 cited in Aikenhead & Jegede, 1999) argument that instruction should provide sensory experiences and experiential learner centred learning. So, exposing them to such relevant and stimulating activities in the classroom will help them to understand the value or significance of their IK in relation to modern science and technology.

➢ *Guided discovery*

From the participants' responses, it is can be seen that they engage learners in activities that can help them discover new and existing IK in their communities. Such knowledge is linked to the science and technology delivered at school.

P4:   *So it will even serve as a room for others to know what they have not even seen, because some of them being township boys and girls may not even have seen it, but they do hear about it. So that will serve as avenue of them seeing that particular thing.* (Appendix K)

As explained above, relating school knowledge to lived experiences "serves as a room for others to know what they have not even seen". In other words, this approach guides learners into creating knew knowledge. This view was echoed in the following expression:

P4:   *Some use mats and other things at home but they don't know where these things are being classified (indigenous or western knowledge). So when you make things like this, tell them and show it to them and bring their mind more close to those things they use at home it will make them relax and bring them closer to the topic.* (Appendix K)

The explanations offered by the participants imply that learners are guided into discovering new forms of IK. It is apparent that some of the learners would be aware of aspects of IK, having grown up in the rural areas others raised in the township or urban area (as the teachers indicated) may have heard about some IK but may not have seen them, hence teaching about these knowledge forms would be an opportunity for the urban learners to discover new forms of knowledge. It can therefore be concluded that the process (alluded to the how) of enacting their IK conceptions is by guided discovery.

6.2.2.2 Analysis of IK as relational knowledge: IK as technological knowledge that is scientifically based

➢ *Improvisation*

Here, the teachers explained that they use improvisation as a way (how) of enacting their IK with the aim of linking (reason) local knowledge to western or school knowledge. This view is captured in the quotes below.

> P5: *By using improvisation. Let's say, we bring in some local tools and materials which will enable them to understand how some local knowledge should be applied or developed.* (Appendix K)

As evident in the above excerpt, the teacher enacts his IK "by using improvisation". He also revealed that "bringing local materials will enable them to understand how local knowledge should be applied or developed". Thus, it can be said that the participant uses improvisation by way of bringing in local materials to enact his IK conceptions. Agreeing to this, P2 made the following comments:

> P5: *Because some of them are not from the same place so they may not know. So the best thing one does is to bring the material closer and to show them what you mean.* (Appendix K)

Participant 3 also agreed to the preceding views by stating the following:

> P3: *In everything they have a principled life; there is one that is more common, so you use it. So that's how I use mine.* (Appendix K)

It can be seen that the teachers use improvisation by way of bringing in material (local tools) when enacting their IK in the classroom.

➢ *The use of indigenous technology as reference points*

The participants identified indigenous technology as one means of enacting their IK in the classroom. The following quotes represent the participants' views.

> P2: *When you talk of indigenous technology and give examples of indigenous technology it will make them understand the lesson very well.* (Appendix K)

It is apparent from the above excerpt that "talking about indigenous technology and giving its examples" is the method or what is described in this chapter as the "how" of enacting IK in the classroom. It can also be said from the above excerpt that using some indigenous technology as lesson exemplar aids the learners' understanding as pointed out above. In other words it facilitates the learners' understanding of the lesson. Thus using indigenous technology as reference points facilitates learners' understanding. Participant 5 acknowledges the use of indigenous technology as a way of enacting his IK in the classroom. The following excerpt represents his views:

> P5 *When am teaching basic technology, when it comes to construction of houses with local materials. I will bring some local materials like hoes, shovels. I also bring red earth or mud (as we call it), bamboo sticks and local mast.* (Appendix K)

It is apparent from the above expressions that these teachers use indigenous technology to enact their IK in the classroom. They pointed out that giving examples of indigenous technology is their method of enactment of IK; this therefore explains "how" their conceptions are enacted. Secondly, there is an emphasis that using IK facilitates learners' understanding. This is to say that their enactment of IK is informed by the need to facilitate learners' understanding. This approach clearly agrees with Snively (1995 cited in Aikenhead & Jegede, 1999) who argues that teachers should provide a "multicultural view" of science and technology by drawing upon a variety of cultures when teaching science.

Furthermore, Participant 2 acknowledged that teachers use IK as reference points when teaching basic science and technology. This view is seen in the excerpt below:

> P2:   *A teacher who is going to teach precipitation will make reference to it. The teacher will tell the students how it is done locally and teach them the modern process.* (Appendix K)

As seen in the excerpt above, teachers uses indigenous practices as reference points in their teaching. In the words of Participant 2 "A teachers who is going to teach perspiration will make reference to it". Hence, this explains how they enact their IK conceptions in the classroom. Agreeing with this, Participant 4 pointed out that she uses IK as a reference when explaining concepts in her class. This can be seen in the excerpt below.

> P4:   *There are topics that I will teach that relates to IK, I will make reference to that. For instance if am teaching about drug abuse, I will make reference to that because it does not have dosage.* (Appendix K)

As seen in the above excerpt, when teaching topics that relate to IK the teacher "will make reference to that". This can be explained as "how" the teachers enact their IK conceptions in the classroom. Evidently, this approach is in line with the suggestion that similarities and differences and strength and weakness of the two traditions (indigenous and science and technology) should be articulated and explored during teaching (Stears, 1995 cited in Aikenhead & Jegede, 1999).

➤ *Oral explanations*

The teachers highlighted the use of the oral explanation method when enacting their IK. It is not surprising to see that the participants employ this approach given that oral teaching is recognised as one of the means of transferring IK (Ogunniyi, 2007; Onwu & Mosimege, 2004).

> P2:   *In some topics like separation of substances. At time you use IK like hand picking, mixture of rice and beans to explain in class. You can also use mixture of oil and water to explain separation of substances.* (Appendix K)

As can be seen from the above excerpt, IK like "hand picking, mixture of rice and beans is used to explain in class". It is significant to note that this method falls under the 15 instructional strategies suggested by Stears (1995 cited in Aikenhead & Jegede, 1999). According to Snively, (ibid) oral narrative and heritage of indigenous or native communities should be seen beyond myths and legend but should become part of the

school science experience. In that regard, the oral teaching or explanation approaches adopted by the participants explains how they enact their IK conceptions in the classroom and this method is among the key strategies suggested for teachers as cultural brokers in an eco-cultural education system.

6.2.3 Analysis of Research Question 2 (a) "What informs their enactment?"

➢ *To link local knowledge to western and school knowledge*

The participants pointed out that enacting their IK conceptions in their teaching of basic 7-9 science and technology is very important because it helps them to link their local knowledge to western orientated school knowledge. This is reflected in the excerpt below.

> P5:   *When it is introduced, they will also know that eh it is indigenous technology. It is also the same thing with eh what is produced or what takes place in the western world.* (Appendix K)

> P2:   *When is introduced they will say so this type of thing have been? oh is what we have been using at home ooh, that they are teaching at school. They will be very much happy.* (Appendix K)

It is significant to note that the participants introduce learners' everyday IK experiences into their teaching of school science and technology to enable them to see the link between such knowledge or technologies and those developed in western countries. In other words the enactment of their IK conceptions is informed by the need to link western knowledge and IK. It is also important to note that linking these two worldviews "will make them very much happy".

➢ *To facilitate understanding*

The teachers indicated that the enactment of their IK conceptions in their teaching activities was informed by the need to facilitate learners' understanding as can be seen in the following excerpts.

> P2:   *It helps the students to understand the lesson very well. Eh the students feel when you talk of technology and give examples with indigenous technology they will understand better. At times some of them don't understand some of the terms, but if you go down and bring it home they will understand very*

well. Although there is time constraints, but whenever you teach and bring the topic home, they will understand it very well. (Appendix K)

P4:   *When you bring those things closer, it will draw their attention to that area of concentration. They will just know that oh these are things am doing at home. Some maybe doing it ignorantly, but when you use it as a reference it will draw them closer to that particular topic. They will even understand it very well, because they will now understand that this is what I do at home without knowing that oh, I can even relate it.* (Appendix K)

Drawing from the above expressions, it can be said that the use of IK as lesson exemplars during school science and technology lessons enhances learners' and students' understanding and draws their attention to that area of concentration. The approach perhaps makes the delivering of science and technology less mystifying and more relevant to learners' lived experiences given that the things the learners are exposed are weaved into teaching and learning activities. As Participant 2 indicated, "it helps the students to understand the lesson very well". Having said that, it can be concluded that what informs the enactment of the teachers IK conceptions is the need to facilitate learners' understanding of the science and technology delivered at school.

> ➤ *To understand how some local knowledge should be applied and developed*

The participants revealed that introducing their IK conceptions in the classroom help the learners' understand how local knowledge is developed and applied. This perspective is captured in the quote below.

P5:   *By using improvisation. Let's say, we bring in some local tools and materials which will enable them to understand how some local knowledge should be applied or developed.* (Appendix K)

It is apparent from the above quote that Participant 2 exposes the learners to indigenous technology in order to enable them to understand how this local knowledge can be used to develop new knowledge. In other words, what informs the enactment of his IK conception is the drive to introduce learners to ways of developing and applying local knowledge.

> ➤ *Avenues for enculturation*

Still on what informs the teachers' enactment of their IK conceptions, it was revealed that enacting their IK conceptions in their teaching presents opportunities for some learners to be exposed to diverse IK practices and experiences. In the words of participants:

> P4:   *At times it will even serve as a room for others to know what they have not even seen, because some of them being township (urban) boys and girls they may not have even seen it, they do hear but hey have not seen it. So that will serve as avenue of them seeing that particular thing* (Appendix K)

> P4:   *Some use mats and other things but they don't know where these things are being classified. So when you make things like this, tell them and show it to them and bring their mind more close to those things they use at home it will make relax, feel more relax and bring them closer to the topic.* (Appendix K)

As indicated in the above excerpts, some learners have not been introduced to IK practices or technologies, perhaps because they grew up in "townships" (urban) areas where such practices were not prevalent or even existent. On the other hand, some learners are exposed to such practices but may not know where they are classified (local or western). Therefore, introducing these indigenous practices in the classroom creates an avenue for learners to be properly informed on the different types of IK that exist. In that regard, it may be concluded that the participants enact their IK conceptions in their teaching practices because it creates an avenue for enculturation.

6.2.4 Discussion of findings regarding Research Question 2 (a)

It is apparent from the forgoing analysis and discussions that different educators employ different methods in enacting their IK conceptions in the classroom and various reasons and factors inform their enactment. While others agreed to use practical approaches, others prefer to expose their learners to hands on experiences and guided discovery. For another set of teachers, contextual problem solving by way of improvisation, the use of indigenous technology as reference points and oral explanations were better methods. But whichever method employed by the teachers there was a reason behind choosing such an approach (what informs their enactment). The variations observed from the teachers responses in terms of methods of enacting their IK conceptions in their teaching are in line with those of Jegede (1999) and Semali and Kincheloe (1999). According to them, there are no

universally acceptable teaching approaches and models of enacting or implementing IK in the classroom other than the ones developed by indigenous teachers themselves. In that light, the teachers use their own IK (the most comfortable approach) when enacting IK in the class in order to make learners understand western science and technology.

The approaches adopted by these participants (teachers) and the rationale behind their choices are in agreement with Jegede's (1999) eco-cultural paradigm. The eco-cultural paradigm acknowledges the difference between school science and technology culture and the home cultures of the learners and thus provides the psychological support as well as the stage for cross-cultural pedagogy. The roles being played by the teachers (participants) in this study in terms of enacting their IK conceptions (cross-cultural instruction) are in line with Stears' (1995 cited in Aikenhead & Jegede, 1999) perception of "teachers as cultural brokers". A science and technology teacher who is a cultural broker will help the learners to navigate easily between their home culture and the culture of school science and technology. Therefore, the participants in this study can be described as cultural brokers given their responses in terms of "how" (methods, roles and responsibilities) they enact their IK in the classroom and "what" (reasons) inform their enactment.

6.3 Research Question 2 (b): *"If not, what informs their practice?"*

The analysis is presented in two parts. In the first part, the findings tabular format (see Table 3). This section focuses on the "What" factors that are foregrounded by the participants in their pedagogical activities given that they are not determined by their IK conceptions. In the second part, I will discuss each of the findings and then conclude the section.

Table 3: Enactment of IK conceptions

Conceptions	Participants	Yes	Maybe	No
IK as informal knowledge		-		P1 P3
IK as relational knowledge		P2 P4 P5		P1 P3
IK as traditional knowledge		-		P1 P3
IK as technological knowledge that is scientifically based		P2 P4 P5		P1 P3
IK as lost knowledge				P1

As can be seen from Table 3, two of the five participants stated that they did not incorporate or enact IK conceptions into their teaching practice. These participants foregrounded the following four issues as what informs their practice:

- Curricular issues – 2 subcategories were established:
  - o Syllabus;
  - o Assessment.
- Lack of teaching resources – 2 subcategories were established:
  - o Lab equipment;
  - o Textbooks.
- Learners' ability.
- Workload.

In the following section I discuss each of the above four issues, inclusive of the variations observed within each issue.

6.3.1 Curricular issues

Participant 1 identified "the syllabus" (curriculum) as the main factor that informs (what determines practice) their teaching of basic 7-9 science and curriculum as can be seen in the quote below.

> P1: *Well, the first thing is the syllabus, scheme which is broken down week to week, month to month and term to term. Do you understand? So, that is the first one.* (Appendix L)

The second participant concurred as follows:

> P3: *Secondly I look at the syllabus.* (Appendix L)

Based on the responses from the teachers, it can be identified that the teachers focused on the syllabus (curriculum) and the contents outlined therein. They maintained that drifting away from the curriculum contents may result in confusion and this will lead to loss of valuable time. In other words, the teachers were inclined to follow the curriculum outline regardless of learners' background. The forgoing expressions therefore justify the assertions made by Jegede (1999) as well as Ogunniyi and Ogawa (2008) that the teaching

of science and technology in African classrooms does not proceed from, or even connect to, the learners' sociocultural environment, rather they are informed by curriculum which is majorly a reflection of the western cultures or knowledge systems. In the same vein, the teachers said curricular issues such as assessment informs their teaching of basic 7-9 science and technology. This perspective is reflected in the quote below.

> P3:   *The main objective of teaching is for them to pass exams and they will know if you are teaching well or not if the children have A's and B's.* (Appendix L)

As can be seen above, Participant 3 pointed out that the main objective of teaching is to help learners "pass exams". In other words, their teaching is informed by the need to help learners pass their examination. Participant 3 reaffirmed his assertion above as can be seen in the excerpt below.

> P3:   *Also, the examining bodies like WAEC do not recognise this IK in the exams* (Appendix L)

It can be deduced that their teaching of basic science and technology is informed by assessment. In other words, the teachers give more credence to the learners' assessment requirements.

6.3.2 Lack of teaching resources

The participants identified teaching resources such as reference points in terms of textbooks and lab equipment as some of the factors that inform their teaching of basic 7-9 science and technology. In other words, they teach according to what is on the ground (available) in terms of teaching resources and where there are no resources to teach some topics, they are overlooked. These views are shown the excerpts below.

> P1:   *The second one is the reference points, which are the textbooks, the recommended textbooks.* (Appendix L)

> P1:   *Then materials on ground. Like some topics we are supposed to do practical there is no material. Lab equipment and all of them.* (Appendix L)

As can be seen in the above quote, the "reference points such as textbook" and "materials on ground" informs their teaching of basic science and technology. In concurring with the

above expression, Participant 3 said "apparatus" also informs his teaching of basic science and technology as can be seen in the quote below.

> P3:   *Lastly, apparatus, equipment. Is really annoying because with all the time constraints you are now subjected to another hardship of making improvisation of these things.* (Appendix L)

It can be deduced from the forgoing expressions that teaching resources such as reference points (textbooks) and lab equipment are the key factors that inform the teaching of basic science and technology.

6.3.3 Learners' ability

The teachers said the ability of the learners are one of the main factors that inform their teaching of basic 7-9 science and technology as can be seen in the expression below.

> P3:   *I think the first thing is the learner's ability. I consider this topic am going to teach now, how best should I send it to them? How will they assimilate it.* (Appendix L)

Agreeing to the above expression, Participant 1 responded as following:

> P1:   *Another thing is the children themselves how much they are able to cope will also help to decide how far or how well you can go.* (Appendix L)

As explained in the above quotes, learners' ability informs the teachers' pedagogical practices. Borrowing from the words of Participant 3, "learner's ability" is the first thing that informs his teaching of basic science and technology. This view was seconded by Participant 1 saying "how much they are able to cope" will determine what to teach and how to teach. It is apparent that the teachers consider the learners' abilities as one of the factors that inform their teaching of basic science and technology. Interestingly however, the learners' IK which perhaps may enhance their understanding of western science and technology are not considered.

6.3.4 Workload

The teachers pointed out that the workload in terms of target for the month and term also informs their teaching of basic 7-9 science and technology as can be seen in the excerpt below.

P3:   *Then the target I have for the week and for the month and for the term* (Appendix L)

Espousing his previous expression, Participant 3 explained that the amount of work to be done will determine his pace as can be seen in the quote below.

P3:   *If your target for the month or for the term is so much and by the time you are running* behind *schedule you speed up.* (Appendix L)

Evidently, workload in terms of target for the term is one of the factors that inform the participant teaching of science and technology in the basic 7-9 streams.

6.4 Discussion of findings regarding Research Question 2

As can be seen from the forgoing analysis, different factors inform the pedagogical activities of these teachers given the fact that they do not enact their IK conceptions in their teaching of basic 7-9 science and technology (see Table 4). While one participant's teaching is informed or determined by assessment and work load the other participant's teaching is informed by reference points. In addition, these participants' pedagogical activities are also informed by factors such as learners' ability, availably of resources, and syllabus. Therefore, these key factors determine how far and how well their teaching of basic science and technology will go in their respective classes.

It is therefore significant to note that the even though these teachers holds different conceptions and advanced understanding of IK, yet their teaching of science and technology in the basic 7-9 stream is not informed by these conceptions. Rather, their teaching activities are inspired or determined by other factors such as highlighted above.

Table 4: Summary of findings of Research Question 2

Are the identified conceptions enacted in the classroom?	Which conceptions are enacted in practice?	If so, how are they being enacted and	If so, what informs their enactment?	If not, what informs their practice?"	
3 out of 5 participants enact the identified conceptions	2 out of 5 identified conceptions are enacted in practice			2 out of 5 participants didn't enact the identified conceptions	
	• IK as relational knowledge	▪ Practical work ▪ Hands on experience ▪ Guided discovery	• To link local knowledge to western and school knowledge • To facilitate understanding	Curricular issues	▪ Syllabus ▪ Assessment
				Lack of teaching resources	▪ Lab equipment ▪ Textbooks
	• IK as technological knowledge that is scientifically based	▪ Improvisation ▪ The use Indigenous technology as reference points ▪ Oral explanations	• To understand how some local knowledge should be applied or developed • Avenues for enculturation	Learners' ability	
				Workload	

6.5 Conclusion

This chapter presented the analysis for Research Question 2: *"Are these conceptions enacted in the classroom? If so, how are they being enacted and what informs their enactment? If not, what informs their practice?*. The chapter was divided into three key sections. The first section responded to the first part of Research Question 2 with the aim of finding out "how" (process of enacting IK conceptions) the teachers enact their IK conceptions in the classroom and what (reasons for its enactment) informs their enactment. In that regard, two main categories (findings) and six sub-categories were identified as listed below:

- Relating school knowledge to lived experience – three sub-categories were established:

- o Practical work;
- o Hands on experience;
- o Guided discovery.
- Contextual problem solving – four sub-categories were established:
  - o Improvisation;
  - o Indigenous technology;
  - o The use indigenous technology as reference points.

With regards to the factors that inform the enactment of the participants' IK conceptions in their teaching, that is, *"if so what informs their enactment?"* four factors or reasons were revealed as informing the enactment of these conceptions:

- To link local knowledge to western and school knowledge.
- To facilitate understanding.
- To understand how some local knowledge should be applied or developed.
- Avenues for enculturation.

The second section focused on Research Question 2 (b). This section aimed to understand "what" informs the two participant's current teaching practices in the basic 7-9 science and technology stream given that their IK conceptions are not enacted in their teaching. It was noted that four major issues and four sub-issues which I term "what" (issues that determine pedagogical practices) informs their teaching of science and technology in school. These issues are outlined as following:

- Curricular issues – 2 subcategories were established:
  - o Syllabus;
  - o Assessment.
- Lack of teaching resources – 2 subcategories were established:
  - o Lab equipment;
  - o Textbooks;
- Learners' ability.
- Workload.

The next chapter will focus on the discussion of the key findings reported in Chapter 5 and Chapter 6.

CHAPTER 7: DISCUSSION RECOMMENDATIONS AND CONCLUSION

In Chapters 5 and 6 I presented the analyses of the first and second research questions respectively. In this final chapter, salient points emanating from the analysis of the two research questions that guided this study are summarised and discussed. The implications of this research study are highlighted with respect to policy and practice. In conclusion, suggestions and recommendations for further research are proffered.

In my problem statement (see Chapter 1) I alluded to the following key concerns raised by various scholars within the science and technology education community. These concerns relate to, amongst others, abstract delivery of science and technology curriculum, poor pedagogical practices, lack of relevance of school science and technology to learners' lived experiences and home culture (IK and practice). It is against this background that scholars such as Jegede (1995) as well as Semali and Kincheloe (1999) argue and advocate for a contextually relevant curriculum (i.e. a curriculum that accounts for learners' daily experiences or interaction with local or IK) and appropriate pedagogical practices that initiate and sustain the interest of indigenous learners in science and technology across Africa. However, designing and adopting a curriculum and pedagogy that will best serve the interest of indigenous learners across Africa has proved to be a challenge. All the literature surveyed points to the significant role played by teachers in bringing such a curriculum into practice. It is in this regard that this study explored basic 7-9 Science and Technology teachers' conceptions of IK in Imo State, Nigeria with the aim of ascertaining the extent to which these conceptions are enacted in their classroom practice. The reason for this particular focus is due to the fact that in Nigeria the discourse on re-inventing the science and technology curriculum in schools in order to make it contextually relevant and embrace IKS is conspicuously absent.

As mentioned in the first two chapters of this study, in 2005 the new Basic Education Curriculum known as Basic-9 Education was introduced by the Nigerian National Council of Education and *science and technology curriculum content* occupied a prominet position in this curriculum (Danmole, 2011). However, Nigeria's vast store of local science and technology was not integrated into this new curriculum. This neglect was frowned upon by scholars such as Abdulrashid (2013), Okonkwo and Oguamanam (2013) and Ezeudu,

Nkokelonye and Ezeudu (2013) who in their studies identified many Nigerian indigenous practices/knowledge that have contributed and continue to contribute towards Nigeria's national deveopment and global competitiveness. The findings of this research do indeed corroborate the work of these scholars by illucidating five identifiable IK and technological practices which could be incorporated into the new curriculum. These indigenous practices vary from the processing of cassava (in making *ggari* and *fufu*) to saponification. These practices were outlined in Chapter 5, section 5.2. Furthermore, the analysis of participants' responses confirmed that such practices are indeed enacted in their current teaching of basic 7-9 science and technology.

The following section presents the summary of findings for Research Questions 1 and 2. First, I present the summary of findings for Research Question 1 followed by a summary of findings for Research Question 2.

7.1 Summary of findings from Research Questions 1 and 2

7.1.1 Summary of Findings from Research Question 1: *"What are basic 7-9 science and technology teachers' conceptions of IK as drawn from their narratives about IK"*

The findings to the above question were drawn from the narratives and focus group interviews held with seven Basic 7-9 Science and Technology teachers in Imo State, Nigeria. As was explained in the methodology and analysis chapters, the interviews aimed to gain deeper insight into the teachers' conceptions of IK and to establish whether the identified conceptions are enacted in their practices and if so, what factors informs their enactment. Where they do not enact those conceptions, the research aimed to identify what informs their current pedagogical practices in their teaching of Basic 7-9 Science and Technology streams.

Thus, with respect to Research Question 1, the analysis showed, first, that five conceptions of IK were held by these teachers. Second, that there were some variations as well as commonalities in the conceptions held by the participants about IK. While some of the teachers conceived IK as ***Informal Knowledge, Relational Knowledge*** and ***Traditional Knowledge.*** Others conceived it as ***Technological Knowledge that is scientifically based*** and ***Lost knowledge***. Evidently, the teachers' conceptions differed from one another based on their individual experiences and level of engagement with IK. These variations in conceptions therefore justify the arguments stemming from the literature that there is no

universally held definition of IK and IK systems, rather definitions of IK are context and individually dependent (Semali & Kincheloe, 1999; Onwu & Mosimege, 2004; Nel, 2005; Jackson, 2013) as evident in the five qualifying components that seem to ground the teachers participating teachers' conceptions. In other words, these five key qualifying components which were summarised as the "what" (properties), the "how" (process), the "where" (place or source), the "who" (holders) and the "when" (time or era) were embedded in the conceptions held by the basic 7-9 science and technology teachers' who participated in this research. It is noteworthy to say that the above conceptions and qualifying components are in line with what Zazu (2008) conceptualised as "content" (facts), processes (methods) and "practices" (application) in his own work on *exploring opportunities and challenges for achieving the integration of IK into environmental education processes*. These components aspects talks to "what" (properties), "how" (process) and "where" (place or source). In addition, these qualifying components correspond to what was described as "metaphysical" and "methodological" in the conceptions held by Namibia teachers about IK (Dziva, Mpofu & Kusure, 2011 cited in Sheya, 2014). These 2 components speak to "what' (properties) and "how" (process). Hence the forgoing findings are consistent with other empirical research findings about conceptions and definitions of IK or IK system.

7.1.1 Summary of findings of Research Question 2 "Are these conceptions enacted in the classroom?" and their implications

With respect to the enactment of teachers' IK conceptions in the classroom and the method of enacting them, the analysis showed that two conceptions were enacted by the teachers. These two conceptions relate to:

- IK as relational knowledge; and
- IK as technological knowledge that is scientifically based.

Through further probing, analysis showed that various methods were employed by the teachers when enacting these two conceptions. For instance, when enacting the conception of IK as relational knowledge, the analysis showed that the participants employed the approach of relating school knowledge to lived experiences. The analysis further indicated that the participants made use of some activities that the learners are familiar with by way *of* "bringing the topic home" when explaining concepts in the classroom. This approach comprises the following components:

- Practical work;

- Hands on experience; and

- Guided discovery.

Employing these approaches meant that the learners were exposed to first hand or real life experiences of IK in school. By implication, the analysis showed that the participants' pedagogical activities (the enactment of IK as relational knowledge) are heavily contextualised.

Analysis of the second conception: technological knowledge that is scientifically based, showed that the participants employed the method of contextual problem solving by way of

- Improvisations;

- Using of IK as reference points; and

- Oral explanation.

Analysis of these methods of enactment revealed that the teachers expose their learners to indigenous approaches to technology first before introducing them to modern or formal school approaches to technology. Furthermore, the analysis showed that enacting the above conception in the classroom nurtures learners' problem solving abilities. It is significant to note that the aforementioned approaches are aligned with Snively (1995 as cited in Aikenhead & Jegede, 1999) who advocated for the employment of teaching approaches that emphasise problem solving approaches which cut across science and technology, socio-cultural context and sustainable development.

Drawing from the discussions so far on the enactment of the two conceptions, it can be deduced that the teachers do not follow a sequential or particular approach when enacting/integrating their IK conceptions in the classroom; rather they adopt their own approaches when enacting these conceptions. In other words, there is no outlined or predetermined way of enacting or integrating IK in the classroom. Also, it can be concluded that the method of enactment employed by the teachers is largely a reflection of their conceptions and experiences about IK.

7.1.2 Summary of findings of Research Question 2 (a) "What informs their enactment?" and their implications

On what informs the enactment of these conceptions, the analysis revealed that different factors informed their enactment. These included the following:

- Linking local knowledge to western and school knowledge;
- Facilitating understanding;
- Understanding how some local knowledge should be applied and developed; and
- Providing avenues for enculturation.

Analysis of these factors showed that learners benefit more when the teaching of science and technology is contextualised. That is to say, learners' understanding of school science and technology is facilitated when IK and practices are used to explain science and technology concepts in class and if the link between IK and technology is made explicit and is fully explained to the learners. For the learners with little or no experiences of IK, enacting the IK conceptions in the classroom gives them the opportunity to know about those practices and how they can be developed and applied. In a nut shell, learners stand to benefit when teachers' conceptions of IK are enacted in the classroom.

The above analyses of teachers' conceptions of IK, the methods adopted by the teachers when enacting their IK conceptions, and the reasons for their enactment correspond with Beck's (1992) idea of inter-epistemological dialogue. According to Beck (1992) inter-epistemological dialogue is a type of reflexive learning that synchronises different forms of knowledge in the learning process for the benefit of the learners. Thus, the methods employed by these teachers when enacting their IK conceptions and the reasons behind such methods can be considered tenable. Additionally, in their enactment of their IK practices, the participants play a significant role as teachers, that is, that of cultural brokers. In other words, they guide the students successfully in negotiating and traversing between their home and school culture (Stears, 1995 cited in Aikenhead & Jegede, 1999). In this regard, Stears (1995 cited in Aikenhead & Jegede, 1999) argues that teachers are the only agents appropriately positioned to help students navigate successfully between their home culture and school science and technology, particularly in a multicultural school setting.

7.1.3 Summary of findings of Research Question 2 (b) "If not, what informs their practice?" and their implications

For the participants that do not enact their IK conceptions in the teaching of basic 7-9 science and technology, the analysis showed that four key issues inform their pedagogical activities:

- Curricular issues;
- Lack of teaching resources;
- Learner ability; and
- Workload.

Analysis of curricular issues revealed that participants focused on the syllabus and followed it sequentially in their teaching. The idea behind this was to achieve set targets in terms of assessment. Looking at this analysis, one can only agree with the assertion of scholars such as Ogunniyi and Ogawa (2008) that the study of Science and Technology in Africa is not informed by learners' lived experience and does not connect to learners' socio-cultural background. In terms of the second issue; the analysis showed that the availability of teaching resources such as textbooks and laboratory equipment determine both the aspects of "what" the teachers will teach and "when" they will teach it. This perhaps implies that teaching and learning activities will not take place if these resources are not available even though there may be opportunities for improvisation. This finding can be considered anomalous given that two of the schools covered in this research are under-resourced schools (even though they are located in the administrative headquarters) and as such could put their vast IK (facilities and practices) repertoire to use in their teaching practices. This implies that learners will continue to be denied ample meaningful learning opportunity as a result of a lack of resources (modern/western) even though such a gap could be filled by available local content, resources and practices.

The analysis of the third issue "learner's ability" revealed that the participating teachers considered the learners' ability (how well they can cope) when carrying out their teaching in the classroom. Although this issue can be considered vital in teaching, learners' IK, which can also facilitate understanding, should be equally considered. Lastly, analysis showed that the participants' pedagogical practices are informed by their workload in terms of targets for the term and year.

Drawing from the forgoing discussions, it is evident that the pedagogical activities of this category of teachers are informed by different issues. One key revelation of the analysis is that even though these teachers hold certain conceptions and understanding of IK, their teaching practices are not informed by such conceptions. Going by the forgoing revelation, one cannot but agree with Ogunniyi (2000) assertion that teachers are more inclined to their scientific worldviews against their indigenous worldviews. Thus, it is obvious that these teachers (supposedly cultural brokers) failed to encourage epistemological dialogue in their classroom even though they are appropriately positioned to do so. This situation means that science and technology will have little or no meaning to learners' because it will always remain at a remove and hence a mystery in terms of their lived experiences.

7.2 Recommendations

It is obvious that teachers hold certain conceptions of IK and these conceptions differ from one teacher to another. Two of these conceptions are enacted by some of the teachers in their teaching practices using diverse methods while some are not enacted. Despite the fact that some of the teachers hold certain conceptions about IK, they failed to enact such conceptions in their pedagogical activities. The following recommendations are based on salient points or findings and the discussion around them. These recommendations are directed at educational policy makers and research studies on IK development.

7.2.1 Recommendations for policy makers

Policy makers need to expedite actions on total inclusion of Nigeria's vast IK into the basic 7-9 school science and technology curriculum. In that light, adequate training on how to enact or integrate IK should be provided for teachers and appropriate teaching facilities such as books with clear instructional strategies and local artifacts should be provided to facilitate implementation. Equally, IK practices of different tribes (places of origin, source and value) in Nigeria should be documented electronically (digital library) seeing that this type of documentation is still not in existence. In addition local IK custodians (*dibia odinala*) should be involved in the identification and codification of IK contents and practices.

7.2.2 Recommendation for further studies and IK development

More studies, exploring teachers' conceptions of IK in Nigeria, should be commissioned and supported at a wider scale in order to understand whether or not the teachers enact

them in their teaching and what informs their decisions. Also, further studies which look at how teachers encourage multiplicity of knowledge (inter-epistemological dialogue) by enacting their IK experiences in a postcolonial African society should be encouraged. It will be equally important in the near future to conduct studies which look at the impact of enacting or integrating IK on students' performance in science and technology.

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APPENDIX A

LETTER TO FEDRAL GIRLS GOVERNMENT COLLEGE PRINCIPAL

University of KwaZulu-Natal

Edgewood Campus

Private Bag X03

Ashwood

3605

22 April, 2014

Dear Sir/Madam,

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

My name is Nwokocha Godson Chinenye a student studying for a master's degree in Technology Education at the University of KwaZulu-Natal, South Africa.

My research study is titled: An Exploration of Basic 7-9 Technology Teachers' conceptions of Indigenous Knowledge as drawn from their lived experiences and classroom practices in Imo State, Nigeria. This study seeks to explore how basic 7-9 technology teachers in Imo state conceive indigenous knowledge and to know whether these conceptions are enacted in their pedagogical practices or not.

I hereby seek your permission to conduct my research at your school in 2014. Data will be collected from the teaching staff of basic 7-9 science and technology using narratives and focus group discussions. The teaching staffs who decide to participate in this study will be required to complete a consent form. Their participation in this study is voluntary. Sir, you are kindly requested to fill in the attached declaration and consent form which acknowledges the permission granted to undertake my research in your school.

I guarantee that the information gathered will be used for the purpose of the research only. For further information regarding this research you may contact either myself or my supervisors Dr Singh-Pillay 031-260 3672 (084 430 3795), Dr Busi Alant 031- 2607606 (0739479893), Nwokocha Godson Chinenye (0719192216, 0847539451).

Your cooperation will be appreciated

Nwokocha Godson Chinenye

I…………………………………………………….. Principal at Federal Government Girls College Owerri Imo State, Nigeria hereby grant permission for the research to be conducted at my school

Signature of Principal   Official Stamp

Date

APPENDIX B

**LETTER TO FEDRAL GOVERNMENT
GIRLS COLLEGE OWERRI TEACHERS**

University of KwaZulu-Natal

Edgewood Campus

Private Bag X03

Ashwood

3605

Dear Participant

INFORMED CONSENT LETTER

My name is, Godson Chinenye Nwokocha I am a Masters student studying at the University of KwaZulu-Natal, Edgewood campus, South Africa.

I am interested in learning about basic 7-9 science and technology teachers' conceptions of Indigenous Knowledge as drawn from their lived experiences and classroom practices in Imo State, Nigeria. To gather the information, I am interested in asking you some questions via an observation and an interview. Please note that:

• Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.

• The semi-structured interview may last 20 minutes and focus group interview may last for about 30 minutes and may be split depending on your preference.

• Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.

• Data will be stored in secure storage and destroyed after 5 years.

• You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.

• The research aims at exploring basic 7-9 science and technology teachers conceptions of indigenous knowledge as drawn from their lived experiences and classroom pedagogy.

• Your involvement is purely for academic purposes only, and there are no financial benefits involved.

• If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

	willing	Not willing
Audio equipment		
Photographic equipment	105	
Video equipment		

I can be contacted at:
Email: godsonnowkocha@gmail.com
Cell: 0847539451, 0719192216
.
My supervisor is Dr. A. Singh- Pillay who is located at the School of Education, Science and Technology cluster, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: pillaya5@ukzn.ac.za   Phone number: 031-26053672

My Co-supervisor is Dr. B. P. Alant,
School of Education
Edgewood campus, University of KwaZulu-Natal
(Nkomo) 0312607606 Email:alantb@ukzn.ac.za

You may also contact the Research Office through:

P. Mohun
HSSREC Research Office,
Tel: 031 260 4557 E-mail: mohunp@ukzn.ac.za

Thank you for your contribution to this research.

DECLARATION

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.

APPENDIX C

**LETTER TO HOLY GHOST COLLEGE
OWERRI PRICIPAL**

University of KwaZulu-Natal

Edgewood Campus

Private Bag X03

Ashwood

3605

22 April, 2014

Dear Sir/Madam,

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT YOUR SCHOOL

My name is Nwokocha Godson Chinenye a student studying for a master's degree in Technology Education at the University of KwaZulu-Natal, South Africa.

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I guarantee that the information gathered will be used for the purpose of the research only. For further information regarding this research you may contact either myself or

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Your cooperation will be appreciated

Nwokocha Godson Chinenye

I…………………………………………………….. Principal at Holy Ghost College Owerri Imo State, Nigeria hereby grant permission for the research to be conducted at my school

Signature of Principal   Official Stamp

Date

APPENDIX D

**LETTER TO HOLY GHOST COLLEGE
 OWERRI TEACHERS**

University of KwaZulu-Natal

Edgewood Campus

Private Bag X03

Ashwood

3605

22 April, 2014

Dear Participant

INFORMED CONSENT LETTER

My name is, Godson Chinenye Nwokocha I am a Masters student studying at the University of KwaZulu-Natal, Edgewood campus, South Africa.

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- Your confidentiality is guaranteed as your inputs will not be attributed to you in person, but reported only as a population member opinion.
- The semi-structured interview may last 20 minutes and focus group interview may last for about 30 minutes and may be split depending on your preference.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalized for taking such an action.
- The research aims at exploring basic 7- 9 Science and Technology teachers conceptions of indigenous knowledge as drawn from their lived experiences and classroom pedagogy.
- Your involvement is purely for academic purposes only, and there are no

financial benefits involved.

- If you are willing to be interviewed, please indicate (by ticking as applicable) whether or not you are willing to allow the interview to be recorded by the following equipment:

	willing	Not willing
Audio equipment		
Photographic equipment		
Video equipment		

I can be contacted at:
Email: godsonnowkocha@gmail.com
Cell: 0847539451, 0719192216

My supervisor is Dr. A. Singh- Pillay who is located at the School of Education, Science and Technology cluster, Edgewood campus of the University of KwaZulu-Natal.
Contact details: email: pillaya5@ukzn.ac.za   Phone number: 031-26053672

My Co-supervisor is Dr. B. P. Alant,
School of Education
Edgewood campus, University of KwaZulu-Natal
(Nkomo) 0312607606 Email:alantb@ukzn.ac.za

You may also contact the Research Office through:

P. Mohun
HSSREC Research Office,
Tel: 031 260 4557 E-mail: mohunp@ukzn.ac.za

Thank   you   for   your
contribution to this research.

 DECLARATION

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.

APPENDIX E
NARRATIVES INTERVIEW QUESTION

Please Sir/Madam can you share some of the indigenous knowledge practices you engage in or
  you experience in your daily life?

APPENDIX F

QUESTIONS GUIDING THE FOCUS GROUP DISCUSSIONS WITH ALL THE PARTCIPANTS

1. Please explain in your own words what your understanding of Indigenous Knowledge is?

2. Do you practice or use your IK in your daily life? Please explain

3. Does your understanding and use of IK influence your teaching of basic 7-9 science and technology? Please elaborate on your response

4. Do you enact your daily IK conceptions and practices in the teaching of basic 7-9 science and technology? Please elaborate

5. What are your views of the current basic 7-9 science and technology curriculum in Nigeria? Please elaborate you response

6. Do you see a link between IK and the basic 7-9 science and technology curriculum?

7. Do you believe/think that the is a place for IK in the basic 7-9 science and technology curriculum? Please explain your response.

8. Do you allow learners in your basic 7-9 technology class to use their IK to explain/understand concepts? Please explain

APPENDIX G

QUESTIONS GUIDING THE FOCUS GROUP DISCUSSIONS WITH THE

PARTICIPANTS WHO ENACTS THEIR IK CONCEPTIONS IN THEIR TEEACHING

PRACTICES

1.   What are the importance of enacting indigenous knowledge conceptions in your teaching of basic 7-9 science and technology?

2.   How do you enact you indigenous knowledge conceptions when teaching basic 7-9 science and technology?

3.   What resources do you use, when enacting these conceptions in your teaching of basic science and technology?

4.   What type of activities do learners engage in?

5.   What teaching methods are used to organize learning when enacting these experiences?

6.   How do learners respond to these method?

7.   What are the difficulties or limitations you encounter when enacting your indigenous knowledge experiences in the classroom?

APPENDIX H

QUESTIONS GUIDING THE FOCUS GROUP DISCUSSIONS WITH THE TEACHERS WHO DO NOT ENACT THEIR IK CONCEPTIONS IN THEIR TEACHING PRACTICES

1.   Why do you not enact your indigenous knowledge conceptions in your teaching of basic 7-9 science and technology?

2.   What informs your teaching of basic 7-9 science and technology?

APPENDIX I

TABLE SHOWING TEACHERS CONCEPTIONS OF INDIGENOUS KNOWLEDGE

	Excerpts	IK Conceptions/Categories
IK Conceptions		
P1 P2 P3	I think indigenous knowledge means the things you learn casually, at home, outside the classroom, you just learn them casually without attaching any importance to them, maybe you see people doing it or you see your mother or father doing it you learn it and maybe at the end of the day, no examination on it. So these are the things we can regard as indigenous knowledge (P1) Is the casual knowledge, is not even so casual (P2). These are informal knowledge acquired informally outside the four walls of the classroom, there is no exam to it but it helps us in our day to day activities, they are indigenous knowledge (P3)	Informal knowledge
P3 P4	Is the knowledge we acquired from our parents at home and we go on with it until we come to school, and when we come to school those knowledge we may not drop, we go up with it and mix it with the ones we learn from the school I think is relating local way of doing things into a modern way of learning. That is, in the sense that our local way of life at home, maybe the way we ferment things, assume you want to teach	Relational knowledge

P5	fermentation you are trying to relate it in the way we do things in our house, how our mothers ferment their own food, try to relate it to the modern way of teaching in the class. I think that's what we call indigenous knowledge (P4) These are local processes, and they are close to eh, when you examine it, it will just be like modern methods used in the breweries (P5)	
P5	I define it as the traditional knowledge that is passed from generation to generation (P3.	Traditional knowledge
P1 P3 P5	That one is science, because you have increased the reaction, you know the surface area, so it reacts, it ferments and the smell will not be there (P1) You know there is a lot of relationship between science and IK, but you cannot know except through this kind of research (P1) From my understanding, it is about the things we witnessed and our local ways those days of making eh small things we can use to help ourselves (P3) To some people it looks like magic but to me, I believe that there is certain evidence of science there. Although they are not able to test the particular ingredient curing those sickness, but there is always a leaf that cures those sickness (P3) In making basket or carving, now those involved in these trades or crafts, at the end of the exercise, there products are tested to see whether it is properly done (P5)	Technological knowledge that is scientifically based

	For instance in food processing, let's say processing of gins. I know in your place there is a place we call Amumara, when I was young, the place was known for producing local gin (Nwaetete). Now, local technology is involved, is almost the same process with the production of whisky and the rest of them (P5)	
P1	Because our ancient people did not go to school, so they can't write down anything. But actually, this things most of science were practiced, but without any documentation, do you understand it now?	Lost knowledge
P7	So what am saying is that it looks like we have forgotten about all those indigenous things & went into the ones we may see as modern technology (P7)	

APPENDIX J

TABLE SHOWING HOW TEACHERS IK CONCEPTIONS ARE ENACTED AND WHAT INFORMS ENACTMENT

Participants	Conceptions	Methods of enactment	Reasons
	▪ IK as informally learnt knowledge		▪ To link local knowledge to western or school knowledge (P4 & P5)
P2 P4 P5	▪ IK as Relational knowledge	Relating school knowledge to lived experiences o Practical work o Hands on experiences o Guided discovery	▪ To facilitate understanding (P2 & P4) ▪ To understand how some local knowledge should be applied or developed (P5) ▪ To bring their mind closer (P4)
P2 P4 P5	▪ IK as Traditional knowledge	Contextual problem solving o Improvisation o to use indigenous technology as reference points o Oral explanations	▪ Avenues for enculturation (P4)
	▪ IK as Technological knowledge that is scientifically based		
	▪ IK as Lost knowledge		

APPENDIX K

TABLE SHOWING   HOW IK CONCEPTIONS ARE ENACTED AND REASONS FOR ENACTMENT

Participants	Excerpts	IK conceptions	How (method)	Reasons
P2	At times some of them don't understand some of the terms, but if you go down bring it home and relate it with the activities they do at home, they will understand very well. Although there are time constraints, but whenever you teach and bring the topic home, they will understand it very.	**IKS as relational knowledge**	We do practical depending on the topic. Like when we did household cleaning agents, I told them to bring eggshell and we dried and squeezed it there, and sieved it.	
P4	Yes, because it is day to day activities, you try to relate it to what you are teaching them in school. So when you bring those things more closer, it will draw their attention to that area of concentration. When I taught them		If is farming like I said before, I will take them to the farm and they will use the Implements which I have brought and do the farming. Implements like holes and machetes and all the rest of them. We use machete to cut the grasses, they circle	At times it will even serve as a room for others to know what they have not even seen, because some of them being township (urban) boys and girls they may not have even seen it, they do hear but hey have not seen it. So that will serve as avenue of

	house help and craft we did the practical in the class. So many of them came with things like threads, needle and knots so we practiced in the class. Some use mats and other things at home but they don't know where these things are being classified (indigenous or western knowledge). So when you make things like this, tell them and show it to them and bring their mind more close to those things they use at home it will make them relax and bring them closer to the topic.		to you work on the soil, the shovel to dig the soil.	them seeing that particular thing
P5	After explanations and teachings have taken place. They are exposed to practical skills, whereby they practice what they have been taught.			
		IK as technological knowledge that is scientifically based		

P2				
			When I taught them house help and craft we did the practical in the class. So many of them came with things like threads, needle and knots so we practiced in the class.	Because some of them are not from the same place so they may not know. So the best thing one does is to bring the material closer and to show them what you mean.
			When you talk of indigenous technology and give examples of indigenous technology it will make them understand the lesson very well.	When is introduced they will say so this type of thing have been? oh is what we have been using at home ooh, that they are teaching at school. The will be very much happy.
			A teacher who is going to teach perspiration will make reference to it. The teacher will tell the students how it is done locally and teach them the modern process.	It helps the students to understand the lesson very well. Eh the students feel when you talk of technology and give examples with indigenous technology they will understand better. At times some of them don't understand some of the terms, but if you go down and bring it home they will understand very well. Although
			In some topics like separation of substances. At time you use indigenous knowledge like hand picking, mixture of	

			rice and beans to explain in class. You can also use mixture of oil and water to explain separation of substances	there is time constraints, but whenever you teach and bring the topic home, will they understand it very well.
				When you talk of indigenous technology and give examples of indigenous technology it will make them understand the lesson very well.
P4			In everything they have a principled life; there is one that is more common, so you use it. So that's how I use mine. There are topics that I will teach that relates to indigenous knowledge, I will make reference to that. For instance if am teaching about drug abuse, I will make reference to that because it does not have dosage	When you bring those things closer, it will draw their attention to that area of concentration. They will just know that oh these are things am doing at home. Some maybe doing it ignorantly, but when you use it as a reference it will draw them closer to that particular topic. They will even understand it very well, because they will now understand that this is what I do at home without

				knowing that oh, I can even relate it. So it will even serve as a room for others to know what they have not even seen, because some of them being township boys and girls may not even have seen it, but they do hear about it. So that will serve as avenue of them seeing that particular thing
P5	First of all I will tell them, this is how a local house is made, but this is how developed building like bungalow's, detached buildings, skyscrapers and these ones seen in developed countries that are made of bricks are made. While our local ones are made with local materials. I will first introduce the indigenous method of making a house with local materials and afterwards I will teach the modern		By using improvisation. Let's say, we bring in some local tools and materials which will enable them to understand how some local knowledge should be applied or developed. After explanations and teachings have taken place. They are exposed to practical skills, whereby they practice what they have been taught. By using improvisation. Let's	They are very important. In the first place, they help to solve problems locally and in school. When it is introduced, they will also know that eh it is indigenous technology. It is also the same thing with eh what is produced or what takes place in the western world.

	method of building house		say, we bring in some local tools and materials which will enable them to understand how some local knowledge should be applied or developed.	
	If is farming like I said before, I will take them to the farm and they will use the Implements which I have brought and do the farming. Implements like holes and machetes and all the rest of them. We use machete to cut the grasses, they circle to you work on the soil, the shovel to dig the soil.		When am teaching basic technology, when it comes to construction of houses with local materials. I will bring some local materials like holes, shovels. I also bring red earth or mud (as we call it), bamboo sticks and local mast.	

APPENDIX L

TABLE SHOWING TEACHERS THAT DO NOT ENACT THEIR IK CONCEPTIONS IN THE PRACTICE AND WHAT INFORMS THEIR CURRENT TEACHING PRACTICES

Participants	What informs practice
	Curricular issues
P1	Well, the first thing is the syllabus, scheme which is broken down week to week, month to month and term to term. Do you understand? So, that is the first one.
P3	The main objective of teaching is for them to pass exams and they will know if you are teaching well or not if the children have A's and B's. Secondly I look at the syllabus. Also, the examining bodies like WAEC do not recognize this indigenous knowledge in the exams
	Lack of teaching resources
P1	The second one is the reference points, which are the textbooks, the recommended textbooks. Then materials on ground. Like some topics we are supposed to do practical there is no material. Lab equipment and all of them.
P3	Lastly, apparatus, equipment. Is really annoying because with all the time constraints you are now subjected to another hardship of making improvisation of these things
	Leaners Ability
P3	I think the first thing is the learner's ability. I consider this topic am going to teach now, how best should I send it to them? How will they assimilate
	Another thing is the children themselves how much they are able to cope will also help to decide how far or how well you can go

	Work load
P1	
P3	If your target for the month or for the term is so much and by the time you are running behind schedule you speed up. Then the target I have for the week and for the month and for the term.

APPENDIX M

TABLE SHOWING INDIGENOUS KNOWLEDGE PRACTICES DRAWN FROM THE NARRATIVES

Participant (Narratives)	1(P1)	2(P1)	Teachers scientific understanding	Teachers scientific understanding	Teachers Link between IK & Science
IK PRACTICES	If I want to prepare fufu (fermented cassava), instead of leaving it to stay for four days and be smelly, what I will do is to grind it as if I want to use it for garri (processed cassava). After grinding it, I will not squeeze out the water the way we do for garri, rather I will cover it and sprinkle more water and allow it to stay for two days instead of the normal four days. You know there is a lot of relationship between science and IK, but you cannot know except through	Again all these egwusi (melon) that we do, I don't know if you do it in your area, that is mgbam (processed melon)? Here after preparing it, they will wrap it in the leaves and then cook it, and then you can eat it. But in my husband's place (Ngwa), they don't cook it, they will roast it. After making the paste with salt, pepper and everything you want to put. They will put it in the ngiga (local basket), and hang it over the fire place and it will roast. It	You know because you have increased the surface area for the reaction, so within those two days it will be like you have fermented it up to the normal four days and the smell will not be there . …so when you wash, it will be fresh as if you fermented it for just one day and you will not prepare it the usual way, you will not cook it the usual way eji eshi akpu (the usual way cassava is prepared), you won't cook it like that, because if you do it will not work. Rather, you will stir it the way semovita is made and when you prepare it you will get a nice fufu (fermented cassava) Hahaha, so that one is science, because you have increased the reaction this thing, the	P1-grind- to incease surface area of cassava- to speed fermentation rate Does not squeeze all water out- as water is needed for hydrolysis(breaking down) of glycoside /water also lower the cynide level by 70-95 %(the roots are high in cynide)- freshness/lack of smell associated with low cyanide level P1-stir it- to	

	this kind of research	will come out very sweet and preserved to, so you won't spend extra money trying to cook it. That smoke coming from the fire place will roast it and give it a nice smell. During Christmas time, we use to serve kola when people visit and it will look as if you baked it but you didn't bake it	you know surface area, so it reacts, it ferments fast and the smell will not be there.	oxygenate it- so its fluffy and light P2-melon wrapped in leaves- leaves have enzymes to soften the mellon and speed the cooking time(enzyme is like a tenderizer) Roasting- Surface temperature of Mellon inceases – carmelization occurs therefore food tastes sweeter and aromas produced due to carmalization process	
	1(P2)	**2(P2)**			
IK PRACTICES	Normally when we do farming those days, after cutting the grasses we burn	But if you want to produce large out those days in a local way, some of them	1.Burning destroys microorganisms which are there to enrich the soil	1.Earthworm – aerate the soil and enrich the soil with humus	

	everything in the farm. But nowadays, I have learnt from studying that that method is primitive method. That burning of bushes kills microorganisms and nutrients in the farm. Some organisms like earth worm, which can enrich the farm by its warm cast are burnt. Nutrients like bacteria which break down leaves and make them decay and serve as manure and fertilize the farm to help crops grow very well are burnt down. So instead of burning the bushes and leaf, the leaves should be left on the floor so that it will decay and become manure to help the crops grow very well.	may hiring labouer's and in those days you know they have many children and their children goes to the farm then with the labourer's they will hire. They will go to the farm, clear the farm, they will burn them and start farming. And some of them have yams. Mainly yams for men and cassava for woman. They will hire labourer's so that they will be able to produce food in a large scale not for only family use	Yams cassava	bacteria needed for decompositio n of organic matter- part of nutrient recycling Both are tubers- with varying degrees of carbohydrates and fibre	

	Also the implement we normally use in those days for farming are not helping, but now you can use mechanized way like tractor and most of them for farming and make bountiful and big harvest. But in those days is only sustained faming, that's farming for only family. It doesn't produce things which we can sell				
	1(P3) 2(P3)	2 (P3)			
IK PRACTICES	Talking about this indigenous knowledge, from my understanding, it is about the things we witnessed and our local ways those days of making eh small things we can use to help ourselves. A lot of things like that happened when we were growing up. I can	Another one is when we were growing up, we had so many important herbs and roots that we use for medicine even though people neglect them too much these days. On many occasions when a child or children have convulsion you will see the old	To some people it looks like magic but to me, I believe that there is certain evidence of science there. Although they are not able to test the particular ingredient curing those sickness, but there is always a leaf that cures those sickness	P3:nchuanwu leaves –has essentials oil, that are antimicrobial, anti convulsant and are used for treatment of malaria, tonic, antiseptic, skin infections- leaf also has anti-inflammatory properties	So I believe that there are so many important chemicals in the nchuanwunta leaf that makes it repel mosquito and cure diseases too. Even here some old men believe that nchuanwunta leaf anywhere it is planted, any particular

remember my grandmother use to put a piece of metal (rod) or stone inside fire and make it hot anytime we are pounding palm oil. Then after pounding the palm fruit she will put the hot stone or rod inside the palm fruit. But those days I didn't understand why she does that why she needs to put a piece of eh mmm metal or stone & make it hot, but I know it makes one funny sound chaaa	women or men rush into the bush and get one or two leaves, but as a person who doesn't know the leaves too well, I don't know how they are able to know the particular leaves that can cure so many, so many diseases like convulsion. My grandmother in particular knows different leaves, herbs and mgborogwo (roots) that she administers to sick children. After pounding the leaf and herbs, she will mix it with hot water and squeeze the water out and then rob it all over the sick child. In a very short time the little child will get up and get well. She use to		Pound leaf + mix in hot water to increase surface area- mix in water to make infusion	ground it is planted, that ground is a blessed ground and it is going to make some other important crops grow on that ground. Latter in secondary school I realized that the name of that nchuanwunta leaf is called ocimum gratissium. So it is important, I don't even know if is what they use in making mosquito coils, but you can see it is our local mosquito coils. You know the other people from advanced communities' uses mosquito coils, but we use nchuanwunta leaf as mosquito repellant. It pursues

| | | have a particular place where she use to keep her herbs and mgborogwu (roots

When I started going to school in those days, my teacher use to tell us about a particular leaf we call Nchuchuanwa (saint leaf). Now it is called Nchuanwunta because it chases mosquito away. anwunta in Ibo means mosquito. So Nchuanwunta (saint leaf) means that is something that chases mosquito away, you understand? So those days we were kids my parents use Nchuanwunta as mosquito repellent. They will place it on top of the lamp | | | mosquitos away, you can never see mosquito come close to nchuawunta leaf… |
|---|---|---|---|---|---|

| | | when the lamp is on and it will produce a kind of smell that chases mosquito away. The smell is pleasant to inhale and harmless to humans but chases mosquitos away. But you can see that anytime that the nchuanwunta (saint leaf) is on top of the lamp no mosquito will come inside that room

…So it was latter that I started thinking about what make this nchuanwunta leaf repel mosquito and it is also medicinal. It is also used for many other things like curing convulsion and stomach upset. So this nchuawunta (saint leaf) leaf is | | | |
|---|---|---|---|---|---|

		a powerful leaf we use in our community, in our local community here. Even some of the eh, some of the local old men here belief that *nchuanwunta* leaf anywhere it is planted, any particular ground it is planted, that ground is a blessed, it is going to make some other important crops grow on that ground. So traditional you are not supposed to uproot the nchuanwunta leaf from the land so that it helps other plants grow.			
	1(P4)	2(P4)			
IK PRACTICES	There was a time in my village, we travelled home. So we are kind of		So I was now saying wow, if such a thing can happen that means the fermentation can take	Oxygen will entre and slow the fermentation	

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| | preparing Xmas. So we harvested all our cassava pilled and so soaked it for fermentation. So along the line after two days, ignorantly my younger sister now put her hand inside the eeh cassava soaked for fermentation. So my mum was kind of shouting that ah ah now that you have put your hand inside the eh fermentation cassava, that this thing will not ferment again. While my mother was looking for a solution to that so someone now told her to put nail inside the cassava so that it will ferment. So, and she did as well, so after three four days, the cassava was supposed to ferment for about | | place in the presence of nail, nail as well. | process if lid removed

Fermentation is an anaerobic process- oxygen inhibits the fermentation process

Adding nails: nails reduces the acidity levels in the fermenting solution –the lower pH value increases the rate of fermentation

Kerosene-0 immiscible in water | |

	three days but because of that touching of it and putting of the nail, the thing now at the fourth day. Also someone now told her that kwa if she doesn't want the cassava, that's the Fufu to smell very much that she should add kerosene so that the smell of that Fufu will not be much. So she did and it worked, so that is my experience.				
	1(P5)	2(P5)			
IK PRACTICES	Technology involves, one of the things involved in technology is how people produce and process what they eat. Now, when I was young, faming more especially cultivate yam farming has its		Now if it is exposed, it will dry and if it dries germination takes place. And it cannot germinate if it is still wet. That is the logic. And if you turn it upside down it will decay. And it will not geminate but when you place it to face the sun, it will dry and it will make it to germinate very well and	The "eyes/shoots" are exposed when placed "top side/dorsal " so allows for sunlight to reach "eyes" to promote growth and photosynthesis- auxin at	

	prominence in Mbaise. So the land is cleared, the bush is burnt and then small mouths are made. The land is a bit cleared, the earth is removed and then the mouths are made. Then in those days, yams seedlings are, are either cut into or three and them planting. But for us who are children, instead of exposing the, exposing it to the sun, we just turn it upside down. Then our parents will say, let us, let us see how you have done it, and when they discover that the yams are not properly placed, they will remove them and say you have done it wrongly, that you are supposed to face it up so that I can germinate.		another one that is upside down will decay and it will be eaten by ants.	correct position to promote apical growth When placed "upside down" – eye could be damaged /no sunlight for photosynthesis to occur- growth retarded Auxin collect at incorrect position – high concentration of auxin at the tip will inhibit growth	

	Because if you, if you turn it upside down, it will just be like that, just like when you are planting pumpkin, fruited pumpkin. If it has not germinated and you plant it, it will not germinate. Instead of it to grow up it will just be growing, be stagnant.				
	1(P6)	**2(P6)**			
IK PRACTICES	There is this experience I had when I was growing up, our local way of making cold water during the dry seasons, like harmathan which we normally have from February till raining season starts.. .. Our local way of making cold water involves cutting fresh banana leaves, dried plantain leaf and uda (selim seeds-xylopia				

	aethiopica)… …we would place the fresh green banana leaf on bare ground and place the dry plantain on top of it and set it on fire. When the plantain leaf is gradually burning on top of the fresh banana leaf, we will now add the uda to the burning fire. The uda will burn slowly and you don't have to add kerosene, foul or any other thing to increase the rate at which the uda burns in order not to spoil the taste of the smoke. When the smoke gradually becomes strong you will notice that it will form a tick blue smoke. When the thick blue smoke is formed, it implies that the uda is now burning, and then we will bring				

	in Una. Una is a big local pot we use in cooking traditional food for traditional events. We now place the pot over the burning fire that comprises of the fresh banana leaf holding the dry plantain leaf and the uda. At this time we will cover the una (the pot) on the flame and allow it to stay for about 5 to 8 minutes. After about 5 to 8 minutes the una (pot) must have trapped the whole smoke inside it (the pot). Within this time frame the uda (salim) must have burnt completely, we now turn the pot around and stand it… …when you stand the pot you will notice that the blue frame have turned to white				

	flames. Then we bring ordinary water, not hot water, just water from the tap or stream or anywhere and put it inside the pot. After pouring it, you cover it and move it away from the sun. Then leave it for about 20 minutes and the water will be cold for drinking. I saw my grandmother do that a couple of times when I was growing up.			
	1(P7)	**2(P7)**		
	I grew up to see my dad do a lot of things technologically. Like weaving of bags with bamboo leaves. After weaving, he will fold it and use a needle sew it into a fanciful bag and he was making money out of …He uses sourced from	Also my mother was into soap making using palm fronds from palm tree. After harvesting the palm kernel, she will burn the palm frond into ashes. The ashes will be left to dry for a long time and it will be mixed with oil, and then the soap	Saponification reaction between acid and base to form a salt

Palm frond has potash/.sodium – when burnt potash transformed to oxides f potassium or sodium when oil is added – reaction occurs to produce hydroxides- red colour is due to oil

It cures rashes due to the | | |

	bamboo leaves. He aligns them vertically and horizontally (alternately) and hits it inside and repeats the process many times until he will get a mat. Afterwards he will join the mats together to make different bags. But those days we were not interested in it you see, but till today I still disturb myself as to why I didn't learn those skills at least to have an idea of what was happening …all these things are local technology and when I went on transfer from Imo state to Abia state I saw all these things there, and they make more money with it. Some of them don't do anything	is ready. The soap is used for washing and bathing. Traditionally, it is used to cure rashes… ..So what am saying is that it looks like we have forgotten about all those things & went into ones we may see as modern technology... …I feel we should also come back to those things and begin to encourage them, people should practice them..	high potassium content		

	else apart from that (it is there occupation), making and weaving and they make money out of it..				

APPENDIX N

TABLE SHOWING INDIGENOUS KNOWLEDGE PRACTICES DRAWN FROM FOCUS GROUP DISCUSSION

Participant(FG)	1(P1)	2(P2)	Teachers scientific understanding	Teachers scientific understanding (Ash)	Teachers Link between IK & Science
IK PRACTICES	Apart from listening to your parents, you are guided. You are guided because even when you watch them do those things, if you are doing your own and you not doing it well you will be corrected. Like teaching a child how to sweep the house, if the child sweeps it anyhow the mother or father or an elderly person will call the child back and say lift up the chairs and stools, and all those things and sweep under. I remember the first time I escorted my granny to the farm. I didn't know	Even in the school, because a child that have not leant how to wash her cloth, if she leaves the house and goes to school she will run into problem. So they are very useful. All those knowledge we acquire casually, they are very useful in every day to day activities…		1.Idea of survival of species – distribution ensures all will not be eaten by termites Some have a chance to grow and the vegetative reproduction can continue	

	how to do it very well, I will even pack the yams, four into one hole so that I will finish very fast and she will come and open the molds and say you must do it one after the other so that you don't waste the yam. Is only one that should occupy that space, so if you are not guided you will not even learn much.				
	1(P2)	**2(P2)**			

IK PRACTICES	Yes. We use it in our daily life, like in making olugbu (bitter leaf) soup. We use ingredients like ejula(snail) and isam (periwinkle) to make a very nice indigenous Olugbu (bitter leaf) soup which people will chop(Gallivan) and like it, not these western education sort of soup. They children will eat it and like it and any man you give it to would like to get it another time. If the person is your husband that will make him to be coming home every time because you make a nice soup for hi	Even the brushing of teeth we do with Maclean and the rest of them. One can use stick. You know that's what we were taught. You fashion chewing stick, some of these sticks contains fluorine which is even good for the teeth and the body. So you tell your children to use chewing stick if they don't see they Maclean, if they don't see the herbal tooth paste, they can go on traditionally with the stick. Some traditional stick, like guava stick and all the rest. Like when we were children we know the ones we can cut without even buying it from the market, you chew it and it will clean your teeth		1 P2 Snails /periwinkle are rich in proteins The bitter leave – will be rich in fibre, folic acid, iron – to constitute a balanced meal Guava shoots- when chewed release essential oils , menthol (for freshness), calcium, magnesium, phosphorus, potassium , sodium and florides – all of which are needed for strong , healthy teeth . the essential oils has antibacterial, antiseptic properties that prevent the growth of plaque	
	1(P3)	**2(P3)**			
IK PRACTICES	Yes, especially those of that like oil bean, pounded	Again, these knowledge they help us so much, at			

	fufu (cassava). You harvest your cassava, ferment it and process it and your fufu (cassava) is ready for consumption. You must not go to the market to buy already made. Again these knowledge help us to save money, because if you learn how to ferment palm oil or how to fry garri you will not go to the market to buy garri and oil	least you save some money. Eh because eh eh if you learn how to eh ferment palm oil, you must not go to the market to buy oil. You can make oil that can last for a year. Eh so, if you learn how to fry garri, you will have garri always at home. So they are very useful.			
	1(P4)	**2(P4)**			
IK PRACTICES	Yeah. Is a day to day activity even, it even agrees with the biblical injunction of training your child the way he should follow and when he grows he will not depart from it. So we use it both in cooking and other domestic activities.				

	Just like my little child I am teaching her how to brush her teeth; even in my absence she can do it. She is now growing with that plus other house activities just as my colleague said you relate it to everyday life activities we do, so we use it every day both in cooking and domestic activities				
	1(P5)	2(P5)			
IK PRACTICES	Let me help you. For instance in food processing, let's say processing of gins. I know in your place there is a place we call Amumara, when I was young, the place was known for producing local gin (nwaetete). Now, local technology is involved, is almost the same process with the production of whisky and the rest of them. Now the get fresh palm			Production of alcohol- fermentation, covering – prevents entry of oxygen and to maintain temperature Heat to aid evaporation of "water in mixture" Heating stops enzyme activities Then very concentrated alcohol is available	

	wine, put it into a basin, put unu awuru, eh what do you call it? Unu awuru That is potassium carbonate. Put potassium there, grind it, put it there, cover it, leave it for three days. The idea of leaving it for three days is for it to ferment so that the alcohol inside it will ferment. Then after that, they will make fire on the tripod, then the will, pour the fermented wine. Eh alcohol into a drum and the drum will stood on the tripod. Then there are pipes, there are opening pipes inside, the fire will be heating the alcohol then there will be evaporation. And after sometime is circulated, you see the gin coming out dropping gradually. Assume you have let's say				

	three jars of pine wine, you only get let's say 750cl bottle. So these are local processes, and are close eh, when you examine it, it will just be like modern methods used in the breweries				

APPENDIX O

PROFESSIONAL EDITING APPROVAL LETTER

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Exploration of basic 7-9 science and technology teachers' conception of IK as drawn from their lived experiences and classroom practices in Imo State Nigeria

I confirm that I have edited this dissertation and the references for clarity, language and layout. I am a freelance editor specialising in proofreading and editing academic documents. My original tertiary degree which I obtained at UCT was a B.A. with English as a major and I went on to complete an H.D.E. (P.G.) Sec. with English as my teaching subject. I obtained a distinction for my M.Tech. dissertation in the Department of Homeopathy at Technikon Natal in 1999 (now the Durban University of Technology). In my capacity as a part-time lecturer in the Department of Homoeopathy I have supervised numerous Master's degree dissertations.

Dr Richard Steele

16 February 2015

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