UNIVERSITY FOR DEVELOPMENT STUDIES

INDIGENOUS KNOWLEDGE SYSTEMS AND THE CURRICULUM OF BASIC SCHOOLS IN THE NADOWLI DISTRICT OF THE UPPER WEST REGION

MICHAEL AZAASOMAH KPAN

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BY

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APRIL, 2020

DECLARATION

Student

I hereby declare that this thesis is my own original research work which has not been presented to this university or any other university for another degree.

Signature: ……

Date:……..

Name: ……

Supervisor's Declaration

I hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines of the University for Development Studies for a Masters of Philosophy degree.

Signature of Supervisor:…….

Date……..……

Name of Supervisor: ……

ABSTRACT

The premise of this thesis was that the educational reforms in Ghana for the past decades have failed to integrate the scientific indigenous knowledge systems into the science curriculum of basic schools. The study, therefore, sought to find out the possible ways of integrating of scientific indigenous knowledge systems in the school curriculum of the basic schools in the Upper West Region, especially in the Nadowli District. A qualitative method was employed. Purposive sampling was used to select the key informants and science teachers. Questionnaire and key informant interview guide were employed in the data collection. The study reveals among other things that scientific indigenous knowledge system is embedded in the traditional life of the people; the science teachers/key informants acknowledged the inclusion of experts in the science lesson delivery; teachers used scientific indigenous knowledge systems in their science lessons for demonstrations; decentralization of the science curriculum such that scientific indigenous knowledge system be examinable in the students' local content; the need for local science laboratories and more teaching of scientific indigenous knowledge systems in the training of science teachers. Also, the integration of the science curriculum with scientific indigenous knowledge systems could be enhanced with the following factors – religious tolerance, favourable political atmospheric, organization of field trips and creation of indigenous laboratories. Based on the findings/conclusions the study recommends that the science curriculum should be decentralized with a government policy backing it; experts in scientific indigenous knowledge system should help the science teachers in the classroom when the need arises; GES should organize workshops for the science teachers and the experts .

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DEDICATION

To my children: Maclean Furikaara, Millian Songsomah and Methodius Zunuo, my beloved wife Rebecca and my late parents Isaac and Marcelline.

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ABBREVIATIONS

ADP	Accelerated Development Plan
AIKS	African Indigenous Knowledge System
BA	Bachelor of Arts
BECE	Basic Education Certificate Examination
BED	Bachelor of Education
BSc	Bachelor of Science
CBD	Convention on Biological Diversity
CRDD	Curriculum Research and Development Division
CSSPS	Computerized School Selection and Placement System
DDE	District Director of Education
DST	Department of Science and Technology
EFA	Education for All
FCUBE	Free Compulsory Universal Basic Education
GES	Ghana Education Science
GMO	Genetic Modified Organisms
GoG	Government of Ghana
HND	Higher National Diploma
HNS	Human, Nature and Spiritual
ICT	Information Communication Technology
IK	Indigenous Knowledge
IKS	Indigenous Knowledge System
IS	Indigenous Science / Integrated Science
JHS	Junior High School
JSS	Junior Secondary School
L1	First Language
LI	Legislative Instrument
MOESS	Ministry of Education Science and Sports
MS	Minor Seminary
NaCCA	National Council for Curriculum Assessment
ND	Nadowli District

NDA	Nadowli District Assembly
NDEO	Nadowli District Education Office
NGOs	Non-Governmental Organizations
OPD	Out Patient Department
PTAs	Parents Teachers Associations
RC	Roman Catholic
RSA	Republic of South Africa
SC	Science Curriculum
SHS	Senior High School
SIKS	Scientific Indigenous Knowledge Systems
SMC	School Management Committee
SPSS	Statistical Package for Social Sciences
TLA	Teacher-Learner Activities
UN	United Nations
UNESCO	United Nations Education Scientific and Cultural organization
USA	United States of America
UWR	Upper West Region
WASSCE	West African Senior Secondary Certificate Examination
WMS	Western Modern Science

CHAPTER ONE

INTRODUCTION

1.0 Background Of The Study

The development agenda of late has the realization of indigenous / technical / local knowledge as an imperative ingredient (Singh, 2013). It therefore, behoves on governments and all actors in the development practice and policy formulation to be awakened to the necessity of incorporating indigenous knowledge in development practice. But the undocumented nature of indigenous knowledge, for example, makes it difficult if not impossible for policy formulators, theoreticians and development practitioners to consider its' value in the development process.

Before the introduction of formal education in Ghana (Gold Coast), there was on-going education as parents, siblings, grandparents and any other significant adults were considered teachers. There was no laydown procedures for this method of education. It differs from family to family and even between communities. Therefore, the informal form of education was relegated to the background and eventually, almost all African indigenous knowledge systems were either labeled superstitious or naïve. Consequently, people of African descent were asked to learn a new language and even the pupils were taken to an isolated environment. This was the beginning of the loss of African Scientific Indigenous Knowledge Systems.

The British colonies were ruled under one umbrella (British West Africa). In 1882 there was a regulation which was on finance and therefore the principle of

payment by results was introduced in the education system. This was to ensure that resources were put into maximum use both financial and human.

Education reforms in Ghana date back to the colonial era. Sir Gordon Guggisberg introduced the first education reform in the then Gold Coast in 1919 (Maison, 2007). Guggisberg's education reform was based on what was known as 'sixteen principles' of education which later became the Educational Ordinance of 1925 (Maison, 2007; Antwi, 1992). The Guggisberg education reform departed from the emphasis of educational programmes on the acquisition of literacy skills as was done by the missionaries but rather emphasized on character-building, industrial and professional training (Antwi, 1992). Even though the reform had an element of character-building it failed to develop syllabi to guide the teaching of character-building. That notwithstanding, the reform envisaged that the boarding and the prefectural systems will offer the grounds for school managers, teachers, parents and prefects to mould the character of students in residence.

Even though the Guggisberg education reform made a gargantuan departure from the over-concentration on acquisition of literacy skills and emphasis on industrial training, it did not overlook the importance of Indigenous Knowledge Systems while preparing the Gold Coasters for effective functioning in their societies. The emphasis laid on respect for traditional institutions is a sign of reverence for Indigenous Knowledge Systems.

Also, the writing of textbooks with local background and the introduction of Ghanaian languages – Twi and Fanti and later Ga and Ewe (Antwi, 1992) is a

plus to the missionaries. This aided in the propagation of the gospel to Africans especially the Gold Coasters.

More so, the launching of the 1951 Accelerated Development Plan (ADP) by Dr. Nkrumah and the subsequent enactment of the Education Act, 1961 Act 87. The major issues in this Act were to increase enrolment in schools by abolishing the payment of school fees and also concerned with the number of years in school. The system was in progressive stages – primary and middle education and secondary education. Therefore it was six years of primary, four years middle school (primary and middle education) and five years of secondary education and with two years for sixth form (secondary education) (Education Act 1961, Act 87).

Ghana witnessed another shift in education policy and practice with the introduction of Junior Secondary Schools (JSS) and Senior Secondary School concept in 1974 albeit on experimental basis. Eventually, the JSS and the Senior Secondary School system was rolled out nation-wide in 1987 (Aboagye, 2007). There was the need for the change in the curriculum and subjects like life skills, technical skills, cultural studies, vocational skills (basketry, cookery, ceramics, sculpture, needlework) among others were introduced. This was to ensure that products from the system would obtain practical knowledge and some may set up their own businesses while others continue to higher levels. Therefore it was almost a terminal point in their education. Also, another reason advanced for the new curriculum was to be more community involvement in the management of the schools – Parents Teachers Associations (PTAs) and School Management Committee (SMC) for community ownership. The reform also encouraged

community participation is curriculum delivery using local expertise in the topic which they are the 'experts'. Besides these, the products should be able to fit into the community thereby contributing to community development. One point which stands out is that around that time Ghana was undergoing structural adjustment and donor inflows was inadequate therefore the call for community participation in formal education.

It has been observed that the 1987 reforms emphasize technical and vocational education and for that matter, some teacher training colleges now (Colleges of Education) were specialized in these fields. Even though some teachers were sent to do in-service training in the new subjects such as technical and vocational skills, the skills obtained from these in-service training remained inadequate. After close to three decades (26 years) of implementation of the JSS concept, the question to ask is: How many Colleges of Education are specially established for the training of teacher to teach scientific Indigenous Knowledge Systems (science) in the JHS?

The predominant Ghanaian language of the community (region) was studied by the pupils. The cultural studies involved thematic areas like music, dance, folklore, drumming, games which are of Ghanaian origin but which was dominated by western music. According to Barnhardt et al., (2005) most educational institutions teach folk culture (storytelling, games, dressing, dancing, drumming, fine art and subsistence) and deep culture (weather forecasting, animal behaviour, navigation skills, hunting and fishing, seasonal changing cycle etc) is never taught. This is a true reflection of the curriculum

especially the Ghanaian language and cultural studies which is now combined as Ghanaian Language and Culture.

In January 2002, the President of the Republic of Ghana (His Excellency, John Agyekum Kuffuor) set up a committee to review the pre-tertiary education system of the country with the view of arriving at decisions that would make the system responsive to the challenges of the twenty-first century. The theme was "Meeting the challenges of education in the twenty-first century" (Republic of Ghana, 2004). The committee was of the view that "the philosophy underlying the education system in Ghana should be the creation of well-balanced (intellectually, spiritually, emotionally and physically) individuals with the requisite knowledge, skills, values and aptitudes for self-actualization and for the socio-economic and political transformation of the nation" (Republic of Ghana, 2004: 10). This was intended to develop the individual holistically to help in nation building almost putting old wine in a new bottle.

1.1 Problem Statement

At the global level, the United Nations (1948) declared the Universal Declaration on Human Rights (UDHR). Article 26 (1) states "everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory..." Article (2) "Education shall be directed to the full development of the human personality..."

The World Bank (2004) report on indigenous knowledge and science acknowledges the importance of indigenous knowledge that:

- both indigenous knowledge and modern science are not really in competition or in conflict with each other but that each has some elements of the other;
- very few, if any, serious scholars actually consider indigenous knowledge to be an exclusive alternative to science; and
- the exclusive use of modern science is not enough for the complex tasks of achieving sustainable development in diverse cultural and ecological contexts (cited in Banda, 2008).

Republic of Ghana (1992) declared the Free Compulsory Universal Basic Education (FCUBE). This made it mandatory for the Government of Ghana (GoG) after ten years of coming into force of the 1992 Republic Constitution of Ghana. Governments have tried hard to make it free and compulsory but with some challenges – quality, access, equity, gender imbalance and so on to some extent.

There is no such distinction between 'science' and 'arts' in the traditional African context and what rural people have is an integrated body of knowledges and practices (Haverkort, 2006; Millar, 2006). In the Africa context, the science is the natural world, the spiritual world, and the human world since all of them interact to produce their knowledge that they need for development (Millar, 2006).

Nazarpour and Rezaei (2011) observed that the lack of indigenous knowledge about indigenous practices in many technologies in the developing countries will lead to failure. Indigenous practices are therefore needed in every human endeavour for survival and development. The technologies are embedded in

their cultural practices as their way of life (Millar, 2006). Since the school is to transmit the culture of the community, teachers should be in a position to carry out this responsibility. In line with this, Singh (2013) writing on 'Globalization and Multilingualism: Case Studies of Indigenous Culture-based Education from the Indian Sub-continent and their Implications' said 'an approach to teaching and learning that facilitates critical consciousness, engender respect for diversity, and acknowledges the importance of relationships, while honouring, building on, and drawing from culture, knowledge, and language of students, teachers, and local community' (pg. 4). Singh was in particular about culture-based education which can also fit into the current discourse.

Education reforms according to Dei (2003) have merely focused on two areas: equity and social justice and provide learners with critical learning skills that challenge mental subversion and allow people to use their creativity and resourcefulness to solve pressing and immediate social problems (pg. 366). Dei (2003) argued that educational reforms in Africa are pressure from the global market context as is seen with the structural adjustment policy in the 1980s. He, therefore, posed the following questions: How are local communities dealing with the challenge? What lessons can be learnt from the educational front through the exercise of local resourcefulness and creativity? One has nothing but to concord with Dei in the context that education is for the local people to better their lives. The community which is to benefit from the education of their children fails to accomplish this task, then what is the relevance of 'educating' their children.

The Presidential Committee on the Review of the Education Reform in Ghana (2000), identified some of the challenges of education as the threat to the preservation of cultural identity, traditional indigenous knowledge, and creativity (Aboagye, 2007). Notwithstanding this, cultural studies which was introduced in the 1987 reforms was eliminated as a subject of study and integrated with Ghanaian language as Ghanaian Language and Culture. It continued to be the case that the education received by Ghanaian children is not that of their culture and therefore the need to include scientific indigenous knowledge into national curricula more pressing now than ever before (Maison, 2007; Owuor, 2007).

It has further been observed that the "pace of science and technology discovery means that curricula must keep abreast of new developments, in order to prepare school leavers for coping with rapid socio-cultural change... while maintaining local relevance" (Hoopers, 2009: 49). This assertion is to lay emphasis on the importance of promoting scientific indigenous knowledge systems in the formal school curricula. Since formal education has come to complement informal education in Ghana, the best way to learn Scientific Indigenous Knowledge Systems is through the formal education system.

Some scholars have observed that the educated Africans were inculcated with negative attitudes toward their own culture and heroes while they revered those of the European and therefore hate their own culture and themselves (Maison, 2007; Grenier, 1998; Marah, 1987 cited in Banda, 2000; Shizha, 2010). In line with this observation McKinley and Stewart (2009) noted that science education in the western style would lead to African students "dissatisfaction with

traditional lifestyles on the part of students" (pg. 52). Besides that, Dziva, Mpofu and Kusure (2011) espoused that formal education may contribute to the erosion of cultural diversity, alienation, and disorientation of the youth. The fact still remains that formal education must try to play its part in imparting the scientific indigenous knowledge system aspect in the formal education system as not all pupils will catch up with western science.

The reverence of indigenous knowledge is not to replace modern science but to complement each other for sustainable development. In view of this MOESS (2007) said "The integrated science syllabus is a conscious effort to raise the level of scientific literacy of all students and equip them with the relevant basic integrated scientific knowledge needed for their own survival and for the development of the country." The question that is asked; what is 'scientific literacy'? The scientific literacy will not be different from the 'universal science' (western modern science) (Das, 2006). What then happens to the 'minority' group of students who will not be able to grasp this scientific literacy with reference to western modern science?

The science syllabus further states that it will provide excellent opportunities for the development of positive attitudes and values such as:

- curiosity to explore their environment and question what they find;
- keenness to identify and answer questions through investigations;
- creativity in suggesting new and relevant ways to solve problem; and
- love, respect, and appreciation for nature and desire to conserve natural balance (MOESS, 2007, pg. ii).

What will be the new and relevant ways of solving problems? Life-world problems are becoming more complex than conventional science is not able to solve some of them – poverty, hunger, child labour, environmental degradation, the low yield of crops due to drought and loss of soil fertility, health problems just to mention a few. Therefore the co-existence and co-evolution of the sciences (conventional and indigenous) may make headway (Millar, 2006, 2007; Banda, 2008).

Instructional materials and medium of instruction affect pupils performance in integrated science especially understanding of concepts (Quansah et. al, 2019). In a study in the Effutu Municipality, the pupils and teachers agreed that the English language as the medium of instruction for was not helping them us they could not express themselves well in the English language. The science equipment was non-existent or inadequate and teachers had to do improvising.

"Since English language is the accepted language in class, integrated science lessons are boring, but when the teacher allows us to speak the Fante language we are able to communicate and make the classing exciting" Quansah et al. 2019).

But there exist a gap of integrating scientific indigenous knowledge system into the science curriculum. If scientific indigenous knowledge system is combined with the integrated science pupils would understand the science concepts better.

From the discourse, the research problem was **the inability of science teachers to integrate scientific indigenous knowledge system into the science curriculum at the JHS in the Nadowli District.**

1.2 Research Questions

1.2.1 Main Research Question

To what extent has there been the integration of scientific indigenous knowledge system into the science curriculum of JHS in the Nadowli District?

1.2.2 Specific Research Questions

1. What are the types of scientific indigenous scientific knowledge system that can be integrated into the science curriculum of the JHS?
2. Are there barriers between school and community that the integration of the scientific indigenous knowledge system into science curriculum could remedy?
3. Do science teachers encourage students in the science lesson the use of scientific indigenous knowledge system?
4. What could be the possible framework for the integration of the scientific indigenous knowledge system and the science curriculum of JHS?

1.3 Research Objectives

1.3.1 Main Research Objective

To examine the extent of the integrating scientific indigenous knowledge system into the science curriculum in the Nadowli District.

1.3.2 Specific Objectives

1. To examine the types of scientific indigenous knowledge systems that can be integrated into the science curriculum of the JHS.

2. To investigate the barriers between school and community that integration of scientific indigenous knowledge system could remedy.
3. To find out if science teachers allow students to use scientific indigenous knowledge system in the science lesson.
4. To examine a possible framework for the integration of scientific indigenous knowledge system and the science curriculum of JHS.

1.4 Significance Of The Study

The research "scientific indigenous knowledge system in the science curriculum of the basic schools in the Nadowli District of the Upper West Region" has a number of stakeholders – Ghana Education Service, policy makers, science teachers, opinion leaders and NGOs interested in education.

The study would also widen Scientific Indigenous Knowledge Systems based on the science curriculum and help science teachers in their lesson delivery and other researchers interested in Scientific Indigenous Knowledge Systems.

In addition to helping teachers in the delivery of science lessons, it would add impetus to the curriculum research division of the Ghana Education Service to come out with a curriculum which will stand the test of time with regard to scientific Indigenous Knowledge Systems in the science curriculum of JHS in the Nadowli District. Researchers into educational research especially curriculum studies will also find important literature to build on.

It would be an informant to policy makers (government) to help shape the educational policy on scientific Indigenous Knowledge Systems in the science curriculum of JHS as herbal medicine is now practiced in our

hospitals and universities offering the course.

1.5 Scope Of The Study

The study took a critical review of the science curriculum in JHS. Its' focus was in the Upper West Region of Ghana. It narrows down to the Nadowli District now Nadowli-Kaleo and Daffiama-Bussie-Issa Districts. It examines the provision of scientific Indigenous Knowledge Systems in the science syllabus within the current JHS system. The study is guided by some philosophical theories of learning, Indigenous Knowledge Systems, nature of science and the science curriculum of basic schools – JHS.

Also, it considered stakeholders in the development of the science curriculum and explored the roles they can play in the implementation of the science curriculum. Whatever is designed by the Curriculum Research and Development Division (CRDD) of the Ghana Education Service, now National Council for Curriculum Assessment (NaCCA) the consumers and implementers are the pupils and teachers respectively. The study, therefore, sought views of these stakeholders in the implementation of the curriculum, especially the science teachers. The custodians of scientific Indigenous Knowledge Systems are the indigenes and for that matter traditional leaders / elders and individuals/families in traditional settings. Much focus was on science teachers as they do their daily teaching and learning with pupils and the chiefs/elders and traditional healers.

1.6 Organization Of The Study

This study was organized into five. The preceding chapter comprised the

background of the study, research problem, research questions – main and specific, research objectives – main and specific, the significance of the study, and the scope of the research and organization of chapters.

Chapter two reviewed relevant literature to the study. Chapter three is the methodology used in this study. It involved the techniques and procedures used in answering the research questions and objectives to be achieved at the end of the research. These included sample, sample size and sampling technique, source of data and data collection tools. Chapter four was the presentation and discussions of research findings using the questionnaires administered to the respondents, the interview conducted and the content analysis of the JHS science syllables. Chapter five focused on the summary, conclusions, and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The study reviewed the available literature. In reviewing literature, therefore, cognizance was taken to organize, evaluate and synthesize the available literature to suit the current discourse. Concepts are also developed to the understanding of the current situation. Some concepts are therefore given in this literature review to understand the situation at hand.

It, therefore, puts into perspective philosophical theories of learning, science or sciences, science education, the science curriculum (integrated science for JHS), African sciences and western science, indigenous, indigenous knowledge, scientific indigenous knowledge system, integration and the way forward. It began with philosophies of learning.

2.1 Philosophies of Learning

A good number of philosophies have been put up by philosophers and researchers concerning how knowledge is acquired and accumulated in society. These theories range from postcolonial, post-modernity, multiculturalism, constructivism, border-crossing, and worldviews which this research has reviewed.

2.1.1 Postcolonial

Carter (2006) described the postcolonial theory as a theoretical tool that gingers channels for assessing philosophical ideas, which do not function in the modern world as far as inter-civilization is concerned. The theory opens up discourse in

inquiry about transcultural processes leading to the appraisal of dominance and sub-dominance cultures (Phiri, 2008). Carter (2006) as cited in Phiri (2008) post-colonialism is capable of permeating many processes and into the deeper ravines like multiculturalism, identity, representation and others which can open up spaces to generate other discussions in science education. Whereas postcolonial theory according to Dei (2002) has become a "meta-theory by essentializing 'difference' and thus risk idealizing and essentializing the human subject by privileging the individuation of the self" (pg. 6). He further argued that many lose their identity as postcolonial is pursuit at the expense of other theories – multiculturalism, post-modernity, and constructivism.

2.1.2 Postmodernism

Postmodernism calls for dissatisfaction with the present state of affairs in society. In the case of science, it would mean dissatisfaction with the way science is conducted, presented and used. According to Hammersley and Atkinson (1995), postmodernism attempts to rejoice the conundrums of field research and social life. The essence of postmodernism is to abandon singular narrative viewpoint or the dominant voice of an authoritative ethnographer (Phiri, 2008). Lyorad (1995) cited in Phiri (2008) challenged the conventional western science wisdom on the relationship between science and culture and the universal science.

2.1.3 Multiculturalism

Multiculturalism, in general, is a view that diversity is normal and that each group ought to enjoy equal cultural, political, economic and social value as all others deserve. In science education, this could be equated to the recognition

that different fields of knowledge exist and that all fields deserve the same attention and opportunities like other groups. This arises when under certain circumstances some people receive low attention than others to obtain higher attention (Stanley and Brickhouse, 2001).

According to Stanley and Brickhouse (2001) and Millar (2006), such views became visible as multiculturalism in science education emerged. Multiculturalists are renowned for challenging the universalistic and realist view of western modern science which in turn provokes counter augments from those who hold on the standard account as the superior and universal way of knowing. Multiculturalists claim that the alternative worldview of indigenous people avails opportunities for comprehending science to non-western learners or indeed open up new solutions into medicine and agriculture that may not be forthcoming from western science (Stanley and Brickhouse, 2001).

Siegel (1997) argues that “as educators, we are obliged to embrace multiculturalism, simply because we are morally obliged to treat cultures other than our own, and members of those cultures, justly and with respect” cited in Stanley and Brickhouse (2001, pg. 38).

Stanley and Brickhouse (2001) questioned the multiculturalists (Siegel, 1997) about the morality and universalism of multiculturalism. They posited, “Where did the moral principle we seek to impose come from? How do we know it is universal? Even within the framework of western philosophy, there is no consensus regarding the universality of moral principles” (pg. 39). Knowledge is not the reserve of any human race or institution but a conscious effort by human societies to inculcate in the younger generations. Therefore to this end,

Stanley and Brickhouse (2001) contended that all forms of knowledge are derived from "antecedent enculturating processes".

The integration of western science and Indigenous Knowledge Systems and technologies is practicable. In this direction, Stanley and Brickhouse (2001) stated that specific technologies or ideas across cultures are possible but the integration of large explanatory frameworks and philosophies are immutable. They went on to further argue that instead of showing students indigenous knowledge, traditional environmental knowledge and western modern science differences, rather approach it as different views of science rooted in certain cultural assumptions that affect how they formulate and solve challenges.

2.1.4 Constructivism

The propounders of constructivism are Jean Piaget and Vygotsky. The challenges of postcolonial, postmodernism and multiculturalism emerged constructivism in the process of reforming science education. Constructivists' paradigm advance relativist view of scientific knowledge as they suggest that individuals construct worthwhile knowledge either individually or socially. Therefore constructivism although accepted by western science scholars it advocates relativist construction of knowledge that relates to social interaction and by implication align with multicultural science educators notion of how scientific knowledge emerges from the community of a people (Stanley and Brickhouse, 2000). Engaging a constructivist approach to teaching and learning implicitly or explicitly creates a link to local people's knowledge that comes underplay in a child's process of learning science (Stanley and Brickhouse, 2000).

Constructivist theory include the "notion that learning is active, social and situated in a particular physical, social and cognitive contexts, that it involves the on-going development of complex and interrelated mental structures, and that the construction of knowledge is, to a greater or lesser degree distributed across individuals, tools and artifacts" (Swan, 2005: 14).

Bidell and Fischer (1992) contended that constructivism is "characterized by the acquisition of knowledge as a product of individual creative and self-organizing activity in a particular environment" (pg. 12). This form of knowledge contrast with the structuralist model which depicts knowledge in terms of abstract universal structures independent of specific context. Constructivism is widely used in educational settings because of its emphasis humanist as a cognitive acquisition of knowledge (Bidell and Fischer, 1992).

Bruner cited in Bidell and Fischer (1992) was of the view that forms of knowledge could be treated in a form of spiral curriculum. These forms of knowledge are: tacit, intuitive, declarative, theoretical, meta-theoretical, procedural and conditional (Bidell and Fischer, 1999).

Adding to the debate on constructivism Swan (2005) stated it is a set of epistemological theories which are grounded in a belief that meaning is constructed in the minds of individuals through the cognitive processing of interactions in the world.

2.1.5 Border-Crossing

A border is a physical barrier that prevents people or whatever it might be from entering the other side. It could further mean anything that hinders the progress

of other things. In addition to that, it could be an ideological barrier imbued with the power to bar someone or persons from passing across a physical or perceptual barrier. Jegede and Aikenhead (1999) conceptualized the transition between a student life world and school as a cultural border crossing. They argue that transcending borders is a matter of negotiation that all learners have to do but the heavy duty laid on minority learners. The minority in their conceptualization be referred to as indigenes who are now learning western science as the standard account. In view of that Demmert and Towner (2003) and Phuntong (1999) stated that one source of learning difficulties for minority students emanates from the cultural mismatch between students home culture and the culture of the school (cited in Singh, 2013). Their premise is based on the 'cultural difference theory' which acknowledges the difficulties minorities may undergo when learning new things and complete new environment (Barnhardt et al, 2005; Singh, 2013).

McKinley and Stewart (2009) in their divergent view on border-crossing said it is possible when there is only one border to be crossed at a time. It is therefore relevant to note that border-crossing with attendant disadvantage calls for multiculturalism.

2.2 Worldviews

People from different cultures tend to differ in their perceptions and conceptions of how the world functions but each group attempt to come up with a reasonable explanation to convince the other(s).

The scientific worldview / western modern science Cleland (2001) Machado and Silva (2007) differs from the worldviews of indigenous people (Kawagley,

1995). Kawagley (1995) and Phiri (2008) stated that the concept of worldview is very closely related to the definition of culture and cognitive map.

Millar (2006) and Haverkort (2006) opined that the worldview of Africans is a hierarchy between divine beings, spiritual beings, ancestors and natural forces. They contended that powers of the ancestral spirits, magic (negative and positive) cannot be delineated from the African worldview. Millar (2006) and Haverkort (2006, 2009) agreed that the African worldview has three components: spiritual, human and natural. In a further conclusion, it was stated that the three worlds are inseparable. Haverkort (2009) on indigenous worldview using India and Sri Lanka apart from the natural, spiritual and social worlds the mind plays a vital role in human existence. With Latin America, the Andes the three worlds are an expression of unity Haverkort (2009).

Zimbabweans in their traditional African worldview, land, water, animals, and plants are not just a production factor with economic significance (Millar, 2006) but interrelated and give human satisfaction with nature. Millar (2006) opines that Africans worldview is also their cosmovision. This entails why some things happen which are beyond the confine of western modern science. Spirituality, humanity, and nature as an integral part of the African worldview are used to explain why certain things happen.

Rudge (2008) looking at the spirituality version in holistic education has four fundamental concepts put forward:

- “There is divine Reality substantial to the manifold world of things, and lives and minds.

- We are all part of a complicated life and we are connected and dependent on each other.
- Every life has a purpose in the universe.
- We are involved in a constant evolution" (cited in Gultekin et al., 2013, pg. 56).

Haverkort (2006) opines that worldviews, sciences, and values should be universal rather an expression of pluralist reality. Since there is no measure of truth in each case it is academic gymnastic for various scholars to argue their way out.

Cobern (1993) cited in Jegede (1999) opines, worldview as "culturally dependent, generally subconscious, fundamental organization of the mind which manifest itself as a set of presuppositions that predispose and are to feel, think and act in a predictable pattern" (pg. 123). Worldview, therefore, is a culturally accepted way of organizing the physical, material (natural) and spiritual world in the African context and physical and material world in the 'Euro-America' worldview.

2.3 Science Or Sciences

Is it science or sciences bring to the discourse table of academic views of Euro-American (western science or western modern science) and African sciences. Millar (2006) contended that Africans do not have science like Euro-America rather it is "sciences". He further went on to state that in the African context there is no distinction between the arts and the sciences as they are both called African sciences.

Victor and Lerner (1971) as postulated by Phiri (2008) "viewing science in terms of knowledge and its use alone falls short of full meaning of science" (pg. 28).

In the words of Haverkort (2006) "science is an activity where 'true' knowledge can only be acquired by rational reasoning and the application of quantitative methods of observation and investigation" (pg. 349).

Science, therefore (Haverkort, 2006, pg. 350):

> "The body of knowledge and its classification under a theoretical framework. It includes the complex of producing knowledge based on a specific worldview and assumptions, general principles, theories and methodologies about which a specific community has reached consensus. The knowledge acquired and the resulting science is always limited and subject to modification in the light of new data and information".

Consensus is a watch word in determining what science is and keep on evolving as new data and information is discovered and added. Knowledge keeps on growing and accessible by a lot of people.

Haverkort, Apusigah, Millar, Shankar, Rist and Delgado (2012) not departing from Haverkort (2006) contended that science is:

"a body of knowledge formulated within a specific worldview and its classification under a theoretical framework. It includes the processes for producing and selecting knowledge, formulating assumptions, general principles, theories, and methodologies and it involves an active role of

specific knowledge community that has reached consensus on these. The knowledge acquired and the resulting science is always limited and subject to modification in the light of new data, information and insights" (pg. 113).

They concluded that science is linked to a specific worldview, theories, methods, knowledge, processes, value and scientific community.

GES (2007) science is defined as:

"A body of knowledge which can be communicated to others and which can be verified by anyone willing to make the effort to do so;

A way of learning which involves first-hand experience, inquiry, problem solving, interpretation and communication of findings and the development of attitudes which promote this way of working;

Exploring the environment, observing things and solving problems" (pg. 9).

To the researcher, science or sciences is a specific worldview, depending on the people involved at any given time in history. The challenge which emerges is the constellation of the notions with a better understanding of the world around us.

2.3.1 Nature of Science

Teachers are the first persons to introduce scientific approaches (western modern science) and need to understand science better before they can impart that knowledge. Gregory Mendel a pioneering biologist in inheritance was

associated with genes but late trends in scientific realm attribute inheritance to chromosomes from genetic variations. It is therefore fundamental for teachers to have in-depth knowledge of western modern science to teach the subjects.

Knowledge and skills from science determine a personal interaction with nature and survival success. In a world predominantly dependent on scientific knowledge and technology in interacting with the environment, it is presumed that science education should unravel the talents that are needed. The world is driven by technology of scientific knowledge (Phiri, 2008). The changing environment and the way of living make it appreciable for children to be scientific literates (Phiri, 2008) to cope with current challenges. Victor and Lerner (1971) as postulated by Phiri (2008) "viewing science in terms of knowledge and its use alone falls short of full meaning of science" (pg. 28). Teachers into this field neglect the nature of science in the curriculum as echoed by Graiz (1937) cited in Phiri (2008).

Science literacy is the core of the United States of America (USA) where citizens are expected to be prepared to lead personally fulfilling responsible lives (Cleland, 2001; Machado and Silva, 2007). (Cleland, 2001; Machado and Silva, 2007) puts the nature of science into three perspectives: the scientific worldview, scientific methods of inquiry and the nature of scientific enterprise. The nature of the scientific enterprise is not in conformity with indigenous science. Indigenous sciences are not seen as an enterprise since it is communal knowledge owned by the community and every person contributes to its production (Barnhardt et al. 2005; Millar, 2006; Phiri, 2008). To add to that,

indigenous science by its nature is oral, not standardized reference about nature (Phiri, 2008).

This situation becomes complicated as indigenous science is done at the individual level or community owned. To compare indigenous sciences with western modern science becomes problematic as the former was not intended for the academia and ideas were not assembled (Dei, 2002; Barnhardt et al. 2005; Haverkort, 2006; Millar, 2006; Phiri, 2008). Indigenous sciences efficacy is concerned with local indigenes who practice and appreciate the knowledge and skills for their daily survival and the future generations still unborn. The scientific worldview in western modern science dilates only on natural and physical worlds excluding the spiritual world (Millar, 2006).

In the African context, a well balanced person according to Millar (2006) is achieved when the three components of human, nature and spiritual interact. If Indigenous Knowledge Systems are to be part of the science curriculum one would appreciate the challenges of spirituality.

2.3.2 Pedagogy of Indigenous Science

Educators would agree that effective teaching and learning revolve the use of learner prior knowledge (Sherman and Sherman, 2004). Constructivists are of the opinion that learners can manage to create new understanding or meaning based on what they have experienced previously (Lippman, MaClendon-Magnuson and Collamer, 1996; George, 1999). The nature of meaning and understanding of concepts is a product of previous/prior knowledge experience on which new ones are created. Teachers are therefore required to consider and draw learners' prior knowledge when they are to introduce a new task.

Kincheloe and Steinberg (2008) opined that the dominant cultural backgrounds continue to dismiss the importance of Indigenous Knowledge Systems in pedagogy. Indigenous knowledge system is seen as a threat to Euro-Americentrism and or as a commodity to be exploited. It is therefore in the light of this that formal education by the colonizers showed disdain to the learning of indigenous languages (indigenous science) (Grenier, 1999). They were only interested in the linguistic aspect to help them in communication and to exploit the human and material resources.

In another view, Wilikai (2007) cited in McKinley and Stewart (2009) educators can use science concepts already in existence within the student's village environment and building vocabulary from their everyday life.

A study conduction by Jegede and Kebukola (1991) in Nigeria found that "students with high level of belief in African traditional cosmology, superstition and taboos made significantly fewer correct responses on a process skill test in comparison with those of low level of belief" pg.57 cited in Riley (2001). It is therefore of great importance to regard students prior knowledge in their traditional setting to the teaching and learning of science.

2.4 Constructivism And Science Education

The teaching of science is influenced by constructivism from the dates of Piaget, Vygotsky, and Dewey (Lippman, et al., 1996). These initial theories of learning advanced the process of learning that are influenced by pedagogical paradigms ever since they existed.

Piaget eloquence of learners developmental stages dictates their cognitive processing of knowledge and their conceptual and psychomotor development influence their progress in an academic pursuit involving reasoning and problem solving (Lippman, et al., 1996; Sherman and Sherman, 2004; Woolfolk, 2005). Piaget theorized a hierarchy of skills that are developmentally arranged, which could be attained based on readiness (sensorimotor, pre-operational, concrete operational and formal operational) (Gleitman, 1992; Lippman et al., 1996). An outstanding observation of Piaget is previous/prior knowledge which the learner brings from home to bear on academic work (Woolfolk, 2005).

Vygotsky articulated the theory of radical constructivism considering Piaget theory of learning (Lippman et al., 1996). He criticised Piaget for failing to specify how children progress from one stage to the other and forgotten of the socio-cultural influence (Lippman et al., 1996, Gupta, 1998). Considering the socio-cultural dimension, Phiri (2008) radical constructivism suggests that, learning is a result of mental construct in an individual mind the materials from an individual past experience, in that new understanding are product of an individual capacity to combine, resolve and recreate new understanding based on what individual already knew upon encountering new experiences. Failure to process knowledge from new experience (Glasersfeld, 1989) is as a result of mismatched of new experience with prior knowledge (Singh, 2013). The challenge of this research is, therefore, to find out how this mismatched of ideas could be harmonized to improve the child learning of science in the classroom setting. For this reason, science teachers should emphasis on the background which learners bring in the teaching and learning of new knowledge in science.

In the constructivist model of learning the five E's (5E's) – engaging, exploration, explaining, extension / expansion / elaboration of concepts and evaluation (Phiri, 2008) are extensive used. This research was, therefore, to engage in a dialogue of engaging and exploration of scientific Indigenous Knowledge Systems in the science curriculum to help learners understand and appreciate their Indigenous Knowledge Systems.

2.4.1 Learner/Child-Centred Approach to Learning

Child-centred approach to teaching and learning is in support of constructivism in the sense that the learner is the centre of focus. Therefore inquiry activities take the centre stage of teaching and learning. The inquiry is advocated by Dewey as constructivism tool (Phiri, 2008). Inquiry prepares learners for life after school (Phiri, 2008).

Individuality in constructivism theory is being criticised (individuality in knowledge construction) an alternative that learners understand and construct meaning better when they interact with expert elders or peers especially when they are deficient of knowledge or skills (Sherman and Sherman, 2004; Woolfolk, 2005). Phiri (2008) deficiency in learning could arise because of linguistic, experiential or reasoning capability. To optimize learning an optimum environment should avail the individual for learning. The implication is that in a good learning environment a mediator or peer educator should be present to facilitate the acquisition of knowledge and skills. In other theories of learning, the learner is seen as a blank slate only to be imparted with knowledge and skills (Farrant, 1986). This to the constructivists is untrue as learning precedes prior knowledge.

Swan (2005) using the Piaget four stages of development: sensorimotor, pre-operational, concrete operational and formal operational, constructivism manifest itself in some forms as cognitive constructivism and social constructivism.

The interest and innovativeness of the learner is also a key factor in learning any new thing (Schlein and Chan, 2012). They found in a study conducted in Canada that Chinese children who were very interested and innovative pick up the English language very fast (Schlein and Chan, 2012). In a like manner, it is believed that students who are not from a certain cultural background will pick fast Scientific Indigenous Knowledge Systems when confronted in the formal classroom situation.

Hein (1999) opined the following principles and characteristics of learning which could be of importance to the research:

1. Learning is an active process in which the learner uses sensory input and constructs meaning out of it;
2. People learn to learn as they learn: learning consists both of constructing meaning and constructing systems of meaning;
3. Learning involves language: the language we use influences learning;
4. Learning is a social activity: our learning is intimately associated with our connection with other human beings, our teachers, our peers, our family as well as casual acquaintances, including the people before us or next to us at the exhibit;
5. Learning is contextual: we do not learn isolated facts and theories in some abstract, the real mind separate from the rest of our lives: we learn

in relation to what else we know, what we believe, our prejudices and our fears;

6. It takes time to learn: learning is not instantaneous; and
7. Motivation is a key component in learning.

2.4.2 Prior Knowledge and Learning

Theorists in child psychology acknowledge prior knowledge as a crucial factor in learning (Sherman and Sherman, 2004; Swan, 2005; Woolfolk, 2005) and Indigenous Knowledge Systems inclusive. Geelan (1997, cited in Phiri, 2008), contended that learners are better able to process new information if they have related background experience. Background experience could be in the form of language, concepts or practical experience which are depended on the learner geographical and environmental placement and socio-economic status of parents. This brings to mind scientific indigenous knowledge system which is geographically and environmentally placed. Relating to some agricultural innovations (Green Revolution) which were transferred to developing countries short-lived (UNESCO and Nuffic, 1999) some factors could be geographical and environmental situations.

The disparities of resources and experiences (Phiri, 2008) have an effect on teaching and learning, therefore, create heterogeneous learning environments that demand critical analysis to identify what the learner brings to the table in science lessons. Phiri (2008) therefore emphasized the need for teachers to relate the geographical location in the teaching of science lessons. Ogunniyi (2008, cited in Dziva, Mpofu and Kusuure, 2011) contends that “conceptions become when it is the most adaptable to a given context... suppressed by or

assimilated into another more adaptable mental state" (pg. 92). They also argue that in some instances individuals may not have previous knowledge of a given phenomenon with scientific concepts but could do well.

These call for scientific indigenous knowledge systems acquisition by teachers to enable them to teach effectively and efficiently in the science curriculum. Pupils with varying degree of understanding could also pick up in the science lesson when their knowledge in scientific indigenous knowledge system is applied or featured in the lesson.

2.4.3 Science Curriculum

For teaching and learning to be effective, the relevance of the curriculum for pupils, teachers and other stakeholders is paramount but much consideration to the pupils. In line with that, Ornstein and Levine (2006) propounded a relevant curriculum as one that takes into consideration the personal needs and interest of students. They, therefore, suggested the following:

i. individualized instruction – independent inquiry and projects;
ii. topics should be of students concern such as drug addiction, urban/rural problems;
iii. provide educational alternatives (*indigenous science*) that allow freedom of choice; and
iv. extend the curriculum beyond the school's walls (*community involvement*) (Ornstein and Levine, 2006) (emphasis added).

On the agenda for indigenous knowledge development, Ocholla (2007) stated that education and training are cardinal points in the popularization of

indigenous knowledge in the schools and the curriculum of educational institutions which extends to the teaching of African history and literature.

> "We need to understand the worldview of students we teach and for whom we design curricula. We need to know what beliefs they bring to the classroom so that we know where to construct scaffolding from indigenous knowledge to modern science and where not to. We need to understand our goal need not require that science become a substitute or replacement for what a child learns at home but rather a collateral learning that encourages students to make their own linkages that accommodate and assimilate knowledge. We need to design science curricula tangent at many points to the culture of the learner" (Riley, 2001; pg. 59).

From Riley perspective, we need not try to teacher western science in isolation but rather complement it with indigenous knowledge which the child already has from home.

2.5 Indigenous Knowledge

Indigenous knowledge has so many connotations depending on the scholar using it. It is sometimes termed 'local knowledge', 'local science', 'African sciences' 'indigenous science' 'traditional knowledge'. UN (2004), used traditional knowledge and defined it as "The knowledge, innovations, and practices of indigenous and local communities embodying traditional lifestyles as well as indigenous and traditional technologies".

George (1999) contended that indigenous knowledge is "knowledge that has evolved in a particular societal context and which is used by lay people in the context of their lives or knowledge possessed and used by people in non-western, non-industrialized, traditional settings" (pg. 80). It is inferred that knowledge is not for commercial purpose as opposed to western knowledge (Viergever, 1999; Barnhardt et al. 2005; Millar, 2006; Phiri, 2008, Lanzano, 2013). The knowledge is to be shared by community members and to achieve societal goals.

Scholars like Dziva, Mpofu and Kusure (2011) defined it as "philosophies, indulgences and developed by long resident societies in their interaction with their natural surroundings and other people" (pg. 90). They, therefore, acknowledge foreign or outside influence in the development of Indigenous Knowledge Systems. On the other hand, Owuor (2007) defined indigenous knowledge as a process of learning and sharing social life, histories, identities, economic, and political practices unique to each cultural group.

Viergever (1999) "indigenous knowledge is seen by indigenous peoples as an inherent part of, on the one hand, their physical environment and, on the other hand, their social structures. . . . knowledge of the physical environment depends on the characteristics of that environment" (pg. 336).

As society develops, there is a time when some social values or attributes are likely to be lost if not extinct. As society advance in development and with the interaction of foreign cultures which are dominant in nature the indigenous culture demises as people acquire formal education. According to Prah (2000) technology has been borrowed without seriousness into integrating such

technology into the existing level and forms of indigenous culture. He further stated that there is the need to build on what exists and is known.

Shizha (2010) in his article "The Interface of Neoliberal Globalization, Science Education and Indigenous Knowledges in Africa" defined African indigenous knowledge / sciences as "culturally-specific knowledge systems that relates to the knowledge of the original people of Africans their oral culture and traditional ecological knowledge as affected by their worldview" (pg. 28).

Owuor (2007) asserted that the integration of indigenous knowledge in formal education requires that educators' and teachers' perceptions of indigenous knowledge be inquired with a view to understanding their capability in developing appropriate pedagogical approaches and materials for implementation of such curriculum reforms. In addition to that, "the pluralistic approach to knowledge systems requires educators to embrace their own logic and epistemological foundations and acceptance that one system of knowledge cannot act as a standard of measure for all knowledge systems" (Owuor, 2007, pg. 34). His assertion in a way contravenes with the western standard of knowledge which is said to be universal.

Owuor (2007) in putting forward what is accepted as universal knowledge and standards of industrialization and economic development in Kenya, the following questions were posed: What knowledge is of worth and in whose interest does the knowledge operate? How can indigenous knowledge and pedagogy be integrated in a reciprocal way with western knowledge in the formal school system? Who counts as experts or innovators in this process? If these questions when answered by educators and teachers address such

questions critically that they may empower themselves and in turn be able to empower students' knowledge construction by building on the indigenous knowledge base that students bring with them into the classroom settings.

Indigenous knowledge provides skills, experiences, and insides into individuals and communities which may improve the living standards of the informal sector of the economy (Ocholla, 2007). He was emphasizing the importance of indigenous knowledge in community development.

Owuor (2007), suggested that teachers and teacher educators to adopt practices that embrace both western and indigenous knowledge in ways that defy dichotomous presentation, foster relevance, inculcate a sense of self-worth, and national pride among learners. As teachers and educators develop a more culturally inclusive curriculum practice, they must confront the emerging challenges from within themselves and the environment in which they are operating.

Others have different binoculars in viewing indigenous knowledge system. Republic of South Africa (2004, cited in Green, 2007), the Department of Science and Technology (DST), in their attempt to explain or define indigenous knowledge said it is tacit knowledge therefore not easily codified. DST further defined it as local knowledge generated by people living within a particular community therefore unique to a given society or culture. Green (2007) addressing the two definitions of indigenous knowledge by the Department of Science and Technology of South Africa said indigenous knowledge is stasis, fixity, and innovation is possible but within a specified group and no contact with outsiders.

According to Foucault cited in Smith (2009) 'local' or 'indigenous' knowledge are all disqualified as naïve, hierarchically inferior and below the required level of erudition and scientificity.

Maurial (1999) writing about "indigenous knowledge and school: a continuum between conflict and dialogue" with people of Peru as the setting postulated that schools have imposed a foreign curriculum and devalued indigenous knowledge, consecrated western worldviews that violates human beings from nature. This raises conflict (Dei, 2002; Millar, 2006; Maurial, 1999). The conflict arises as the school tries to impose on pupils knowledge of the science in the western style.

In another development, Maurial (1999) said indigenous knowledge is a cognitive and wise legacy as a result of their interaction with nature in common territory. The basis of indigenous knowledge is local, holistic and 'agrapha' (not written/oral – Hispanic). There is no specific location for learning indigenous knowledge – rivers, homes, gardens, forest (Maurial, 1999).

Kincheloe and Steinberg (2008), indigenous knowledge is a multidimensional body of understanding that has speciality since the beginning of the European scientific revolution of the seventeenth and eighteenth centuries been viewed by Euro-culture as inferior and primitive. They contended if the Euro-Americans come to understand the epistemology of indigenous knowledge the Cartesian and Newtonian foundation of science will shake.

Using the Chagga people of Tanzania (Mosha, 2000) cited by Kincheloe and Steinberg (2008) stated that this epistemology could not claim power via the ability to delineate or validate knowledge in non-Chagga culture. Kincheloe

and Steinberg opined that knowledge production/epistemology are locational and culturally based, for that matter validation with others (western knowledge) will not be applicable. They, therefore, call for transformative negotiation which demands no final end-of-history resolution.

Using the multi-logical context of knowledge epistemology, Kincheloe and Steinberg (2008) opined that people from various backgrounds look at things from different perspectives thereby different results of the same thing. Science teachers should, therefore, employ the multi-logical approach in teaching. The learner should be treated with respect to race, gender, class, and location in the situation of knowledge production.

Ocholla and Onyancha (2005) indigenous knowledge "a dynamic archive of the sum-total of knowledge, skills, and attitudes belonging to a community over generations and expressed in form of action, object and sign languages for sharing. These skills, knowledge, and attitudes are shared, adapted and refined and therefore change with time" (pg. 247). Ocholla and Onyancha (2005) and Ocholla (2007) argued that indigenous knowledge has been neglected, vindicated, stigmatized, illegalized and suppressed among the majority of the world communities.

UNESCO and Nuffic (1999) indigenous knowledge refers to a large body of knowledge and skills that have been developed outside the formal educational system and enables communities to survive" (pg. 10). This talks about the survival (livelihoods) of indigenous people. To a large extent, indigenous knowledge is now recognized as a partner in the development and further recognized in educational settings (Ocholla, 2007; World Bank, 1998).

Indigenous knowledge has the following characteristics:

i. is generated within communities;
ii. is location and cultural specific;
iii. is the basis for decision making and survival strategies;
iv. is not systematically documented;
v. concerns critical issues of human and animal life: primary production, human and animal life, natural resource management;
vi. is dynamic and based on innovation, adaptation, and experimentation; and
vii. is oral and rural in nature (UNESCO and Nuffic, 1999).

The characteristics as stated above – been dynamic and based on innovation both acknowledge knowledge production goes through a process.

Going through the what researchers and international organizations what indigenous knowledge is, this study indigenous knowledge would be a large body of knowledge and skills that have been developed outside the formal educational system and enables communities to survive in a traditional setting with minimal interaction with outsiders. Outsiders are non-residence of the area mostly western industrialized nationals.

2.6 Scientific Indigenous Knowledge System

Scientific indigenous knowledge system is not easy to define. The available literature review so far all tried to explain or defined indigenous / technical knowledge used by people in a specific geographical area. For science both western and indigenous people have their own explanations. For instance

Millar (2006) said Africans do not have difference between the arts and sciences.

(Haverkort, 2006) opined that science is a body of knowledge and its classification under a theoretical framework. It includes the complex of producing knowledge based on a specific worldview and assumptions, general principles, theories and methodologies about which a specific community has reached consensus. The results are subject to modification in the light of new ideas. The view of Haverkort is the western modern science. But how far is this from indigenous science / knowledge. If it is a worldview as stated above then the indigenous science is the worldview of Africans. They also follow their own methodologies.

To compare indigenous sciences with western modern science becomes problematic as the former was not intended for the academia and ideas were not assembled (Dei, 2002; Barnhardt et al. 2005; Haverkort, 2006; Millar, 2006; Phiri, 2008). Indigenous sciences efficacy is concerned with local indigenes who practice and appreciate the knowledge and skills for their daily survival and the future generations still unborn. The scientific worldview in western modern science dilates only on natural and physical worlds excluding the spiritual world.

George (1999) contended that indigenous knowledge is “knowledge that has evolved in a particular societal context and which is used by lay people in the context of their lives or knowledge possessed and used by people in non-western, non-industrialized, traditional settings” (pg. 80).

The researcher going through the itinerary of literature on indigenous knowledge and science, it is not easy to conclude on which is the best among the lot. For this study, scientific indigenous knowledge system is the knowledge system which is within a certain geographical location, used by the people for their everyday life activities and have been sustained for generations and the generation still unborn. Their everyday activities include agriculture, healthcare, spirituality, and social life.

I do not conclusive say that scientific indigenous knowledge system could be exclusive of foreign influence but its interaction is minimal. This is because the world today a global village and no man live in an island.

2.7 Policy On Indigenous Knowledge

For effective and pragmatic measures on Indigenous Knowledge Systems, there is a need for a policy framework and legislation. Republic of South Africa (2004) adopted an Indigenous Knowledge Systems policy after approval by cabinet. The policy framework proposed the integration of Indigenous Knowledge Systems (IKS) in the areas of education, commerce, agriculture, the sciences, law, languages, arts, social sciences, and health. The interest of this research is on the education and the science aspect. According to the policy document, “Indigenous knowledge is dynamic in nature and changes its character as the needs to change. The transformation of education syllabi from the primarily content-driven approach to one of the problems solving creates a further impetus for the central recognition of indigenous knowledge” (RSA, 2004: 17). The Department of Science and Technology was therefore tasked to

spearhead the process of integration and implementation of the policy documents.

Green (2007) in his write up "The IKS Policy of 2004: Challenges for South African University" takes a succinct look at the policy. He made the following observation: power-knowledge and ideology, challenges relating to the commercialization of knowledge; and epistemological question. The problem of power-knowledge and ideology bring fore the issues of culture as genealogical inheritance linked to a particular geography, gendered knowledge and equating traditional value with frames of knowledge with the rights-based discourse. Commercialization of indigenous knowledge has the concerns of establishing intellectual property rights and patent as indigenous knowledge is shared knowledge. Green (2007) contends that the epistemology of indigenous knowledge is in variance with western knowledge system as challenges to the successful implementation of the South Africa policy.

Banda (2008), in studying the hybridization of the Chewa African IKS into the formal curriculum revealed that there is the need for a policy framework on the part of the government to make the hybridization possible. He, however, suggested that the policy document should contain the Chewa African indigenous knowledge documented, the people with special skills acknowledged and rewarded and knowledge shared with other institutions (Banda, 2008).

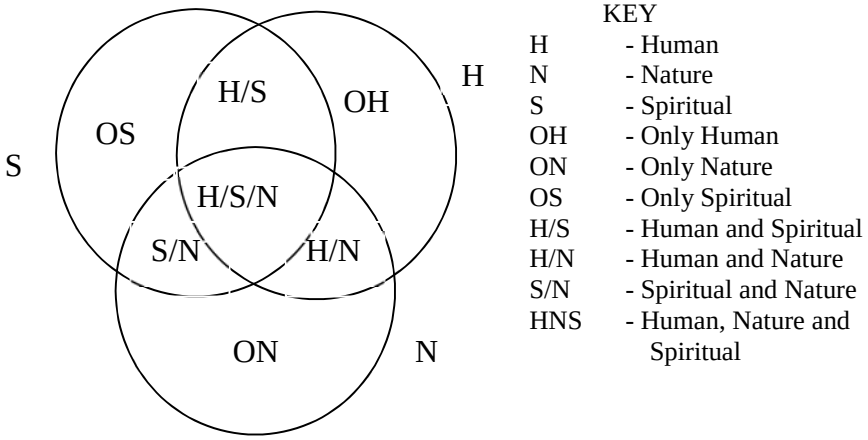
The indigenous knowledge policy in Ghana has a chequered history with particular reference to education. In the Ghanaian situation, IKS could be equated to Ghanaian language. In the JHS curriculum, Ghanaian language and

cultural studies were studied as subjects on their own merit (MOESS, 1990). When Kuffour administration reviewed the curriculum of basic schools in Ghana in 2004, the curriculum of the Ghanaian language and cultural studies were merged as Ghanaian Language and Culture (MOESS, 2004). Indigenous knowledge system in the science curriculum is not taken care off.

2.8 IK And Its Challenges In The Science Curriculum

Researchers have pointed out that some indigenous knowledge background could conflict with western modern science (George, 1999; Barnhardt et al. 2005; Aikenhead, 2001; Millar, 2006; Singh, 2013). Millar (2006) identified three interlocking circles which present Africans' worldview (spiritual, human and natural worlds).

Figure 2. 1 The Constellation of the Human, Nature and Spiritual worlds



Adopted from Millar (2006)

The linkage which is missing in western modern science is spirituality. The interlocking circles, therefore, produce the worldview of Africans which is unique and surpass the understanding of westerners/outsiders in the community. Aikenhead (2001) presented aboriginal knowledge experience which conflicted

with a western standard account. The aborigine has a belief in thirteen moons as against twelve with the western account (Aikenhead, 2001). Kawagley (1995) studying the Yupiag worldview on belunga whale tracking and fishing, in general, presented a different perspective of western account. Moken usually asked the spirits of the tree before logging and also share forage food with ancestors (Arunotai, 2006). The Moken of Thailand belief is also in consonance with the Chewas of Zambia (Banda, 2008).

Kawagley, Norris-Tull, and Norris-Tull (2010, cited in Singh, 2013) noted:

> "Yupiaq people view the world as being composed of five elements: earth, air, fire, water and spirit. Aristotle spoke of four elements: earth, air, fire and water. However, spirit has been missing from western science. The incorporation of spirit in the Yupiaq worldview resulted in an awareness of the interdependence of humanity with environment, a reverence for and a sense of responsibility for protecting the environment" (pg. 227).

This worldview is not far from what Millar (2006) also identified as nature, spiritual and human.

For teachers to teach and learners to comprehend in science lessons, they should be aware of the environment and work with elders in the community to make use of relevant knowledge (Barnhardt et al. 2005; Phiri, 2008) of their pupils.

It is postulated that learners who live in two worlds develop the two knowledge concurrently (Carter, 2006, cited in Phiri, 2008). But the question then is "is this

hybridization of learning" or what Millar (2006) and Dziva, Mpofu and Kusuure (2011) will term as "co-existence" and "co-exist" respectively. Phiri (2008) contended that the margin of western modern science denies learners the opportunity to co-learn western modern science with indigenous knowledge system. Since there is no one community under this sun which can live independently, the co-existence of the two knowledge system is good. But this will depend of the magnitude of the co-existence if one do not supress the other.

Indigenous science is possible in school curriculum if there is political will on the part of governments. Research conducted by Sundar, (2002, cited in Phiri (2008) in two India projects revealed that the Vedic because of the Hindus rights and political power were able to include their beliefs into the certified knowledge backed by Vedic indigenous science. On the other hand, the Advias project failed because of political unwillingness to include it. Haverkort (2006) writing on "Dialogues Within and Between the Sciences: Issues and Strategies From Endogenous Perspective" stated that the position of power (political power) in science with regard to the north and south divide is not anything good to write home about.

George (1999) affirmed that the use of indigenous knowledge in the classroom is not simply because it is not 'packaged'. On the other hand, indigenous knowledge is possible if the government takes full control with legislative backing. Government interest in policies / projects are legislated. This ensures that implementers of the policies do not go outside the confirms of the policy.

Thomas (2003) studying Keiyo science reiterated that much of science is found in peoples' language which science teachers need to explore. Thomas (2003)

therefore admonished science teachers to be in constant touch with the community (especially elders) to help in the teaching of indigenous science in the science curriculum.

George (1986, cited in George, 1999) a study conducted in Trinidad and Tobago suggested that indigenous knowledge could be used in conventional science by giving the following category of examples:

i. using lime juice and salt to remove rust stains from clothes in terms of acid/oxide reaction;
ii. 'vervine' (*Stachyeroheta*) brew used in treating worms in children has components of medicine;
iii. sweet food causes diabetes like diabetes linked to sugar; and
iv. cutting hair in full moonlight will grow back to an increased length.

Using the four categories of learning, George (1999) stated it could be related to indigenous knowledge associating with indigenous technologies used in the community.

i. Category three can be explored by students but the point of departure should be stressed, that is sweet food causes diabetes;
ii. Category two could be beyond the student ability but highlight the fact that there is much to be explored in the world that is 'vervine' brew use in treating worms; and
iii. Category four draws on knowledge from different knowledge systems that are cutting hair in full moonlight will grow back to an increased length.

This issue is said to be beyond the understanding of the pupils. This is, therefore, the point of departure of western science and IKS.

Stanley and Brickhouse (2001) contended that to provide science education for non-western, apart from epistemological and moral factors political factors have to be considered.

The science teacher in the community should understand their worldviews and use them in the science lessons. They should understand the relevance of IKS both at the concepts and principles and at the level of presuppositions that guide actions. George (1999) and MOESS (2007) the science curricula at the lower level are designed to serve as building blocks for those who will continue it to the secondary and university levels. The science curriculum of basic schools in Ghana is in line with the assertion of George (1999). The syllabus makes provision for further studies of those who will be interested in science education at a higher level.

One thing observed by Cobern (1991) cited in McKinley and Stewart (2007) is the issue of a worldview which seeks to explain multiple perspectives on knowledge and knowledge systems used in the nature of science and scientific theory caused by science educators.

George (1999) suggested that in the training of teachers it should highlight conventional science as one way of knowing which serves to explain and predict but need to be encouraged to develop understanding and appreciation for traditional wisdom and its characteristics. “The ultimate goal (*science education*) is to facilitate the empowering of students with the indigenous knowledge base to understand and evaluate what conventional science has to

offer and to make judicious choices between the indigenous knowledge and conventional science when the situation arises" (George 1999, pg. 92) [Emphasis added].

Education reforms in Africa are anchored on equity and social justices to provide critical mental conscientization. According to Dei (2003) "the education reforms in the 1980s and 90s were intended to address the northern / western European elitism to content of Ghanaian knowledge need" (pg. 370). Shizha (2010) did not depart from Dei (2003). He stated that innovation (reforms) after independence did not focus on culture and the place of learners in science.

Thus Dei (2003) proposed critical teaching in schools. He enthused that critical teaching will interrogate the four characteristics of valid knowledge on-going in schools (Hatcher, 1998, cited in Dei, 2003) as students are not empty vessels to be filled with knowledge (Dei, 2003). Dei referred to the four characteristics to include abstract universalism, decontextualization, consensualism, and marginalization.

Dei (2003) and Grenier (1998) reported that in a science lesson (making soap) the teacher makes use of local materials like palm oil, coconut, plantain peels and ash instead of the imported materials (oil). One way of destroying 'oppositional knowledge' is a denial of authenticity and indigenous identity (Dei, 2003; Barnhardt et al. 2005). This has been the case in IKS in the science curriculum. A study of the science syllables of the JHS reveals that IKS for that matter indigenous technology has not been included in the science curriculum.

Stanley and Brickhouse (2001) further stated that it is practicable to integrate specific technologies or ideas across cultures but the integration of large, explanatory frameworks and philosophies is not possible. They stated instead of showing students the differences between indigenous knowledge, traditional environmental knowledge, and western modern science, they would rather approach it as different views of science rooted in certain cultural assumptions that affect how they formulate and solve challenges (Stanley and Brickhouse, 2001).

Jegede (1999) contended that there are five socio-cultural predictors which influence the teaching and learning of science: authoritarianism, goal structure, traditional worldview, societal expectation and sacredness of science. In the traditional setting, adults are seen as authoritarians and therefore not questioned when they speak. It is believed that some indigenous knowledge practices are scared and only some families/individuals/ institutions practice it.

Often a learner's understanding of any new meaning is strongly influenced and determined by prior knowledge that is in turn determined by cultural beliefs, traditions, and customs governed by a worldview. More importantly, as such, Africa pupils construct their understanding of nature on a daily basis using their worldview as prior knowledge (Aikenhead, 1997; Dziva, Mpofu and Kusuure, 2011; Kaino, 2013).

Ocholla (2007) identified six steps to be taken in order to integrate indigenous knowledge with other knowledge systems. These are: recognition and identification; validation / affirmation – identifying its significance, reliability, relevance, transferability and effectiveness; codification / recording /

documentation; storage for retrieval – development of indigenous knowledge repositories requiring taxonomies, database, indexing and preservation for easy access; indigenous knowledge transfer; and dissemination and use of indigenous knowledge.

Dziva, Mpofu and Kusuure (2011) "Teachers conception of indigenous knowledge in the science curriculum in the context of Mberengwa district, Zimbabwe" observed that pupils traditional beliefs hinder the study of modern science.

Owuor (2007) writing on "Integrating African Indigenous Knowledge in Kenya's Formal Education System: the Potential for Sustainable Development" contended that Kenyans education context recognize the need to address deficiencies of knowledge development that is formulated in western contexts. He further stated that the integration of local knowledge that is more appropriate to the needs of the indigenous communities is hoped that local problems can be addressed effectively (Owuor, 2007).

2.9 Education And Curriculum

The concepts education and curriculum are been discussed in the ensuing sub-headings. These are discussed in relation to the study.

2.9.1 Education

In its broader sense, Dei (2002) defined education as "the varied options, strategies, and ways through which people come to know and understand the world and act within it" (pg. 3).

Some explanations of education as writers tried to avoid defining education are excerpts from Banda (2004: pp. 24 - 25) which scholars have attempted to explain education:

> We infer that education is the process of bringing up children by adult members of the family and the society, a process of rearing children, a process of guiding, directing and educating children (Masango et al. 2000: 19).
>
> In day's world, education has come to be linked with economic progress, transmission of culture from one generation to another, as well as the development of intelligence (Carmody, 2004:x) [objectives and purpose of education].
>
> Educated persons are those who can choose wisely and courageously under any circumstance. If they have the ability to choose between vagueness and vulgarities, regardless of the academic degrees they have, then they are educated (Khera, 2004: 22) [outcome of educations or product of education]
>
> To be educated is not to have arrived at a destination; it is to travel with a different view (Peters, 1973:107) [Education as a system].
>
> Education refers to a sum total of structures [or system] whether in a country or group of countries or at a particular time, whose purpose is to educate pupils, which function according to more or less precise rules (Mialaret, 1985:14) [Education as a

system].

Other scholars look at education in its holistic form. Mahmoudi, Nasrabadi and Liaghatdae (2012) defined it as "an approach to pedagogy that can meet the needs of all types of learners, that can be a source of fulfillment and gratification for teachers, and that prepares future citizens who will contribute a concern and mindfulness for others, for their communities, and for the planet" (pg. 185).

Thaman (2000, cited in Kano, 2013) argued that education cannot exclude cultural knowledge since the content of education has value underpinning it, associated with a particular culture – a way of life that includes particular ways of knowing, knowledge and wisdom, as well as ways of communicating these. Education, therefore, is the transmission of culture and what is taught to any society young ones may be their own in combination(s) with other cultures. Sometimes this dual or co-existence with IKS is submerged in western modern knowledge (Millar; 2005; Barnhardt et al., 2005).

From the above explanations of education, USAID (1998) concluded that education is to provide essential values, knowledge, and skills to a country population in so doing have a long-term impact on country's human resource base while providing individuals greater control over their lives.

For education to take place (formal education) there must be a school. An effective school is one where children are fully engaged in the process of learning and can be judged by the level of designated skills, knowledge and disposition its students master over a given time (USAID, 1998). In this sense, the skills and knowledge learnt are tested or examined after a specific period of time through a standardized test system. This given time is usually in terms of

the school calendar year which is guided by the curriculum. It further also stated that the characteristics of an effective school include the following:

> a school climate with high expectations from children, capable, motivated teachers; strong leadership, high learning time, and an organized relevant curriculum; effective learning and teaching strategies variety in teaching methods and materials; integration with children experience and culture; and frequent assessment of students learning and feedback. Supporting condition and input: counting involvement and support; nourishment and healthy children who are ready to learn; functioning government policies on school management, financing, resources and evaluation, a qualified teaching staff; adequate materials and school facilities and regular supervision and professional support for teachers (Heneveld, 1994 cited in USAID, 1998).

Idiata (2006) summarized the characteristics of western education as “school is a structure very far away from the concerns of the community” (pg. 79). Dei (2003) and Idiata (2006) therefore concluded that the school has produced graduates who are foreigners to their environment. Idiata (2006) posited that western school does not create know-how (expertise) nor good manners, schools train people to assume careers, generating social apartheid and extrovert structure. This is true as ‘school leavers’ have lest reverence for their culture while adoring the ‘masters’ own.

From the foregoing discussions, education is not peculiar to any single society, country or continent. Education is therefore is a life-long process

which usually begins from birth, acquiring knowledge and skills which are functional for the individual development and the society as a whole.

2.9.2 Curriculum

Various scholars explain or define a curriculum to suit their situation and for that matter, there are varied explanations or definitions of the term curriculum.

"The curriculum – taught and untaught – represents the totality of experiences of the child within schooling (aims, content, pedagogy, assessment). It includes unassessed and uncertificated elements including opportunities to acquire vital 'personal' and 'social' capital" (Oates, 2011, cited in Biddulph, 2013: 133). Therefore curriculum is a 'human creation' serving a range of needs and purposes reflecting and responding to needs of society (Margon and Lambert, 2000 cited in Biddulph, 2013). From the perspective of Margon and Lambert, the curriculum should be dynamic in nature and respond to societal needs at any particular time in a country (Dei, 2003).

John Frederick Dewey (1859 – 1952) argued that effective education needed a curriculum that starts with the capabilities and interest of students and learning is essentially a social and interactive process (Biddulph, 2013: 137). This is in line with the constructivist theory of learning where learning is a social process of interaction (Stanley and Brickhouse, 2000). This research investigates the possibility of the child using the knowledge acquired at home (indigenous knowledge system) in the science classroom.

In addition to the above explanations John Kurr "all the learning which is planned and guided by the school, whether it is carried out in groups or individually inside or outside the school" cited in Biddulph (2013).

Smith (2000) identified curriculum as 'a product' which is an objective-led approach to curriculum design and Graves (1979) objective-led curriculum a linear model of curriculum planning presents education as means by which to change behaviours (cited in Biddulph, 2013). The purpose and aim of education are to change the behaviour of the youth (children) to the desired of society in which the children are found and the world as a whole so that they would contribute to the development of the society too.

Lawton (1974, cited in Kaino 2013) defined curriculum as "a selection of the best of a culture, the transmission of which was so important that it was to be entrusted to specially prepared teachers to handle the curriculum from the same culture".

The curriculum, therefore, is all the planned and unplanned activities society intends to impart into their younger generations to preserve, conserve and modify the culture for a harmonious society.

2.10 Science Curriculum For Junior High Schools In Ghana

Before delving into science curriculum the concept of science and curriculum have been discussed in science or sciences and curriculum. In this study, science syllabus and science curriculum are used interchangeably.

To begin a review of the science syllables, suffice to quote from Ryan (2003, cited in Dziva, Mpofu and Kusure, 2011: 90) "Curriculum development in some

developing countries is being undertaken as a global project rather than inclusive of the needs, policies, and cultures of the host nation".

UNESCO Science Agenda – Framework for Action, 3.4 "science and other systems of knowledge" 83 and 85 have these statement: 83: "Governments are called upon to formulate national policies that allow a wider use of the applications of traditional forms of learning and knowledge, while at the same time ensuring that its commercialization is properly rewarded" and 85: "Countries should promote better understanding and use of traditional knowledge systems, instead of focusing only on extracting elements for their perceived utility to the science and technology system. Knowledge should flow simultaneously to and from rural communities".

It is of interest to note that the integrated science curriculum (syllabus) developed by the Ministry of Education Science and Sports (MOESS, 2007) followed the western science (western modern science [WMS]) orientation. The focus, therefore, was on the creation of a "scientific culture" in line with the country's strategic programme of achieving "scientific and technological literacy" in the shortest possible time. Scientific culture should, therefore, become the common property of every citizen of this country because it is the antithesis to superstition and the catalyst that will help us towards a faster development.

The syllabus further stated that:

> A conscious effort to raise the level of scientific literacy of all students and equip them with the relevant basic integrated

scientific knowledge needed for their own survival and for the development of the country. It is also expected that scientific experiences in JHS will cultivate in pupils an interest and love for science that will urge some of them to seek further studies in science as preparation for careers in science. The study of science will also provide excellent opportunities for the development of positive attitudes and values:

- curiosity to explore their environment and question what they find;
- keenness to identify and answer questions through investigations;
- creativity in suggesting new and relevant ways to solve problem; and
- love, respect and appreciation for nature and desire to conserve natural balance (MOESS, 2007 pg. ii).

Creativity and suggesting new and relevant ways to solve problems as values to be instilled in the pupils presupposes that pupils knowledge in the environment by the use of IKS would be appropriate if allowed in the teaching and learning and final their examination purposes.

The aims of the science syllabus are ten in number. Among them of interest to the research are:

1. develop a scientific way of life through curiosity and investigative habits;
2. appreciate the interrelationship between science and other disciplines;

3. use scientific concepts and principles to solve problems of life;
4. recognize the vulnerability of the natural environment and take measures for managing the environment in a sustainable manner; and
5. take preventive measures against common tropical diseases.

Going through the JHS syllabus it was surprising to find out that no mention was made of indigenous knowledge or indigenous science.

Not undermining the above statement, one good thing about the syllabus is its spiral approach adopted for the study of science. The spiral approach affords the students opportunity to learn concepts and skills at different levels with increasing depth that matches with their cognitive development (Stanley and Brickhouse, 2000; MOESS, 2007).

The five themes in the syllabus include the diversity of matter (living and non-living things), cycles, systems, energy and interactions of matter. These themes are actually broad enough to provide the basis for further studies of science.

The syllabus recommended team teaching as teachers did not have requisite skills to teach integrated science. Most teachers in the pre-service were trained as chemist, physicist, biologist, and agriculturalist and for that matter, there was the need to train teachers to teach integrated science. This was a recommendation by the Ministry of Education Science and Sports in support of teachers to acquire the necessary skills and knowledge to impart in their pupils (MOESS, 1985).

2.10.1 Strengths of the Science Curriculum

The science curriculum developed in 2007 for the current JHS system has a number of good things that the research would point out at this stage. In 3.2.2 (of the first year, T/LA students were to plan a 3-year crop rotation programme and local crops were mentioned as yam, millet, tomatoes, cowpea to be used.

In year two 1.2.2 content on non-reactive metals, students were to visit a goldsmith at his / her workshop to observe what goes on there.

In year three 5.2.3 an objective: analyse the role of technology in industrialization. The T/LA, students were to discuss the effect of technology on traditional cultural practices e.g. habits, healthcare delivery, farming practices, source of energy, sanitation, religious strength and practics etc. This was good but whether teachers will be able to handle as most teachers may not have deep cultural knowledge (Rahman, 2000).

2.10.2 Weaknesses of the Science Curriculum

Despite the good intentions of the science curriculum to develop and instill scientific knowledge and skills into pupils, the following could be pointed out which are not in favour of SIKS.

Ghana Education Service in the implementation of the new reforms which saw JSS metamorphosed into JHS in the then President Kuffuor administration the science education in the JHS is silent about indigenous / traditional knowledge / science in the science curriculum.

The syllabus remarkably ignored IKS in almost all of its examples given. The first year 1.1.3 Teaching / Learning Activities (T/LA) in the purification of water when there is an outbreak of disease used a white cloth. There are traditional methods of purifying water in small quantities which are not mentioned for cooking and drinking.

MOESS (2007), science syllabus stated that "Improve science education at all levels and in all aspects of the educational system, especially at the basic and secondary levels" (pg. 22). The policy statement acknowledged the improvement of science education but no mention is made of indigenous science. The policy was therefore a confirmation to the Euro-American model of education which sees only the 'truth' (Tinnaluck, 2004) coming from the western modern science.

Dei (2002) and Millar (2006) contended that the integration of indigenous knowledge into western academies is to recognize the co-existence of knowledge and complement each other. The knowledge could also be in conflict as there are from different epistemological entities (Ocholla, 2007; Dziva, Mpofu and Kusure, 2011).

2.11 IKS And The Ministry Of Health Policy

The Ministry of Health sector medium term development plan 2014 – 2017 (Republic of Ghana, 2014) there was a concerted effort to indigenous / traditional medicine with orthodox healthcare. One of its strategies adopted was "scale up the integration of traditional medicine into existing health service delivery system" (Republic of Ghana, 2014). In the Wa Regional Hospital, there is a poster with an inscription "Traditional Medicine is available in

consulting room 5". The World Health Organization (WHO) defines traditional medicine as "the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness". In some of the healthcare institutions (hospitals/clinics), traditional healers are attached. For an example is the bone setting at Duong and Gwollu in the Upper West Region. The people into these healthcare (traditional) are usually the elderly. The young ones who are now schooling should be given the opportunity to learn the IKS. One does not dispute the fact that IKS are not taught in the school, but the depth is negligible. Millar (2006) asserted that African indigenous sciences are found in all spheres of life including the arts.

2.12 IKS And Western Science (Knowledge) Comparison

So far the literature has revealed a number of commonalities and divergence in IKS and western science (Tinnaluck, 2004; Millar, 2006; Banda, 2008; Barnhardt, et al, 2005; Dei, 2002). The table below shows some differences in indigenous systems knowledge and western science.

Table 2. 1 Differences Between IK and WS

Indigenous knowledge	**Western science**
Local: is rooted in a particular community. A set of experiences generated by people in the community.	**Universal or global:** the knowledge generated in modern scientific institutions and some industrial firms. This knowledge has the same 'universal truth' no matter where it is.

Tacit: embedded in people who generate it and use it. Hence, it is difficult to capture and codify this kind of non-formal knowledge.	**Explicit**: The knowledge has been noted for its rigorous procedures of creation through observation, experimentation, and validation. These procedures could be specified and put into instruction easily.
Transmitted orally: rarely recorded in written form. It is transferred through imitation or demonstration.	**Transmitted in written form academic and schooling system**: As the knowledge is produced and carefully documented, it can be taught via the formal education system.
Experiential rather than theoretical knowledge: derived from experience and trial and error. It is tested through time in "social laboratory of survival of local communities"	**Theoretical knowledge**: Knowledge is derived from hypotheses and scientific methods. Studies have been made in laboratories or with scientific or mathematical models.
Loaded with spiritual and social values: Spirituality is an important and inseparable dimension of IK. Subjectivity takes the role. Nature is revered as mother or provider of all things.	**No spiritual values:** It separates attitudes, beliefs or cultural dimensions from the knowledge creation process. Objectivity is the approach. Nature is to be conquered or mastered.
Holistic approach: Humankind is considered part of nature. Natural tendency towards equilibrium is the central theme of IK.	**Compartmental approach:** This system of knowledge breaks down matter for a study into the smallest components in order to reach into the deeper and hidden facts of what is being studied.

Adopted from Tinnaluck (2004)

George (1999) corroborated with Tinaluck (2004) about the differences between indigenous knowledge and western knowledge with some minimal significance which is IKS are not generated by planned procedures and rules.

In a study conducted by Banda (2008) 'Education for all (EFA) and the African Indigenous Knowledge System (AIKS): the case of the Chewa people of Zambia' found out that the gap between the school and the community of the Chewa people are tabulated below.

Table 2. 2 Gaps Between Chewa AIKS and the Formal Education

Specific areas where the gaps manifest themselves	**Perceived dangers gave by majority of the respondents**
• Two contradictions – school and community cultures • Lack of collaboration between a) teachers and parents b) pupils and their parents c) pupils and the immediate environment • Breakdown of Chewa family values • Lack of community involvement in school	• The child is ever negotiating between the two cultures and being rejected by both • Chewa AIKS is considered inferior by the elite, some teachers, pupils, and parents preference to perceive rewarding formal school • No agreement between teachers (the 'educated' and performers) and parents (the illiterate and spectators) • Some aspects from formal school harmful to Chewa AIKS • Environmental knowledge of pupils is ignored • Loss of the Chewa culture (local and limited) in preference to the formal school one (modern and universal)

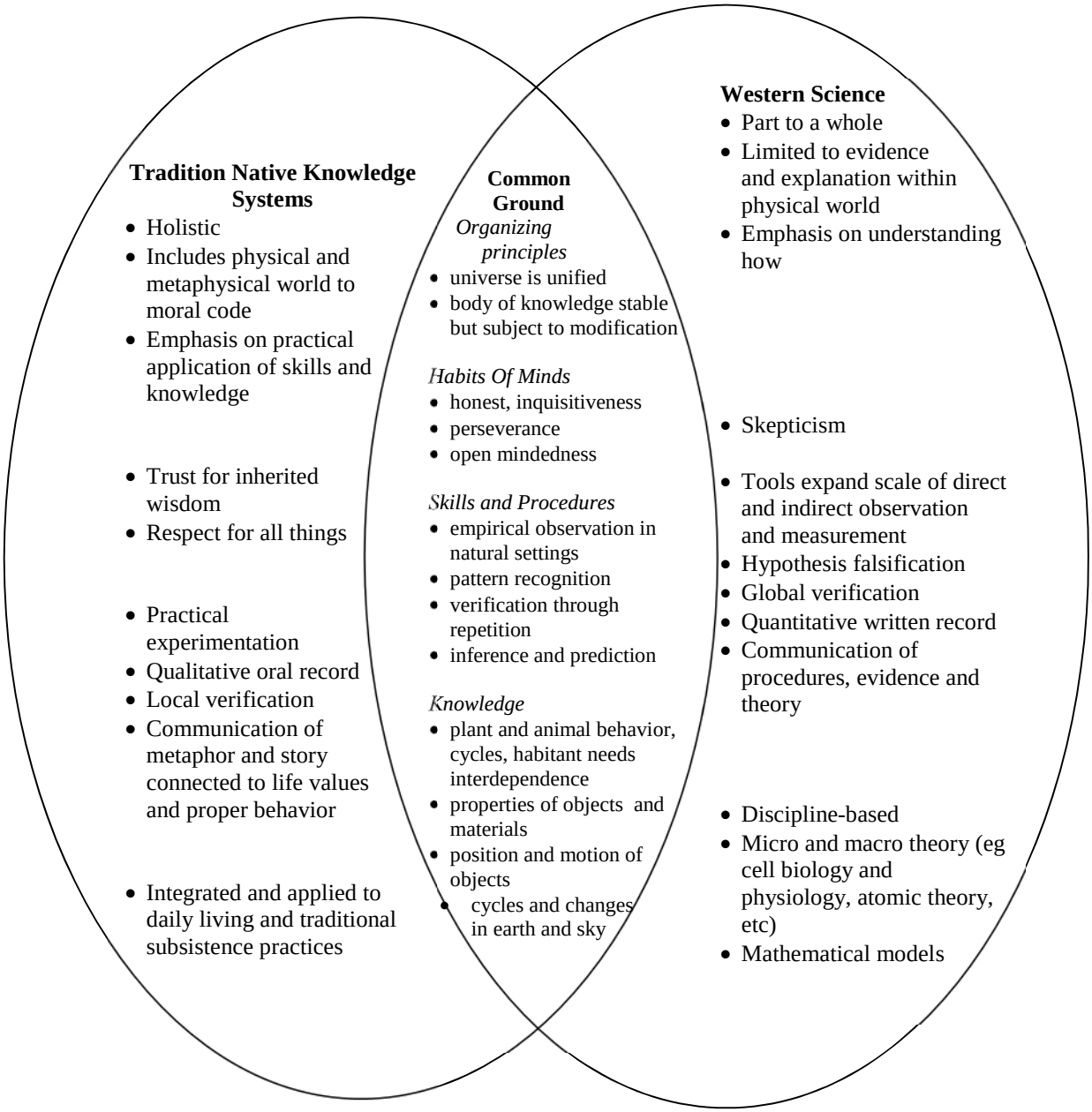
discipline and programmes • Irrelevant curriculum • Varying and sometimes contradiction purposes for schools among various partners • Both school and Chewa AIKS have rigid principles and treat their forms of knowledge as 'truths'	• A child could be half-baked in both forms of education • Conflicting ideas may make children lose interest in both forms of education and even cause tension • Divided community and school into the educated and uneducated • Divorce pupils from communities they are meant to serve • Ignore knowledge on practical, occupational and life skills acquired informally could be forgotten • Pupils feel shy practicing Chew AIKS • Pupils treating parents and community ignorant

Adopted from : Banda (2008)

2.13 Framework For The Integration Of IKS Into The SC

In almost all research works, there is a benchmark which is used – framework. The framework is mostly used as a guide in conducting the research which helps to delimit it to specific areas. The research made maximum use of Barnhardt et al. (2005) qualities associated with traditional (indigenous) knowledge systems and western science.

Figure 2.2: Converging and Diverging Points of IKS and Western Science



Adopted from : Barnhardt et al., 2005

Writing on 'IKS and the Alaska Way of Knowing' Barnhardt et al., (2005) acknowledge that indigenous people are rethinking their role and seek to blend their way of knowing with new practices from the west. The major limitation of this research was lack of expertise IKS and western experience in science for advance progress. To this setback, the University of Alaska Fairbank,

introduced courses at the master's level to include IKS. This collaborative studies brought together the communities and the school for exchange programmes. This epitomized the power of IKS in formal education.

Figure 2.2 above will be used extensively in this research. The common grounds – organizing principles, habits of minds, skills and procedures and knowledge are of great importance in unveiling the integration of the science curriculum in the basic schools in the Nadowli District.

Knowledge is continually evolving as it comes into contact with other knowledge (people), the non-common grounds as identified by Barnhardt et al. (2005) was of immense concern to the study.

2.14 Conclusion / Research Gaps to Address

The chapter delved into the available literature to make an informed decision on areas that had not been tackled and also areas that will help in the current research. Philosophical theories of learning, indigenous knowledge system, indigenous science, western science, differences and similarities between IKS and western science and framework of action for this research have been studied. Furthermore, the study of the science curriculum of basic schools has revealed the lack of inclusion of IKS in the current science curriculum.

There are researches in IKS (Dei, 2002 and 2003; Millar, 2005; Haverkort, 2006; Banda, 2008). These researches especially Banda (2005) using the EFA model to achieve education for all using the Chewa AIKS of Zambia. However, in Ghana, much of the researches are not on integration or non-indigenization of IKS into the science curriculum. This research, therefore, tries to indigenize

the science curriculum of the JHS system in the Nadowli district. The education reforms in Ghana at the basic level since 1975 from the experimental JSS to JHSs in 2007 have been entrusted some amount of management and supervision in the community (School Management Committee – SMC) and Parents Teachers Associations (PTAs) and other local experts in the delivery of the curricula.

The significance of the research with its main objective to examine the factors that account for the non-indigenization of scientific IKS into the science curriculum of the JHS is the first of its kind in the JHS science curriculum. While other researchers have focused on parents, teachers, and pupils, this study included traditional leaders (chiefs) and persons with expert knowledge in scientific IKS perceived by many Ghanaians as custodians of our heritage and traditional healers. Otherwise, many research works aimed at answering the question 'what is AIKS and why it continues to exist despite in contact with other cultures'? This research goes further to look at whether the inclusion of scientific IKS in the science curriculum could enhance the understanding and further studies in scientific indigenous knowledge system in the future.

Moreso, it sought to find out frameworks that could be used to integrate the science curriculum. This research could not have come at a better time than this since education reforms continue to take the western model leaving the beneficiaries at bay. It could be a turning point in reforms focusing on science curriculum been indigenized.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter was the methodology used to carry out the study. There are a number of methodologies open up to social researchers. Any one of them may depend on the cost, reliability validity and even convenience. The study used the qualitative methods. According to Flick et al. (1991, cited in Sarantakos, 2005) is used when:

i. There is the need to study reality from the inside'
ii. There is the needed to capture 'as it is', that is, interaction
iii. The researcher intends to present the information gathered, not as number or formulae but verbally, in detailed and complete form (pg. 134).

Research methodology is to follow procedures and techniques in an attempt to ascertain what the research intends to add to knowledge or reaffirms existing knowledge (Dordah, 2013).

This chapter would therefore look at profile of the district (Nadowli District) – location, demographic structure, and educational infrastructure. The research design – target population, sample size, sampling technique, sources of data, data collection techniques and instruments, data analyses and ethical considerations.

3.1 Profile Of The Study

The profile of the study area is into three folds – location, demographic information and educational infrastructure. The location of the study area is in the proceeding sub-heading.

3.1.1 Location

The Nadowli District was one of nine districts of the Upper West Region now divided into two districts – Nadowli-Kaleo and Daffiama-Bussie-Issah. It was created in 1988 by Legislative Instrument (LI) 1437. The district capital, Nadowli, is linked to Wa the Regional Capital by a 50 kilometer-tarred road stretching from Jirapa District to the Wa Municipal Assembly.

The district lies between latitude 10˚05'00'' N and 11˚0'00'N and longitude 2˚44'00''W and 2˚15'0''W. The Nadowli-Kaelo District is bounded by the Jirapa District to the north, Wa Municipal to the south, Daffima-Issah-Bussie District to the east, and the Black Volta to the west (see Appendix A page 138).

The vegetation of the district is Guinea Savannah. This consists of grasses with isolated trees such as the shea trees, dawadawa, and acacia. Shifting cultivation has given way to intensive cultivation and overgrazing, especially around major settlement as well as bushfires have destroyed the original vegetation in most places of the district leading to farmers farming on marginal lands. Of late most animals (cattle, sheep, and goats) are being stolen which leaves most farmers not wealthy (Millar, 2006) as farmers count animals as wealth. However, there is enough evidence of a major effort by the district at re-aforestation (Nadowli District Assembly, 1998).

3.1.2 Demographic Information

The 2010 Population and Housing Census put the population of the district at 94,388, made up of 44,714 males and 49,664 females with a share of 13.4% of the region population (Ghana Statistical Service, 2014). The average population density is thirty-one (31) persons per square kilometer. About 45% of the population falls within the age 0-14, 49% making up the active economic group with 6% being the aged (Ghana Statistical Service, 2014).

3.1.3 Educational Infrastructure

The district is one of the deprived in the region in terms of educational infrastructure. It has a total of six (6) Senior High Schools (SHS) public including a community owned one. There is a College of Education established known as McCoy College of Education. Also, there is a Youth Development Centre at Issah. Furthermore, there is a Minor Seminary (MS) (St. Michael) at Kaleo for first and second year formation. There is a Catholic Sister's convent at Daffiamah which train girls in vocational skills. According to the Nadowli District Education Office (2011, 2012 & 2013), there are forty-seven (47) JHS in the district and eighty-eight (88) primary schools. With the new educational policy of every child attending kindergarten before primary one, there has been an increase in the number of kindergartens to seventy-eight (78) almost the same number as the primary schools.

The following statistics from the Nadowli District Education Office (NDEO) in 2011 show the state of the enrolment in the district. In 2010/2011 academic year, pupils population stood at 7,384, 18,680 and 5,809 for kindergarten, primary and JHS respectively. The teachers were 119, 427 and 271 for the

kindergarten, primary and JHS respectively. In all, there are eight hundred and seventeen (817) teachers comprising four hundred and sixty-three (463) professionals and three hundred and fifty-six (356) non-professionals (Nadowli District Education Office, 2011). The national report on education shows a slight difference in the figures which is very negligible (MOESS, 2012). The JHS has a total of two hundred and seventy-one (271) teachers, only one hundred and eighty-five (185) are professionals (Nadowli District Education Office, 2011) while GES (2011) puts it at 188 in the 2010/2011 academic year. With reference to the teacher-pupil ratio, it was twenty-two (22) which is not a good statistic compared to 19 and 17 for regional and national respectively (MOESS, 2012). Further comparison of the teacher-pupil ratio in 2006 to that of 2011 has worsened as twenty-six (26) against 39 (MOESS, 2012). Extracts from the 2010/2011 academic years indicated some imbalances in the professional teachers' distribution in the district. For instance, 1:76, 1:104, 6:151 and 10:247 that is, number of teachers to that of pupils Tabiasi, Dapuoh, Duong and Kaleo R/C JHS respectively. This is a gross and mismatch in the allocation of teachers in the district which is likely to affect pupils' performance at the Basic Education Certificate Examination (BECE).

The district is zoned into eight circuits for effective supervision and monitoring. These are Daffiama, Issah, Sankana, Kaleo, Charikpong, Takpo, Jang and Nadowli circuits. A substantive circuit supervisor was responsible for each of these circuits and reports directly to the District Director of Education (DDE) through the assistant director in charge of supervision.

3.2 Research Design

It is the basic framework outlining the interrelationship between various study activities required to effectively and efficiently address the main research question (Ahiadeke (2008). The study employed the descriptive method as naturalist research. Social scientists/researchers are opened to a number of research designs: exploratory, explanatory and descriptive designs (Singleton and Straits, 2005). However, the description design was much more appropriate. The descriptive design is factual, more structured, focus on few dimensions of well-defined entity and measures many in an orderly manner. Furthermore, the descriptive design describes the current status of a situation and it is also used for assessing the attitudes, opinions, and views of a group of people or individuals. The views, opinions and attitudes of the science teachers and the chiefs/elders and traditional healers were sought in the study. On the basis of these arguments, the study adapted a descriptive design.

3.2.1 Target Population

The population of the study was teachers in the Nadowli district. Since these categories comprise of KG, primary, JHS, Senior Secondary Schools and the vocational / technical institute teachers. The target population of the research was participants who have rich knowledge about the subject matter under study and will also add knowledge to the existing knowledge. In this regard, the target population was science teachers, chiefs/elders and traditional healers.

The study narrowed down the target population of the science teachers to only the science teachers in the district who are teaching at the JHS level. For the

chiefs/elders and traditional healers, they were also taken accordingly from the various circuits within the district.

3.2.2 Sample Size

In determining the sample size of any research, Sarantakos (2005) stated three methods of doing this which mostly depend on the quality and quantity or both. The three methods identified include non-statistical estimation, statistical computation, and tables. The table estimation is readily computerized table with the population estimation (*p*), the difference between them (*p*) and 100 (*q*), the chosen confidence level (Z) and the maximum deviation (E). Krejcie and Morgan (1970) cited in Sarantakos (2005) using the estimating sample table offer the simplest way of determining sample. For example, a population size of fourty-five (47) would have a sample size of 40 (Sarantakos, 2005 pg. 173).

Instead of considering the population of science teachers in the basic schools in the ND, that is forty-seven (47) JHS in the district but two had no science teachers making it fourty-five (45) science teachers. The researcher had a final sample size of forty-one (40) science teachers using the table estimation sample table. (see Appendix B, page 139)

The other target population was the chiefs/elders and traditional healers. A sample size of sixteen (16) – eight chiefs/elders and eight traditional healers.

Forty (40) science teachers, chiefs/elders eight (8) and traditional healers eight (8) making a grand total of fifty-eight (58) respondents were used for the study.

3.2.3 Sampling Techniques

Sampling techniques are ways of getting a sample for research or the purpose of achieving a certain goal / aim / objective. There are two main types of sampling techniques as probability and non-probability. Both probability and non-probability methods were employed intermittingly in the selection of the research participants.

The main reason for sampling is to enable a researcher to study a relatively small part of the target population and yet obtain the required information (Sarantakos, 2005; Singleton and Straits 2005, Cohen et al. 20211).

3.2.4 Purposive Sampling

The topic under study "IKS and science curriculum of basic schools in the ND of the Upper West Region of Ghana" used purposive sampling for almost all the research participants. In purposive sampling Creswell (2013) asserted that the units of the sample are selected not at random but they are intentionally picked for study because of their peculiar characteristics which are not randomly distributed in the universe but are typical or exhibit most of the characteristics of interest to study. The justification as espoused by the researcher was due to the nature of the topic under study. Indigenous knowledge system is in the custody of chiefs / elders and traditional healers (medicine men) and in the communities. The science teachers are also considered because they are the ones teaching integrated science in the schools.

The chiefs are custodians of tradition and therefore have in-depth knowledge of the scientific IKS of the community. Traditional healers were purposive for the

reason that they used scientific indigenous knowledge system in the treatment of their clients and are not evenly distributed in the entire population.

Since the target population was fourty-five (45) and the sample size forty (40) I had to apply the simple random sampling to get the forty (40) science teacher.

3.2.5 Simple Random Sampling

This method was used in the selection of the forty (40) science teachers in the district. In simple random sampling, the lottery method was applied. There were only forty five (45) JHS science teachers at the time of data collection. All the forty-five JHS names were written on pieces of paper with numbers 1 – 45. The numbers were then folded and kept in a basket. They were then randomly picked without replacing until the forty schools were gotten. The numbers were recorded against the schools. The science teachers in the schools were therefore automatic study participants.

3.3 Sources Of Data

This study made use of the two sources of data as secondary and primary. The Secondary source of data for this study included publications, articles, journals, archives and internet. The JHS science syllables was the main source of secondary data used in chapter four. The primary sources included in-depth interview (key informants) and questionnaire. Primary data was used to answer the research questions set out to be accomplished. With the use of content analysis, the syllabus served as both primary and secondary data.

3.4 Data Collection Instruments / Tools

There are number of data collection instruments available to researchers such are interview, observation, participant observation, key informant, questionnaire etc. The primary data from the chiefs/elders and traditional healers was collected using in-depth-interview / key informant guide and questionnaire for the science teachers. These two tools are discussed below.

3.4.1 In-depth Interview / Key Informants Guide

In-depth interview refers to a technique used to drive a vivid picture of a research participant's perspective on a topic / issue. It was conducted on face-to-face bases with the chiefs / elders and traditional healers. I used this tool because it allowed participants to talk about their personal feelings, opinions, and experiences. This questions were posed in a neutral manner/environment, listening attentively to participants' responses, and asking follow up questions and probes further based on those responses.

A checklist/interview guide was used for this in-depth interview and some participants' concerted to be recorded (voice recording). The recordings enabled the researcher to replay and helped in the analyses.

The initial stage of the interview was just to relax participants such that they feel free to give off their best in the discussion.

Three assistant researcher were trained to help in the in-depth interview of the chiefs / elders and traditional healers. The assistants were persons who come from the district could speak the local dialect (Dagaare) fluently.

3.4.2 Questionnaire

Questionnaires are data collection tool used in soliciting information from respondents. It is a form of a document containing a number of questions / items on a particular theme, problem, issue or opinion to be investigated. The questionnaires were only given to the science teachers in the study area who were the sample of study. These were used because of the following reasons:

i. the response rate was high
ii. teachers could answer the questions themselves with minimal explanation
iii. the questionnaire was organized systematically and sequentially around the central theme of the research.
iv. The questionnaire was deviod of ambiguity, simple and straightforward questions. Also, the items in the questionnaire were not difficult for the respondents considering their educational level.

A disadvantage associated with the questionnaire is the low response rate. This problem of low response rate was taken care off as circuit supervisors were used to deliver the questionnaires and the researcher made follow-ups. The respondents are known in their locations (schools) and the researcher was able to trace them through the circuit supervisors. Hundred percent retrieval was achieved.

The main types of questionnaires used in the study were – open /closed ended which are discussed below.

3.4.2.1 Open-Ended Questionnaire

Open-ended questionnaire or free-response allows respondents freedom to give their own answers to the questionnaire item the way they under it. This was used in assessing exactly what respondents know or feel about the integration of scientific indigenous knowledge system in the science curriculum. In effect, open-ended questionnaire were given to respondents to express their opinion.

The open-ended questionnaire permitted probing for more information and varying opinions or attitude on an issue. The probing was done by asking research participants to give reason(s) to some of the responses in the questionnaire. One disadvantage associated with open-ended questionnaire is the processing of the data as every item must be read and categorized. This was taken care-off by categorizing and coding before using the SPSS application to analysis them. Also, since the research was descriptive in nature the open-ended questionnaires allowed more explanation to the questionnaire items where necessary.

3.4.2.2 Closed-Ended Questionnaire

Besides the open-ended questionnaire, close-ended questionnaire sometimes called forced-choice. These items call for short quick responses with “yes” or “no”. The research did not only use the ‘yes’, ‘no’ but other alternatives were included in the questionnaires and if an alternative is not found ‘others or specify’. These involved a little bit of writing.

3.5 Data Analysis And Presentation

This research was qualitative and was best presented in a descriptive format. It relied on the description in the analyses and presentation of the research data. Also, it was not easy to have purely descriptive research without some amount of quantitative analysis. The Statistical Package for Social Sciences (SPSS) was employed in the analysis of the biodata of respondents (science teachers) and other items which were not qualitative in nature. As much as possible the open-ended items were categorized and coded for easy analysis by the SPSS. Some original texts were maintained intact wherever the situation demands especially the interview guide for chiefs / elders and traditional healers. The content analysis was used with the science curriculum (science syllabi) to answer the question "Are there scientific indigenous knowledge systems in the science curriculum/syllabi". Also, bar charts, graphs were used where it was deemed fit. The in-depth interview was transcribed presented in a descriptive format. Correlation and other statistical analyses were employed to establish the trend between professional science teachers and non-professional science teachers.

3.6 Ethical Considerations

The researcher had an obligation to respect the rights, needs, values, desires, interest of the research participants (Creswell, 2013). In order to achieve this ethical goal, the researcher did the following:

1. A letter was given to the district director of education to conduct the study in the district. As permission was granted by the district director of education, the science teachers' consent was sought for in the introductory part of their questionnaire. They were assured that it was

an academic exercise and it would not expose their identity. Their names were therefore not provided on the questionnaire. This then guaranteed accessibility to the science teachers.

2. Chiefs / elders and traditional healers were visited to get their consent for the key informant interview. As tradition demands, I went through the gatekeepers. I had to follow the protocols. I did respected their culture and norms. For the chiefs / elders and traditional healers accessibility was not easy. I had to persuade them to participate in the research and as tradition demands I had to part with 'cola' in the entry and after they participated. All in all, the purpose of the research was achieved.

CHAPTER FOUR
DATA PRESENTATION AND ANALYSIS

4.0 Introduction

This chapter presented the data which was collected in the field from research respondents – science teachers, chiefs / elders and traditional healers using the interview guide and questionnaire. The various themes in the research are presented in a logical manner. The raw data from the field are presented in tables, frequency tables and other statistical figures which are relevant to the discourse. In-box text were also used when the need arises. The first section of the presentation discusses the biodata of the respondents who were used in this research.

4.1 Biodata Of Respondents (Science Teachers)

The biodata of the respondents (science teachers) comprised sex, religious background, certificate obtained in teaching, certificate of competency in teaching, length of being in the teaching profession and length of teaching integrated science.

4.1.1 Sex of Respondents (Science Teachers)

The sex of the respondents (science teachers) is presented in a frequency table as shown in table 4.1 in the next page.

Table 4. 1 Sex of Respondents (Science Teachers)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	37	92.5	92.5	92.5
	Female	3	7.5	7.5	100.0
	Total	40	100.0	100.0	

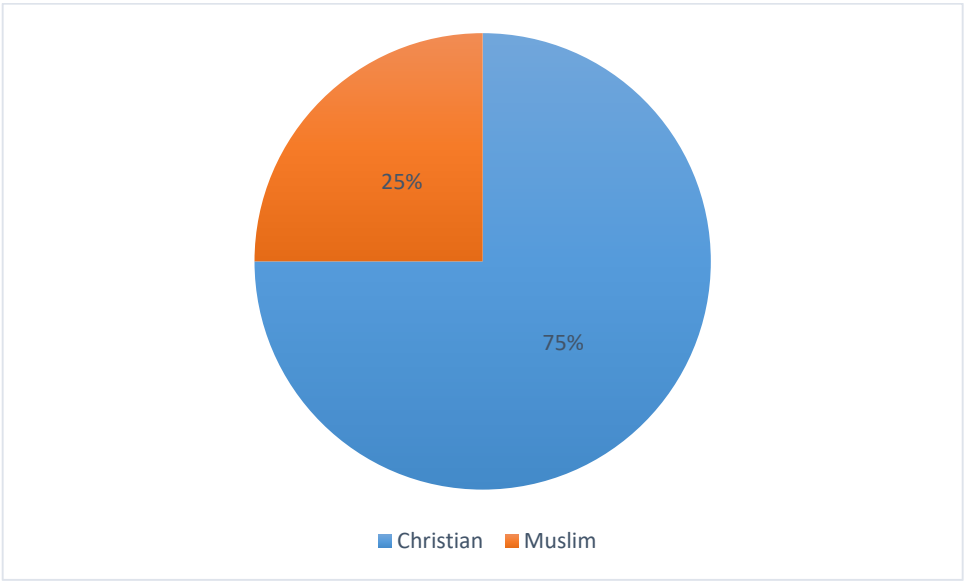
Source: Field Data, October 2014

From table 4.1, 37 of the respondents were males representing 92.5 percent and three females representing 7.5 percent. This is an indication there are more males teaching science than their female counterparts in the study area at the JHS level. More females should be encouraged to do science at the colleges of education or at the universities. The Governement of Ghana (GoG) has taken science and mathematics very serious as there are annual events/programmes dubbed Science and Mathematics Clinic for Girls.

4.1.2 Religious Background of Respondents (science teachers)

Christians are the majority of the science teachers in this study area with 30 (75%) respondents and Muslims 10 (25%). No other religion was mentioned in this study which confirms that majority of science teachers are either Christians or Muslims but it has been dominated by Christians in this research. Figure 4.1 depicts the religious background of the respondents in this study.

Figure 4. 1 Religious Background of Respondents (Science Teachers)



Source: Field Data, October 2014

4.1.3 Qualification of Respondents (Science Teachers)

This expands to include all certificates which the respondents have acquired to enable them join the teaching profession. The highest qualification was masters in education and the least being WASSCE/SSSCE/GCE 'O'/ 'A' level holders. These were further categorized into professional and non-professional. Table 4.2 illustrates this information about the science teachers in the JHS of the ND in the Upper West Region of Ghana.

Table 4. 2 Qualification of Respondents (Science Teachers)

Qualification	**No. of Teachers**	**Percent (%)**
Professional	31	77.5
Non-Profession	9	22.5
Total	**40**	**100**

Source: Field Data, October 2014

From table 4.2, 77.5 percent are professional teachers with 22.5 percent are non-professional teachers. Among the professional, 11 of them were holding first degrees and the twenty (20) holding diploma in education. This shows that most of the teachers are diploma holders who might have gone to do top up to get diplomas or might have gone to the Colleges of Education which started the diploma programmes in 2004 and the first batch was produced in 2007. The government policy of updating non-professional teachers to professional teachers or getting rid of non-professional teaching may be yielding results as there are few science teachers who are non-professional.

In order to know the strengths and weaknesses of these teachers who teach integrated science in JHS, a question was posed of their competencies acquired in their course of education which enables them to teach science. This point is discussed in the next sub-heading under a certificate of competency.

4.1.4 Certificate of Competency

In the Ghana Education Service, teachers are expected to specialize in an area of competency. The universities, especially University of Education – Winneba, and University of Cape Coast were established to train teachers for the first and second cycle institutions and any person who does education have major and minor subjects of competency. These are illustrated in table 4.3 in the next page.

Table 4. 3 Certificate of Competency in Teaching

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Vocational/technical	5	12.5	12.8	12.8
	Science	26	65.0	66.7	79.5
	Social Studies	2	5.0	5.1	84.6
	Others	6	15.0	15.4	100.0
	Total	39	97.5	100.0	
Missing	System	1	2.5		
Total		40	100.0		

Source: Field Data, October 2014

Table 4.3 presents courses of competency of the science teachers in the JHS of Nadowli District in the Upper West Region. 65 percent (26) teachers had their competencies in the sciences which included agricultural science, integrated science, mathematics, physics, biology, and chemistry. The rest of the 32.5 percent (13) was shared among vocational/technical, social studies and others inferred from table 4.3. With these competencies acquired in their training as science teachers they are expected to translate into results (BECE) especially integrated science all things being equal barring other factors which might hinder progress.

The proceeding subtitle discusses how long the science teachers have been in the Ghana Education Service.

4.1.5 Teaching Experience and Number of years Teaching Integrated Science

A cross tabulation use using in determine with there is a correlation between between the number of years in the servive and how long one has been teaching integrated science. The results are tabulated in table 4.4 below.

Table 4. 4 Teaching Experience and No. of Years Teaching Integrated science

		How long have your been teaching integrated science			Total
		0 - 5	6 - 10	11 - 15	
How long have been teaching	0 - 5	20	0	0	20
	6 - 10	10	5	0	15
	11 - 15	0	3	1	4
	16 - 20	1	0	0	1
Total		31	8	1	40

Source: Field Data October 2014

The length of been in the Ghana Education Service and the number of years teaching integrated science has collaborated. The highest number of respondents (20) are in the 0 – 5 years brackets. If the years were specified and not in a range it could have brought out the actual number of years these teachers have been teaching the subject. Also, these teachers are diploma holders judging from the preceding according to their qualifications (see table 4.2). The teachers in this range have produced students from 2009 to 2014 but most probably in 2012/2013 and 2013/2014 academic years all things being equal as they might have started with these students to complete their three years basic education course.

4.2 What Is Scientific Indigenous Knowledge System?

Scientific indigenous knowledge system seems to be one of the current contemporary discourse with varying views of what its meaning is, definition or explanation should be. This study used scientific indigenous knowledge system as the knowledge system which is within a certain geographical location, used by the people for their everyday life activities and have been sustained for

generations and the generation still unborn. Their everyday activities include agriculture, healthcare, spirituality, and social life.

Data from the field also upheld some of these views expressed by scholars who are into IKS. They expressed views in varying context but all pointing to some commonality such as local, culturally based, native, belong to a specific community, bequeathed from generations, ancestral in nature (George, 1999; Maurial, 1999; UN, 2004; Owuor, 2007) with unending vocabulary. These expressions are in box 4.1 on the next page.

Box 4. 1 Scientific Indigenous Knowledge System

1. Local knowledge that is unique to a given community, culture or society which is the basis for the level of decision making in agriculture, health, food preparation, education, natural resource management, and other activities in a rural community.
2. Locally oriented scientific principles including their technical know-how ideas used to generate or manufacture things useful to mankind in the society in which we live without the inclusion of any modern or exotic ideas.
3. Knowledge based on people social, physical and spiritual understanding which has informed the peoples' survival and contributes to their sense of being in the world.
4. scientific indigenous knowledge system evolved naturally by people usually through trial and error and which is passed on from generation to generation
5. Knowledge developed by the community, therefore, a community asset as opposed to modern scientific knowledge.
6. Indigenous knowledge system is about traditional beliefs and superstition.
7. Scientific indigenous knowledge system could be attested with all the three aspects of the african worldview (natural, human, spiritual) coming into play

Source: Interview / Questionnaire, October, 2014

Point one (1) in the box 4.1 encapsulates all that indigenous people do as a society (locality) and their existence. This affirms UNESCO and Nuffic (1990) that the indigenous knowledge system is a large body of knowledge and skills that have been developed outside the formal educational system. In the rural areas, most of their livelihoods revolve around agriculture. *We use the wind direction, weather condition, migratory birds and others to determine when to do every agriculture activity* (Chief). Therefore indigenous people are able to predict how their farming yields or activities would be or begin their farming activities. Fishing as part of agriculture and livelihood of subsistence for rural people fishermen are able to determine when bumper harvest would occur at certain times of years/months and mostly this comes to fruition.

Still analyzing these statements by the research participant, rural people healthcare systems are based on plants and animals products (Witol, 2010). *Before the advent of modern medicine, we used to cure almost all diseases at that time and even now despite the advanced technology in modern medicine. Some people still prefer to come for consultation when they are skill than going to the hospital* (Traditional healer).

Also, hospitals in Ghana today doctors who have gone to medical schools to learn traditional medicine and practice alongside the orthodox medical practitioners. Clients (patients) have the right to visit any of them at the Out Patient Department (OPD) consulting rooms for healthcare services.

A set of scientific principles and procedures acquired through the study of science to produce local goods and services. The survival of human society is the ability to produce the goods and services which are required for the daily

living. In this context, scientific principles and procedures are necessary to produce the required goods and services.

This definition supports what Millar (2006) as the three components of the African worldview (physical, nature and spiritual).

The researcher further had one of the research participants who stated that "*scientific indigenous knowledge system evolved naturally by people usually through trial and error and which is passed on from generation to generation"* (Interview, October, 2014). Most of the scientific principles and laws which have come to stay also went through the trial and error method and finally arriving at a conclusion.

In another sense, this research posited that scientific indigenous knowledge system is developed by the community, therefore, a community asset as opposed to modern scientific knowledge. In the modern scientific realm, knowledge is patented and copyright reserved. In this way, the knowledge is protected and authorization must be sought from the rightful owner/owners. As it is pointed out, community knowledge is owned by all and no copyright. In some instances, some community knowledge is on family lines. Such include carving, fishing, hunting, healing/traditional medicine soothsaying just to mention but a few. Bone setting which is done at Duong Clinic is handled by experts who come from a family line and therefore handed over to them by their past generations. "*Today some of these medicines or traditional herbal can be owned by 'outsiders' if they pay for the necessary rites to be performed for them to acquire the needed skills and knowledge"* (traditional healer). An 'outsider'

is any person who do not belong to that linage and wants to acquire the necessary skills or knowledge to enable him/her treat ailments.

4.2.1 SIKS System Studied and their Relationship with Science Topics

In every Teacher Training / College of Education or at the University, courses are tailored towards what the products would do in the society or the knowledge that they would acquire to be functional in the workplace. The respondents were quizzed to find out whether they had that opportunity or some courses that were taught had a bearing on scientific indigenous knowledge system. 57.5 percent (23) respondents said they were taught some amount of scientific indigenous knowledge system. It, therefore, gladdens the heart of the researcher as they would put what they have learnt into practice in the teaching of integrated science. The researcher went further to find out whether these things learnt had any bearing with science and the topics learnt.

95 percent of the respondents did indicate that the topics which were treated in their course of studies were actually related to scientific indigenous knowledge system. Since the topics were related to scientific IKS, the research instrument sought to find out from participants topics that were learnt in their course of study.

The topics covered a vast area of knowledge based on science. These are found in box 2 in the next page.

Box 4. 2 Topics Learnt which have Bearing with IKS

1. Food processing and preservation – fish smoking, gari processing, grain storage
2. Local industrial activities – soap making, shea butter extraction; acids and bases and salts
3. Fermentation
4. Biogas production
5. Climate change
6. Responsible use of water and forest
7. Healthcare – eliminating poison using dawadawa powder with water or honey
8. Farming systems
9. Science and technology
10. Endogenous technology and development
11. Superstitious belief and taboos and their scientific meaning
12. Animal and crop production biotechnology
13. Soil and water conservation

Source: Field Data, 2014

Almost all these are contemporary topics which are also found in the integrated science syllables such as the acids, bases and salt, farming systems, science and technology and misconceptions of some traditional belief systems which are hampering the development of science (MOESS, 2007).

4.3 Scientific IKS In The Study Area

The research tried to find out the scientific indigenous knowledge system in the communities/schools under the research. The idea of 'Sankofa' let's go back for it. Our local communities have survived over the centuries before the advent of modern science. All daily activities of local communities (local/native people) contain some scientific bases.

The interview with chiefs/elders and traditional healers gave the following are scientific indigenous knowledge system in the study area in box 4.3.

Box 4. 3 SIKS in the Study area

1. The use of ash in the preservation of farm produce and other domestic activities.
2. In the production of local soap, salt-pitter is gotten from ash mixed with other natural ingredients such as apple fruits left over to prepare the soap.
3. The area of brewing pito (local liquor)
4. Blacksmithing
5. Healthcare
6. Agriculture – farming, fishing, hunting, rearing of animals
7. Art, sculpture, and ceramics

Source : Field Interview, October 2014

The use of ash in the preservation of farm produce and other domestic activities. The people used ash in the preservation of their farm product in barns, silos, and pots. This is because contains some amount of acid insects such as weevil do

not attack the grains. The ash is further treated to get salt-pitter for cooking vegetable soup and other dishes.

In the production of local soap, salt-pitter is gotten from ash mixed with other natural ingredients such as apple fruits left over to prepare the soap. One disadvantage which was observed is that the ash into salt pitter is the acid content is not known and that is where modern science has the advantage. The soap could cause skin bleaching or diseases when the acid content is above what the body can contain.

The use of yeast as an ingredient in the brewing of the liquor is for it to ferment. In the brewing of pito, the malt is treated for one week beginning from soaking the guinea corn in water, decanting off the water, and spreading for three to four days to mature before it is dried.

With the healthcare it has taken a different dimension as it favours both modern and traditional medicine. The research found out that the local healers/herbalists are still very important in the study area despite modern medicine which is leading over traditional healthcare. In some communities they traditional healers' people consult when they are not well. Duong clinic was mentioned as the bone setting is done with modern healthcare now attached. "*In the local communities too, almost all herbs/trees have medicinal value. Indigenes consult these herbalists/healers who prescribe some of these herbs to them for treatment in time of ailment"* (Traditional healer)

As Millar (2006) opined, in the African context there is no difference between the art and the science as they are both intertwined without any delineation. In this sense, respondents shared the same view in connection with scientific

indigenous knowledge system being both an art and science. Some of these are found in their expression on their artifacts especially, walking sticks, the carvings of their gods or earthwares (Interview, october, 2014: chiefs, elders and tradtional healers). They use the pots for the storage of water, boiling herbs, and for pito.

Agriculture is part and parcel of indigenous people lifestyle. They see it as a way of survival not for commercial purposes despite the fact that some farm produce may be sold to seek for medical care, payment of children school fees, dowry just to mention a few. The system of farming which was land rotation has given way for crop rotation and intensive farming. Farmers have knowledge using natural phenomena to determine when rainfall will start, end, and amount of farm yield in the year (Barnhardt et al., 2005). These are usually done by observing the wind direction, some migratory birds, time of some insect appearance, the sky. Barnhardt et al. (2005) said this is the deep aspect of the culture. In this regard, it is only people who have studied these natural phenomena for a long time are able to predict. Climate change has affected this prediction of people who have studied nature for a long time or the use of natural occurrences (Mawunya and Adiku, 2013; Sagoe, 2006). Also fishing as a farming activity is not done by everybody in the study area but only some particular families and especially those living along the Black Volta who does all year fishing but has their bumper harvest during the early rains and the last quarter of the year. Soil and water conservation methodologies are employed in their farming practices too. Farmers make small ridges (contour farming) to prevent soil erosion and runoff which might carry away some soil nutrients. Hunting as posited by Barnhardt et al., (2005) is an aspect of deep culture which

is not taught in the science curriculum in the JHS. Respondents remarked that it is an aspect of scientific indigenous knowledge system which is done by some group of families or individuals.

Another scientific indigenous knowledge system in the community is the production of gunpowder. This technology is *"used for hunting but in the days of old, as defense from the attack of enemies"* (Chief). People are able to use the gunpowder to prepare cartridges which are used in single barrel guns for hunting and protecting oneself from attacks by robbers. This technology goes with blacksmithing in the production of locally manufactured guns – pistols and single barrels.

4.3.1 Common Scientific IKS

Scientific indigenous knowledge system varied in every community and for that matter on tribal and ethnic lines despite some commonality. In this study area of the ND, it is predominately occupied by the Dagaaba (the people) and Dagaare (as the language) spoken by the inhabitants. Despite the infiltration of other languages, 90% of them are Dagaaba (Ghana Statistical Service, 2014). The common scientific IKS in the community are group under sub-heading for discussion. These are agro-business, agriculture, local industry, cultural norms and beliefs, primary healthcare, building technology.

4.3.1.1 Agro-Processing

The study area is predominately farmers (Ghana Statistical Service, 2014). Since agriculture has a lot of aspects, the products from the various farming activities undergo further processes from the raw stage designated as the agro-

processing. In this areas research respondents mention a number of things which are concerned with agro-processing such as dawadawa processing 'kalee' (local maggie), shea butter processing, soap making, tinning of animal skins and pito brewing. The dawadawa is one of the nutritious food ingredients in the community. In its processing, it undergoes a lot of fermentation through bacterial action which makes it digestible. It is scientifically proven that the dawadawa contains the following nutritional values: moisture 19.48%, dry matter, 80.54%, ash 1.40%, protein 10.44%, fat/oil 27.13%, carbohydrates 37.24% and fibre 2.82% (Sackey and Kwaw, 2013).

The shea butter produced is used in cooking and treating fractures and sprains. In the tinning of skins, the shea butter is further used. Shea butter is used in the cosmetic industry for making creams and other body products. These days it is further used with cocoa in the making of some cocoa products. It is, therefore, a traditional export commodity carried out by the Ghana Export Promotion Council. The shea and the shea butter industry employs 62% of local women in the study area and is, therefore, women dominated (Ghana Statistical Service, 2014). Abujaja, Zakaria, and Adam (2014) found out that women between the ages of 40 – 60 are more likely to embrace new technology in the extraction of the shea butter. This is because the processing is energy supping and tedious.

The other agro-processing undertaken is the production of local soap popularly called 'Enaa kuro'. A lot of scientific processes are involved in the making of this soap. Firstly, apple fruits are dried and burnt into ashes and filtered and heated to get salt pitter. Other ingredients are then added in the process to get the soap.

4.3.1.2 Carving and Pottery Industry

In this research, some of the local industries found in the area are not into any large-scale production. These are done on subsistence bases especially the curving. The farming tools especially the hoes use sticks, in addition, to getting a complete hoe with the blade. Modern hoes could have both blade and the handle being metal. Without the stock (hoe stick) the hoe is incomplete and therefore cannot perform the function it is designed for. The blades are made by blacksmiths who get their metal parts from scraps or meted sheet from the metal industries.

4.3.1.3 Agriculture

Agriculture is the backbone of Ghana's economy and ND (Nadowli District) is not an exception. The 2010 Population and Housing Census (Ghana Statistical Service, 2014), agriculture in the district has 85 percent of the active population. The farming methods and the farming practices which were mentioned by the respondents included but not limited to the following: poultry, food crop production, animal husbandry, soil and water conservation, and gardening. Animal husbandry is either free-range or semi-intensive method of animal keeping in the communities. The animals that are reared include sheep, goats, and cattle. Of late, cattle stealing is rampant and hindering their rearing in the study area as most farmers have lost all their cattle to thieves – herdsmen and natives. The few that have them are herded by Fulani herdsmen who sometimes may not return all after the days' grazing from the field or a herd lost with the herdsmen. In herding cattle, cowboys used to learn about medicinal plants (Banda, 2005) through the sense of smell. They also learn about diseases of

these animals (veterinary) and therefore treat their animals when they are sick (none serious ill health). In poultry keeping, most of the indigenes prefer to keep the local breeds of birds as they have spiritual value to them (Millar, 2006). They are used for their sacrifices to the gods. Furthermore, herbalists and traditional worshippers use these fowls to purify their gods before/after a patient has undergone treatment which may be part of the 'dowry'. Due to climate change which is affecting food crop production in the study area, some indigenes do still prefer their old food crops seeds as it is believed that their forefathers begot it for them. This situation in the near future has to give way for improving agricultural technology which is emerging and with the debate on genetically modified organisms (GMO) foods and the effect of climate change on the savannah belt which is almost turning into a desert with a limited amount of rainfall annually. The annual rainfall between 1979 – 2004 was 900 – 1200mm with an average of 989mm (Nsiah-Gyabaah, 1994). As farmers claim there has been a gradual reduction in the amount of rainfall the study by Nsiah-Gyabaah (1994) rather revealed the contrary as there was a gradual rise in the average annual rainfall from the period 1979 – 2004. It was rather the prolonged rainfall from the early rains to the major season when sowing is expected to be done is shortened.

4.3.1.4 Cultural Norms and Beliefs

AIKS cut across all their sphere of life. Africans cannot be delinked from their cultural roots and for that matter their gods and beliefs systems. Superstition in the African is inseparable despite secular education has left some graduates to distaste their cultural norms and beliefs systems (Dei, 2003). Some of these

norms or superstitious beliefs have a scientific background, “not marrying a close relative” which is incest and may lead to people having hereditary diseases such as sickle and the like.

One common belief of indigenous people is witchcraft. Research participants (chiefs/elders and tradition healers) were of the view that this kind of knowledge is exclusive to some families or individuals in the community. This is not unusual for people or individuals in this category unless you also belong to that cult. It is further believed that this supernatural phenomenon could be acquired or gotten from birth. Their activities could be harmful or protective. The harmful ones most activities take place in the night despite some few activities which might be done during the day as reported by the research respondents.

4.4 Mode of Transmission of SIKS

Psychologist Piaget has studied children and has stated the four stages of child development. As the individual develops, the person acquires or learns some of the things either by doing, imitation or observation. In this research, respondents were to indicate the mode of transmission by ticking the appropriate responses – multiple responses. The results are tabulated per table 4.5 on the next page.

Table 4. 5 Mode of Transmission of SIKS (Science Teachers)

Items	No. of Responses	Percent (%)
Acquired	31	31.62
Given by others who have it	40	40.81
Learnt	25	25.51
Through socialization	2	2.04
School (formal education)	0	0.00

Source: Field Data, October 2014

The mode of transmission of scientific indigenous knowledge system is concerned with African metaphysics. The data from the field in table 4.5 indicates that formal education has nothing to do with scientific indigenous knowledge system transmission. In this direction, formal education has no role to play in letting students learn about scientific indigenous knowledge system. The field data in table 4.5 further indicates that this type of knowledge is usually given to people.

The key informants in the study were of a different opinion. They believe that scientific indigenous knowledge system can be taught in the school. They agreed that witchcraft is not possible to be included because it is not common and you cannot see it with your physical eyes. Conclusion may be drawn that such knowledge is in families' lines but cannot be taught in schools.

4.5 SIKS And How It Is Used In Science Lessons

The central theme of this research is scientific indigenous knowledge system in the science curriculum of basic school the case of the ND in the Upper West Region. In order to find out facts about the phenomenon, research respondents (science teachers) were quizzed to indicate whether they use scientific indigenous knowledge system in their lesson delivery in connection with the research objectives. This had a very good affirmation of 68.4 per cent as against 31.6 per cent. The researcher can confidently state that the science teachers in the ND use scientific indigenous knowledge system in their science lessons delivery.

The 31.6 per cent of the research respondents who did not use scientific indigenous knowledge system in their lessons were asked to give reasons for not incorporating it in the science lessons. The reasons advanced included but not limited to the following: cannot be proven by scientific means and put pupils into fear; students get confused when the teacher is trying to explain or compare with the scientific methods; different from modern scientific knowledge system; not contained in the science syllabi; teachers lack the know-how to impart to students; some topics are not practical to use SIKS; and syllabi designed with modern scientific base and examination oriented.

The respondents 68.4 per cent affirmers were to state the topics which mostly they apply scientific indigenous knowledge system. Almost every topic in the syllable was covered ranging from matter to science and technology which is spiral in nature (MOESS, 2005). The topics were acids, bases and salt; crops and animal production; soil and water conservation; weather and climatic

conditions; ecosystem; carbon cycle; reproduction in humans and plants; farming systems; separation of mixtures; purification of water; saponification; superstition, taboos and beliefs systems and their scientific explanation; interaction of matter. The list was endless. These are the major topics which are found in the integrated science syllabi of the JHS.

The science teachers were asked how they apply scientific indigenous knowledge system in the teaching of integrated science. They used as examples to ensure that students understand science is within them. Lessons are made more lovely and understandable when concrete examples are used (Farrant, 1986) and are also within the students' school and home environments. Science, therefore, is not an abstract to the pupils. This will also encourage them to do science at a higher level of education.

As Millar (2006) stated, the African view of science is that sciences cannot be delinked from the arts. The research participants in this study had an opinion that they use scientific indigenous knowledge system to explore other aspects of the cultural life of the local / indigene community through songs and rituals. How can rituals in the traditional setting be used to explain science lesson? Some rituals in some of the study communities' – widowhood rites, 'bagre', burial rites, naming ceremony and sacrifices to the gods and others unknown to the teachers as they are not from the study communities.

In addition to examples and to explore the cultural life of the community, demonstration and experimentation and the use of indigenous resource personnel in the teaching of a science lesson. One aim of the introduction of the JSS / JHS concept was that all schools should be community-based and owned

(MOE, 2005). For that matter, local / indigenous resource persons were to be part of the curriculum delivery not forgetting integrated science. Some of the teachers reiterated this dimension of the JHS concept which is very commendable. Demonstration of some science lessons concerning agriculture, students are taken to school garden / farm. Also the science of making soap in the local community, students are taken to these people / places to learn first-hand information. Students are taken through the process – saponification. In some homes, parents are engaged in the making of local soap which involves saponification.

Apart from using lecture, demonstration, discussion methods in the delivery of the science lessons, scientific IKS was also applied in the child-centred method of teaching as opposed to teacher-centred. Respondents used this method to enhance their teaching and the students to understand the lessons better. This teachers said mostly they use the discovery method in the teaching. In this method, the topic/lesson is introduced to the leaves the students to work on tier own and only do minimal interaction with the by moving around to when students have problems. Pupils at this level are more likely to remember the things that they have been taught through the child-centred approach which mostly involved role play.

4.6 Professional And Non-Professional Teachers Teaching IS

In the Ghana Education Service (GES), there are two categories of teachers – professionals and non-professionals. The professionals are those who have undergone teacher education in terms of content, pedagogical skills, and methodology while the non-professionals are those without the methodological

and pedagogical skills. The major aim of the methodological and pedagogical skills is to enable the teachers to teach effectively and efficiently for the students to understand the lessons been taught while others can argue that some teachers are borne but not trained.

In this research two statements were put:

A: Professional integrated science teachers find it easy to link scientific indigenous knowledge system with integrated science lessons.

B. Non-professional integrated science teachers find it difficult to link scientific indigenous knowledge system with integrated science lessons.

Table 4. 6 Professional and Non-Professional Science Teachers

	Frequency	Percent (%)
Agree with A	1	2.6
Agree with B	15	39.5
Disagree with A	5	13.2
Agree with A and B	11	28.9
Disagree with A and B	5	13.2
Undecided	1	2.6
Total	38	100

Source: Fieldwork, October 2014

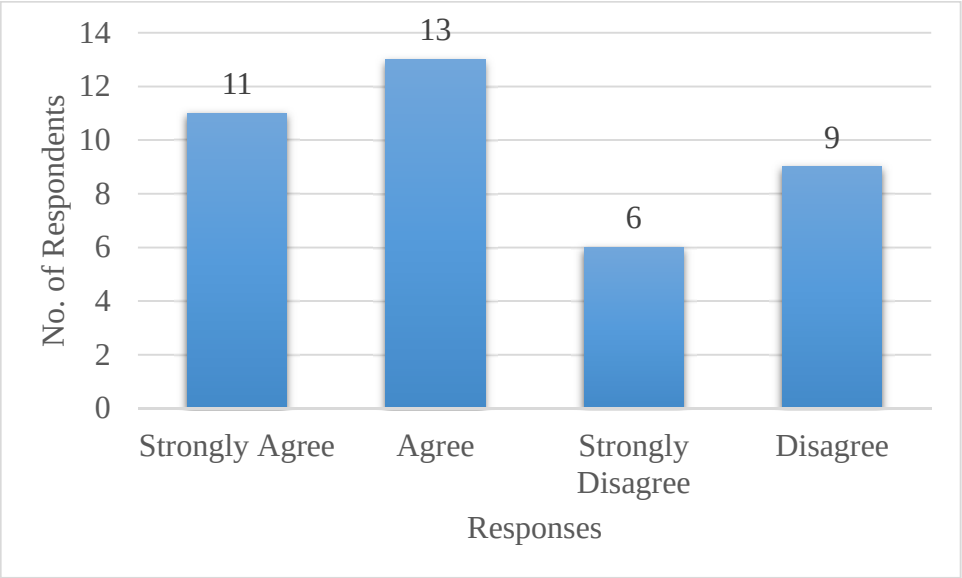
From table 4.6, 15 respondents representing 39.5 per cent agreed that it is the non-professional teachers who find it difficult to link scientific indigenous knowledge system in the integrated science lessons. At the extreme was 2.6 per cent agreed with statement A and undecided.

To get a better understanding of why the respondents answered the statements that way, a cross-tabulation of their competencies with their responses to the two statements A and B were done. In the cross-tabulation, it was found out that those teachers who had competencies in the science had agreed with the statement that non-professional science teachers find it difficult to link scientific indigenous knowledge with integrated science lessons (see Appendix C, page 140).

4.7 Pupils Background Knowledge In SIKS Challenges To Learning Integrated Science

Jean Piaget is of the view that before a child can learn any second language or ability to comprehend that language, the child background in the mother tongue is very important. Because of this, the educational system in Ghana emphasized the use of the first language (L1) in the lower primary. Scientific indigenous knowledge system is linked to mother tongue as it is their first form of contact before formal education begins. The test item in the questionnaire was therefore put in the pairwise ranking strongly agree to undecided as figure 4.2 shows the responses in the next page.

Figure 4. 2 Pupils Background in SIKS is a Challenge to Learning IS



Source: Field Survey, October 2014

From figure 4.2 thirteen (13) of the science teachers representing 33.3 per cent agreed that pupils background knowledge in scientific indigenous knowledge system is a challenge in the learning of modern scientific knowledge system (33.3%) and at the extreme end six respondents representing 15.4 per cent strongly disagreed with the majority. 28.2 per cent also strongly agree that pupils background in SIKS is a challenge to learning modern science. There is no much difference in the strongly agreed and agreed. The researcher cannot conclusively say that pupils background is a hindrance to learning modern science in the ND.

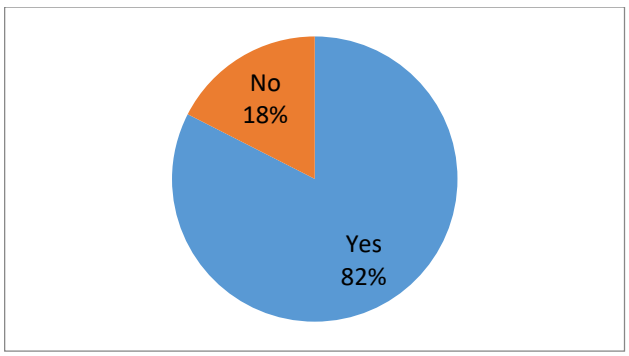
Similar to pupils background knowledge in scientific IKS possess a challenge to the learning of IS was whether SIKS can easily be taught in the integrated science lessons. Respondents were to choose from alternatives ranging from strongly agree with to strongly disagree with the statement. The response was

not different to figure 4.2 as 55 per cent agreed with the statement and 2.5 per cent (1) respondent also strongly disagreed with the statement. The two statements responses, therefore, contradict each other. It was to follow that since it was a challenge with pupils background knowledge in scientific indigenous knowledge system it was to presume that the teachers of science would find it hard to teach for the pupils to understand. In this research, internal triangulation was employed as the case of the two statements above. This was to ensure that responses of respondents were consistent but this has failed to hold with these two close statements.

4.8 Experts In Curriculum Delivery

Going further, the educational reforms in Ghana targeted full community participation in teaching and learning process and school administration to a limited extent. It was, therefore, envisaged that persons who have some 'specialized' knowledge in some areas within the curriculum could be of help in the delivery of those areas. The participants (teachers) responses are presented in figure 4.3.

Figure 4. 3 Experts Participation in IS Lesson



Source: Field Data, October 2014

In figure 4.3, 82 per cent of the respondents (33) acknowledge the immense contributions which would be made by the experts (indigenes) if they are engaged in the curriculum delivery especially in integrated science. 7 respondents with a percentage value of 18 per cent disagreed. In this research, every opinion or answer expressed is of value to the research. The chiefs, elders and traditional healers were also of the opinion that they could also be part of the instruction as the school is for them too. Therefore, respondents (teachers) were to give reasons for either affirmation or non-affirmation to the question of experts taking part in the curriculum delivery in the integrated science lessons.

Proponents of the affirmation of experts in the delivery of the science curriculum had some points to buttress their argument. The science teacher from Nadowli Model JHS stated "*qualitative in nature and therefore need different experts, scientific indigenous knowledge system is subjective, materialistic, spiritual in nature, intuitive and holistic as against modern science"* (Interview October, 2014). Millar (2006) writing on IKS has been collaborated by this science teacher. Indigenous people attached some importance of spirituality in their daily activities. In favour of the experts are: serve as resource persons to facilitate teaching and learning for that matter the acquisition of modern scientific knowledge as they move along the educational ladder; outmoded cultural practices will be demystified thereby helping students to know the differences between modern science and IKS and their relationship. Practice as they say make man perfect was also echoed by the respondents as pupils solve scientific problems (challenges) early enough and therefore making progress easily. Apart from the above stated reasons to include experts in the science curriculum, they are also of the view that students would appreciate what is

happening in their community as they would know that indigenization is part of their school system. Furthermore, it was observed that science is a broad area and others outside the normal classroom setting would make an impact and would, therefore, enhance learning and understanding. Knowledge as is so broad that it cannot be known by only one or some few persons. Despite the fact that cultural studies which was studied separately is now combined with Ghanaian language as a subject and repackaged as Ghanaian Language and Culture, participants are of the view that experts who are partaking in the science curriculum delivery would increase pupils awareness of their cultural identity. Modern science which we are all inclined to is the culture of the 'white man' which they have to acculturated and indoctrinated into Africans through formal education and evangelization.

There are others in this research who think contrary to the views expressed by respondents who agreed. Some of their major concerns were *classification of materials, self-expression, and confusion between the two knowledge systems (indigenous and modern science). They saw the system of classification to be cumbersome for the experts to do for students to understand. People might possess the knowledge but the methodology to use it to impart knowledge* (Interview, October, 2014) for respondents against the use of experts. As teachers in the field of science education, they usually undergo training before teaching and the experts might possess the knowledge but lack methodological skills. The teachers not in favour of the experts further argued that the two knowledge systems would be confusing to the students as they may have different terminologies which might be incongruous with each other (Dziva, Mpofu and Kusuure, 2011).

The foregone discussion on experts' participation in the science curriculum delivery could by sum as inevitable part of society and the educational system especially the school is far from the society which is not supposed to be the case. They should be part to assist teaching and learning as students would see different faces at certain times in the curriculum delivery which would let them retain some if not all things that are learnt therefore memory retention would be enhanced and the passing of exams (BECE) would be a joy to society.

4.9 Factors That Can Enhance Indigenization Of The SC

Respondents (science teachers) were quizzed on factors which could enhance the indigenization of the science curriculum. Among the factors which were elaborated included but not limited to *experts to be part of the curriculum design and development, adoption of old indigenous technologies, basic scientific tools / apparatus, establishment of indigenous science centres, GES recognizing scientific indigenous knowledge system to be part of the science curriculum and examinable, in-service training for science teachers and non-interference of politics into education* (Field Data, October, 2014)

The respondents demonstrated the value of experts in the design, development, and implementation of the science curriculum. They see the design and the development of the science curriculum only being done by the CRDD/NaCCA of the GES only. They were of the opinion that those at the centre do not consult the teachers who are on the ground doing the delivery and implementation of the science curriculum. Also, for this project to be successful, experts in scientific indigenous knowledge system are supposed to be part of the design, development, and implementation. Therefore they alluded to the inclusion of

traditional rulers, herbalists and others who are at the forefront of promoting, preserving and maintaining our cultural systems and values.

In addition to the above points of promoting, preserving and maintaining our heritage respondents are of the view that old cultural systems and values die hard for that matter, some of these cultural values/systems could be incorporated into the science curriculum. There are technologies in agricultural practices which farmers have used for centuries but still relevant today. These include their resistance to the weather (climate change) coupled with low yields. Some seeds/grains are resistant to the weather (climatic change). Because of that indigenes prefer their local breeds of birds to the exotic ones as the exotic ones are not used for ritual and sacrificing for the gods.

On the part of the establishment of indigenous centres (laboratories), the science teachers want them not to be far from educational centres to enable students to make use of them to acquire additional knowledge. Much as possible they could be incorporated into the modern science laboratory. Science teachers are also asking for indigenous topics, TLMs and the training or inclusion of scientific indigenous knowledge system in the curriculum at the Colleges of Education.

In Ghana, almost everything is politicized today. This can be seen in the educational reforms since independence and especially during the revolutionary era to the fourth republic. In the early concept of the JSS with experimental schools in the 1970s and was implemented nation-wide in 1987. The regime of the President John Agyekum Kufuor also saw another new reform in the JSS to JHS and SSS to SHS with a four-year system in the SHS. When there is political acceptance (Sundar, 2002 cited in Phiri, 2008), it would be easy to be factored

into the science curriculum and since the BECE is a national examination not like the WASSCE which is international. Even with the WASSCE, there are some subjects which so many countries offer and others do not except the Mathematics, English Language, Integrated Science and Social Studies which are common. Others like geography, building construction, among others are grouped into various countries and candidates who are not from those countries are not expected to answer questions on those sections/parts.

The world is becoming religiously polarized between Christianity and Islam as these two religions have various sects not forgetting traditional religion which has fewer followers in Ghana (Ghana Statistical Service, 2014, 2015). Research participants were of the view that religious tolerance would be a factor to enhance the indigenization of the science curriculum as Christians and Muslims may think that it belongs to the traditionalist.

4.10 How to Integrate the SC – Framework for Indigenization

In the preceding heading, factors that can enhance the integration of the JHS science curriculum the research participants catalog a number of issues on the factors. Among them are religious tolerance, favourable political atmosphere, organization of field trips, creation of indigenous laboratories just to mention a few.

The following paragraphs delved into the framework or the how of the integration of the science curriculum. The research participants have stated that the curriculum of the integrated science is bookish and does not link to the social setting and therefore advocated for its practicality. The JHS concept framers had envisaged the practicality of the whole curriculum (MOE, 2004) but from the

perspective of the research respondents we can conclude that it has lost its original plan of producing students who could enter the job market or start their own enterprises and others continue to the tertiary level.

As respondents agreed to include experts in the curriculum delivery of integrated science as 82% in figure 9, are of the opinion that this expert knowledge should be introduced to teachers in the diploma awarding institutions (Colleges of Education) to equip them with the needed pedagogical skills to deliver in the integrated science classroom not forgetting in-service training for teachers who are already in the field.

The GES has a specialized unit in charge of reviewing or developing every part of the subject area according to current research findings – CRDD / NaCCA. It was the view of the research participants that much consultation needed to be done particularly with science teachers, pupils and experts in the scientific indigenous knowledge system to come out with an indigenized science curriculum. From the standpoint of the science teachers, they see the CRDD / NaCCA of the GES as a body which does not do wider consultation before developing or reviewing the science curriculum.

Decentralization of the science curriculum is further advocated for by the participants in this research. The GES which is the implementer of policies from the Ministry of Education has a unified science curriculum for all schools in Ghana. The same content is given to all students both in the urban or good schools versus the rural or mushroom schools. This has also further aggravated the situation with a centralized system of progressive examination BECE conducted by the WAEC for all students. If what the research respondents

advocated for if put in place it will end this BECE system which is centralized at the disadvantage of the rural students who do not have other opportunities enjoyed by their counterparts in the cities or urban centres.

4.11 Challenges To The Integration Of The SC

The main objective of this research was the integration of the science curriculum to make local content available to the less privilege and late developers who cannot catch up with modern science to also develop their potentials. 72.2 per cent of the respondents said there would be challenges in the integration of the science curriculum with 27.8 per cent thinking otherwise. The participants were therefore asked to state reasons why there are going to be challenged in the indigenization of the science curriculum.

These responses are discussed under teacher-related issues, funding, pupils and others.

4.11.1 Teacher-Related Challenges

The challenges to the integration of the science curriculum which are teachers' base included: lack of training centres, teachers ill-equipped with scientific indigenous knowledge system, lack of supervision and inadequate teaching and learning materials. The teachers were of the concern that there are no training centres such as the modern science laboratories in the various schools which they could go and learning new things discovered with regard to the scientific indigenous knowledge system.

This lack of training centres takes us to another pedestal of ill-equipped teachers. If laboratories which would enhance their learning of the new things

are not there, it would eventually lead to ill-prepared teachers for the task ahead of them. As far as teacher education is concerned in Ghana, the science teachers are used to the modern science laboratories instead of indigenous laboratories which are even found everywhere in the teacher's environment. We can foresee that that laboratory which is within them and could have been learnt has been ignored for lack of interest that is the social and physical environments.

Another challenge raised by the participants was lack of supervision. This lack of supervision stems from either circuit supervisor not doing their work in terms of supervising the teachers or the headteachers not checking teachers lesson notes, observing teaching and learning and checking students books to see whether teachers give adequate assignments or exercises. Not all the schools are covered with trained science teachers which have further worsened by inadequate science teachers in the system. This research indicated that 32.5 per cent of the science teachers did not have competency in science background (refer to table 4.3). It has also come to light that teachers have inadequate knowledge in handling some topics as per the science teachers. This could be so as they were not taught scientific indigenous knowledge system in the training colleges or College of Education. In addition to the above, the teaching and learning materials are not available as stated by the research participants.

4.11.2 Resources

The success of any project or programme depends on the people (human resources) to implement and the availability of financial resources. In this research, the implementers (teachers) who are supposed to do the implementation if it is approved by the stakeholders especially GES,

respondents are of the view that funds may not be there for logistics. This is because there would be the need to produce new textbooks which would incorporate the scientific indigenous knowledge system. An issue of re-training science teachers came up as it is connected with the availability of funds to organize workshops for teachers in this new knowledge.

It was also observed that there are inadequate science teachers in the district as shown in table 5. The district had 32.5 per cent of the science teachers not having competency in science but other areas are teaching integrated science. The respondents advocated for the re-training of the science teachers in this direction.

4.11.3 Student Related Challenges

Challenges are normal facets of researches and the respondents themselves are not left out. The research had some challenges which relate to the learners themselves. Teachers of science recognized students lack interest in studying the scientific indigenous knowledge system in question. The reason was that it is non-examinable. Also, the respondents agreed that pupils have varying background knowledge which is brought to bear in the classroom situation. Researchers are of the view that if these are not well integrated there could be a conflict of knowledge acquisition (Dei, 2002; Millar, 2006; Maurial, 1999). Science for that matter both modern and indigenous science is culturally based (Millar, 2005). The research respondents expressed the view that the minds set of the pupils in the assimilation of scientific IKS are likely to be hampered. The minds set of the individual goes with the interest in learning the subject. If the student's minds are not prepared psychologically with this new knowledge to be

introduced in the science curriculum, it would be difficult to achieve the aim of integration.

4.11.4 Other Challenges

Other challenges which are not related to the teachers, funding, and students are: language barrier, paradigm shift, lack of documentation of indigenous knowledge system, inadequate number of expertise in IKS, lack of technological transfers, non-examinable, the difference in the belief system and custom were mentioned by the respondents.

The indigenous or traditional knowledge refers to a specific locality in whatever they do to maintain their life subsistence and for generations' unborn. It would, therefore, be hard for others to learn this kind of knowledge system despite similarities which might exist among them (Barnhardt et al. 2005). This, therefore, relates to the language barrier in the learning of scientific indigenous knowledge system. Children are noted for quite easily understanding and speaking of every language if there are exposed to it in their early stages of development (Farrant, 1986). The problem then emerges as there are many Ghanaian languages which are studied in the schools and therefore will be varying in context but in the same content.

People who are used to doing things the same way finds it difficult to change to innovations as propounded by the behaviourist theories of diffusion. The science teachers saw this paradigm shift from western science to scientific indigenous knowledge system with a mixed feeling. The paradigm shift to this new system requires a policy direction from the Ministry of Education and the GES to implement this policy.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The inability of science teachers to integrate scientific indigenous knowledge system into the science curriculum at the JHS in the Nadowli District was the research problem of study. The main research question was to what extent has there been the integration of scientific indigenous knowledge system into the science curriculum at the JHS in the Nadowli District?

The specific objective to unearth were: to examine the types of scientific indigenous knowledge systems that can be integrated into the science curriculum of the JHS; to investigate the barriers between school and community that integration of scientific indigenous knowledge system could remedy; to find out if science teachers allow students to use scientific indigenous knowledge system in the science lesson; and to examine a possible framework for the integration of scientific indigenous knowledge system and the science curriculum of JHS.

5.1 Summary

The findings of this study are responses from the data collection instruments / tools which were administered and answered by the research respondents (science teachers, chiefs/elders and traditional healers) and the secondary data.

Scientific indigenous knowledge system found by the research in the study include – agro-processing, blacksmithing, preparation of local beer “pito”, healthcare, farming systems, soap making, superstitious beliefs and taboos,

preservation of farm produce. All the common knowledge are related to agriculture. The uncommon indigenous stated was witchcraft. This is in families but others can acquire it if they wish.

There was the incorporation of traditional medicine/herbs/ healing in some modern health facilities example Duong clinic. People are still consulting traditional healers in their communities when they fall sick.

56 per cent of the respondents (science teachers) had received tuition in their courses of training in indigenous knowledge system. This was also related to science as 95 per cent attested to this fact. The topics treated in their training included food processing and preservation – fish smoking, gari processing, grain storage; local industrial activities – soap making, shea butter extraction, acid, bases and salt; fermentation – pito brewing; health care – eliminating poison (food poisoning) using dawadawa powder with water or honey; farming systems; science and technology; superstitious belief and taboos and their scientific meaning or explanation; and soil and water conservation.

Teachers in the study area use scientific indigenous knowledge system in their science lesson as 68.4 per cent of the respondents (science teachers) reported that. The topics which scientific indigenous knowledge system is used included bases, acids and salt, animals and crops product, reproduction in animals and plants, purification of water, separation of mixtures, taboos and beliefs systems and their scientific explanations. Scientific indigenous knowledge system is further used in the science lessons as examples to retain memory. It is also used to explore aspects of the cultural life of the indigenes through songs.

Both key informants and science teachers agreed that experts in scientific indigenous knowledge system would help in the teaching and learning of integrated science especially topics were the science teachers lack that knowledge.

The respondents ascertained that non-professional teachers find it difficult to link scientific indigenous knowledge system with the science lesson with a score of 38.5 per cent. The outliers' only one respondent (2.6 percent) thinks that professional teachers find it difficult to link the scientific indigenous knowledge and modern science lessons.

Scientific indigenous knowledge system background hinders the learning of integrated science. The respondents had 33.3 per cent as those who alluded to this fact. In another light, respondents agreed that scientific indigenous knowledge cannot easily be taught in the integrated science lessons.

82 per cent of the respondents agreed that experts (indigenes) should be part of the science curriculum instruction. They agreed that they are resource persons; outmoded cultural practices would be demystified and differences between modern science and scientific indigenous knowledge system would be appreciated by pupils.

The research found out the science teachers said scientific indigenous knowledge could not be taught in school because of metaphysics natures. The key informants in the study were of a different opinion. They believe that scientific indigenous knowledge system can be taught in the school. Their only concern was that witchcraft is not possible to be included because it is not common and you cannot see it with your physical eyes.

Factors that can enhance integration of the science curriculum include the following: non-political interferences in education; experts included in the curriculum design and implementation; scientific indigenous knowledge system been part of the science curriculum and examinable; and above all in-service training for science teachers.

The 'how' of the integration of the science curriculum was viewed in terms of political tolerance; NaCCA in consultation with experts, teachers, and students; decentralization of the integrated science curriculum. The BECE could be decentralized according to the locality of the student just as the Ghanaian Language and Culture which is written in the students' local area language.

Despite the fact that respondents advocated for the integration of the science curriculum, they had the following challenges if the policy is to be implemented:

a. Teacher-related – lack of supervision by the supervisory authorities, ill-equipped with scientific IKS and lack of local science laboratories;
b. Pupils related – lack of interest in scientific indigenous knowledge system, confusion between the two knowledge system (indigenous and modern sciences);
c. Resources – human and financial resources. Financial resources to get the needed logistics for the policy to be implemented;
d. Others such as unwritten, non-documentation and language barrier. The scientific indigenous knowledge system in the current status in the study area is not documented. This, therefore, suggests the needed for documentation and people

should take the keen interest to develop and document our heritage.

5.2 Conclusions

The study draws the following conclusions from the findings. First of all, the common scientific indigenous knowledge system in the study area are found in agriculture, healthcare and local industries. They use these knowledge for their daily survival. Despite the influence of western science and technology especially in the agricultural sector, they still maintain some animals and crops species. The healthcare system is not completely neglected by the indigenes. Modern healthcare compliments with the traditional healthcare system but not in competition.

Secondly, science teachers in the ND in teaching their students, incorporate scientific indigenous knowledge system. If there is policy backed by legislation this may go a long way to cater for all pupils who will take part in the BECE.

Thirdly, the competencies of the teachers affect their perception of the integration of the scientific indigenous knowledge system into the science curriculum. Research participants are of the view it is easy for someone who has done science education to appreciate and links modern and scientific indigenous knowledge system in the science curriculum in the course of teaching.

There was the need to include experts in the delivery of the science curriculum as the science teachers advocated that the experts would complement their teaching and pupils may understand better.

Lastly, the integration of the science curriculum would be possible if the following factors were considered: political tolerance; NaCCA consults with experts, teachers, and students when designing the science curriculum; decentralization of the integrated science curriculum. The BECE could be decentralized according to the locality of the student. The only challenges would be teacher-related; pupils-related; resources – human and financial resources and undocumented SIKS.

5.3 Recommendations

On the basis of the summary and conclusions of this research, the following recommendations are made:

i. Traditional rulers / healers and the classroom teachers should be included in the design, development, and implementation of the science curriculum with NaCCA.

ii. School heads and science teachers should identify persons within the school community or outside to help them on topics which are beyond their competency.

iii. The JHS integrated science syllable should be integrated with scientific indigenous knowledge system during the design of the syllable by NaCCA.

iv. For effective and efficient use of the chiefs / elders and traditional healers (experts) GES should organize workshops for sensitization.

v. For the how of the integration of the science curriculum with scientific indigenous knowledge system, the study recommends that the curriculum should be decentralization, include experts in the

teaching and learning for effective and efficient use of the chiefs / elders and traditional healers (experts), GES should organize workshops for the sensitization. There should be a policy document backed by government legislation for the integration and decentralization of the science curriculum.

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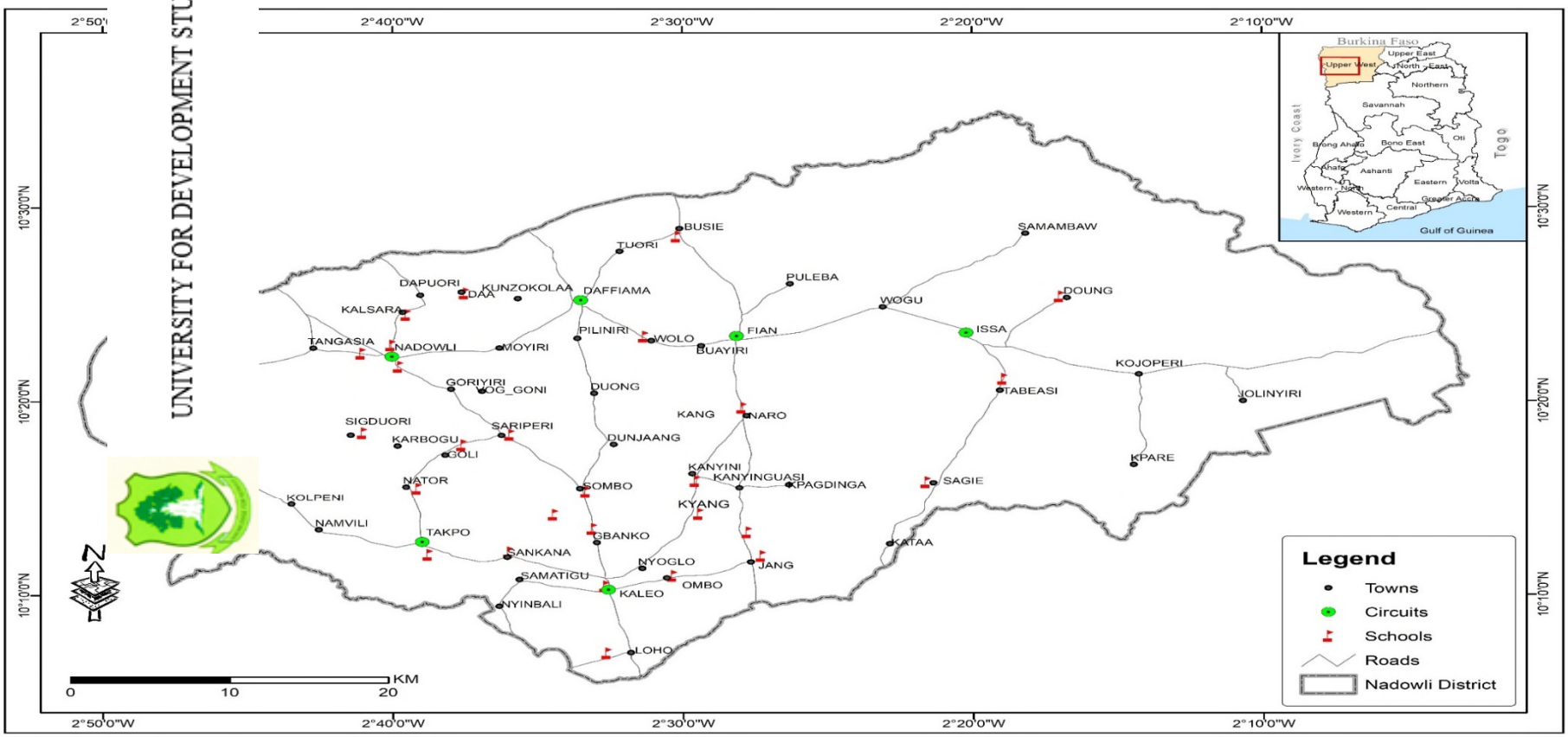
APPENDICES

Appendix A: M y Area



Appendix B: Table For Determining Sample Size From A Given Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

Adopted from Sarantakos, 2005 page 173

Appendix C: Cross-Tabulation Of Competency With Professional And Non-Professional Teachers

ificate of competency in teaching * Professional or non-professional Cross tabulation

Count

		Professional or non-professional						Total
		Agree with A	Agree with B	Disagree with A	Agree with A and B	Disagree with A and B	Undecided	
Certificate c Competenc	Vocational/technical	0	1	0	2	1	1	5
	Science	1	12	2	7	2	0	24
	Social Studies	0	1	1	0	0	0	2
	Others	0	1	2	2	1	0	6
Total		1	15	5	11	4	1	37

Appendix D: Research Instrument One

IN-DEPTH INTERVIEW GUIDE / CHECKLIST FOR KEY INFORMANTS (CHIEFS, ELDERS AND TRADITIONAL HEALERS)

Interview code …….

General information

1. Interviewer name …….
2. Date of interview …….
3. Time of interview ……..
4. Sex Male [ ] Female [ ]
5. Age 20 – 39 [ ] 40 – 59 [ ] 60 – 79 [ ] 80+ [ ]
6. Occupation ……
7. Any position held in the community ……..

MAIN THEME

8. What do you understand by the term scientific IKS?
9. Are there any scientific IKS in this community? List them.
10. In your view what IKS are most common to everybody in the community? List them
11. Mention those that are preserved to individuals/families/clan/groups?
12. Mention the IKS which are more scientific in nature.
13. What is your opinion of integrating indigenous knowledge into the science curriculum?
    a. What can be done to make this possible – integration/harmonization?

b. What factors will also challenge this integration/harmonization

14. What is your view on letting people who possess this knowledge to part take in the teaching of science in the JHS?

15. Since the school has taken over the education (socialization) of our children, what strategies would you suggest be put in place for them to learn these scientific IKS?

16. Any other information which you would like me to know concerning scientific IKS

Thank you for your time and energy and having the patience to attend to my questionnaire.

Appendix E: Research Instrument Two

QUESTIONNAIRE FOR SCIENCE TEACHERS / SCIENCE COORDINATOR

Biodata

1. Sex
    a. Male [ ]
    b. Female [ ]
2. Age
    a. 21 – 30 [ ]
    b. 31 – 40 [ ]
    c. 41 – 50 [ ]
    d. 51 – 60 [ ]
    e. 60 +[ ]
3. Religious background
    a. Christian [ ]
    b. Muslim [ ]
    c. Traditionalist [ ]
    d. Others (specify) …….
4. Educational background
    a. Basic [ ]
    b. Secondary [ ]
    c. Post-secondary [ ]
    d. Tertiary [ ]
5. What certificate do you use in teaching?
    a. ‘A’ 4-year [ ]

b. 'A' 3-year [ ]

c. Diploma (education) [ ]

d. Diploma (HND) [ ]

e. BA [ ]

f. Bsc [ ]

g. BED [ ]

h. Others (specify)……..

6. What was your main course/subject of studies? Example: biology, integrated science, psychology etc

Specify……

7. How long have you been teaching?

a. 0 – 5 years [ ]

b. 6 – 10 years [ ]

c. 11 – 15 year [ ]

d. 16 – 20 year [ ]

e. 20 + [ ]

8. How long have you been teaching integrated science?

a. 0 – 5 years [ ]

b. 6 – 10 years [ ]

c. 11 – 15 year [ ]

d. 16 – 20 year [ ]

e. 20 + [ ]

SCIENTIFIC IKS (OBJECTIVE 1)

9. What is your understanding of scientific Indigenous Knowledge Systems……

……..…….....……..……..…….....……

10. In the course of your training were you taught topic(s) in scientific indigenous knowledge system?

    a. Yes [ ]

    b. No [ ]

    If yes, state the topics that were taught

    ……..……

    ……

11. Mention any scientific IKS within your school community.

    ……....……

    ……....……

12. Classify the scientific IKS under

    a. common scientific indigenous knowledge system

       ……

       ……

    b. individual / group / family / clan scientific IKS

       ……

       ……

RELEVANCE OF SCIENTIFIC IKS IN THE SCIENCE CURRICULUM / SYLLABI (OBJ 4)

13. Do you use IKS in the teaching of science lessons?

    a. Yes [ ]

b. No [ ]

If no, state the reason(s) why you do not use IKS

……

……..……

14. Do pupils find it difficult to link indigenous knowledge system with the science lesson?

a. Yes [ ]

b. No [ ]

c. If yes, explain: …….

15. Pupil's background knowledge in IKS is a challenge in the teaching of modern science (western science)?

a. Strongly agree [ ]

b. Agree [ ]

c. Strongly disagree [ ]

d. Disagree [ ]

e. Undecided [ ]

16. Would you suggest that scientific indigenous knowledge should be part of the science curriculum?

a. Strongly agree [ ]

b. Agree [ ]

c. Strongly disagree [ ]

d. Disagree [ ]

e. Undecided [ ]

17. Scientific IKS (concepts) can be studied in the science lessons.

a. Strongly agree [ ]

b. Agree [ ]

c. Strongly disagree [ ]

d. Disagree [ ]

e. Undecided [ ]

18. What factors will enhance the possible harmonization/integration of scientific IKS into the science syllabi/curriculum

……

……

19. What are the possible challenges of harmonizing indigenous knowledge in the science curriculum

……

……

20. State the benefits of harmonizing/integrating scientific IKS in the science curriculum/syllabi.

……

……

Thank you