INTEGRATION OF INDIGENOUS KNOWLEDGE IN TEACHING
MATHMATICS CONCEPTS IN PRIMARY SCHOOLS IN VIHIGA
COUNTY, KENYA

BY

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DECLARATION

DECLARATION BY THE CANDIDATE:

I wish to declare that this thesis, Integration of Indigenous Knowledge in Teaching Mathematics Concepts in Primary Schools in Vihiga County, Kenya, except where indicated to the contrary within the text, is my original work, and has not been presented for the award of a degree in any other university. No part of this thesis may be reproduced without prior permission of the author and / or Moi University. All the sources used in this work have been acknowledged by means of citation and references.

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DEDICATION

This work is dedicated to my Dad and Mom whose sacrifice for my education inculcated in me a spirit of determination and quest for knowledge. To my unfailing husband Vencious Mukanzi whose encouragement and support has been my greatest source of inspiration and strength and my esteemed children Obi Carl and Dexter Itemere for giving Mom humble time to work on this document. Thank you very much for your encouragement.
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Secondly, My heartfelt acknowledgements go to my supervisors Prof. Khaemba Ongeti and Prof. John Chang’ach for their expertise in shaping this work. Their patience and perspicuous comments in correcting and guiding me in this work are of immense value. Their challenging views led me into a deeper understanding of this work. To these two mentors, I am profoundly indebted.

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ABSTRACT

The current paradigm shift towards promoting education for sustainable development gravitates toward alternative approaches to school curricula in Kenya. What is it that can be achieved by integrating Indigenous Knowledge (IK) into the formal education system? To address some of the knowledge deficiencies that are currently formulated from the western perspective, this study was to explore the integration of indigenous knowledge in teaching of mathematical concepts in primary schools in Vihiga County, Kenya. The study adopted Constructivism theory attributed to Piaget, Vygotsky and Bruner. Mixed method approach using cross-sectional survey design was used. Data was collected concurrently where both qualitative and quantitative data were collected in one phase. The researcher triangulated research instruments which included questionnaires, observation schedule and focus group discussion (FGD) guide. The target population were class six teachers of mathematics and class six pupils, for the purpose of getting a representative sample, proportionate sampling was used to select 10% (40) of the schools in the county. The sample comprised all the class six teachers of mathematics and 5-12 class six learners in the selected schools. Descriptive statistics was used to analyse quantitative data while Pearson Product Moment Correlation was used to test the hypothesis. Qualitative data was analysed thematically and reported through narration. Findings indicated that knowledge that can be derived from various forms of the Luhya tradition is abundant in traditional decorations, weaving, constructions, games, story-telling and many others. Also, the findings revealed that, there is a low positive relationship between teacher’s perception and the level of integrating indigenous knowledge in mathematics curriculum ($r = 0.182, p<0.026$). Majority of the respondents 75% (30 out of 40) indicated that IK is rarely incorporated in the classroom teaching. Learners' responses from FGDs revealed that they have an understanding of local knowledge and how it can be used in math concepts. Strategies for incorporating IK to maximum learners ability included learner-centered approach, activity-based approach and exposure to activities that take place at various cultural villages. Some of the problems facing teachers while incorporating IK in Mathematics were attitudinal, institutional, and systemic. From the findings the researcher concludes that this study was viable since majority of the respondents 80% (32 out of 40) agreed on the existence of indigenous knowledge that could be applied in teaching math so as to help bridge the gap between what is usually taught in the classroom and what exists in the society and to socialize learners with math concepts. Therefore, results from this study has the potential to inform the education stakeholders such as policy makers, teachers, curriculum developers, and parents on the importance to inculcate into our children the virtue of taking lead in their own construction of knowledge based on their local experiences by adopting strategies to incorporate IK in mathematical concepts. Further research should be done in order to find ways in which IK can blend with modern technology to solve current problems.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>EAEC:</td>
<td>East African Examination Council</td>
</tr>
<tr>
<td>ECEC:</td>
<td>Early Childhood education and care</td>
</tr>
<tr>
<td>FGD:</td>
<td>Focus Group Discussion</td>
</tr>
<tr>
<td>ICT:</td>
<td>Information Communication and Technology</td>
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<tr>
<td>IK:</td>
<td>Indigenous Knowledge</td>
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<tr>
<td>IKS:</td>
<td>Indigenous Knowledge Systems</td>
</tr>
<tr>
<td>K.C.P.E:</td>
<td>Kenya Certificate of Primary Education</td>
</tr>
<tr>
<td>K.I.E:</td>
<td>Kenya Institute of Education</td>
</tr>
<tr>
<td>KICD:</td>
<td>Kenya Institute of Curriculum Development</td>
</tr>
<tr>
<td>MATH:</td>
<td>Mathematics</td>
</tr>
<tr>
<td>NGOs:</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>UNESCO:</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>UNICEF:</td>
<td>United Nations International Children's Emergency Funds</td>
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<td>WKS:</td>
<td>Western Knowledge Systems</td>
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CHAPTER ONE
INTRODUCTION TO THE STUDY

1.0 Introduction
Integration of indigenous knowledge (IK) in school curriculum bridges the gap that seems to be prevalent between classroom activities and activities outside the classroom by ensuring that mathematical concepts learned in classrooms are not done in isolation but takes into account daily experiences of children. In various countries of the world including Kenya, there exists indigenous knowledge that can be meaningfully integrated into the Western school curricula to improve learning outcome. In Vihiga county Kenya, the Luhya tribe has some of the indigenous knowledge expressed in artifacts that can be integrated in mathematical concepts such as; counting, repetitive cycles, similarity and symmetry. Many Luhya objects used in daily life embody mathematical concepts and a mathematical knowledge of forms, shapes, and symmetries. They reveal knowledge of the properties and relations of circles, angles, rectangles, squares, regular pentagons and hexagons, cones, pyramids and cylinders. However, how IK is incorporated by teachers and learners in teaching and learning primary school Mathematics has not been sufficiently documented. In this study the researcher sets out to explore the Integration of indigenous knowledge in teaching mathematics concepts in primary schools in Vihiga County, Kenya

1.1 Background of the Study
Indigenous knowledge (IK) refers to the local knowledge that is unique to a given culture and acquired by local people through the accumulation of experiences, informal experiments, and intimate understanding of the environment in a given culture (Chikaire, Osuagwu, Ihenacho, Oguegbuchulam, Ejiogu-Okereke, & Obi 2012). Indigenous knowledge systems (IKS) are better understood as practical,
personal and contextual units which cannot be detached from an individual, their community, or the environment both physical and spiritual (Howden 2001). IK is generally used synonymously with traditional and local knowledge to differentiate the knowledge developed by and within distinctive indigenous communities from the international knowledge systems generated through universities (Semali & Kincheloe 1999), government research centers, and private industry which is sometimes called the ‘Western knowledge system’ (Maurial 1999).

Indigenous knowledge system (IKS) constitutes the core of community development processes such as agriculture; preservation of food; collection and storage of water; animal husbandry and ethnic veterinary medicine. It also forms the basis of indigenous interpretation of meteorological and climatic phenomena; orientation and navigation on land and sea as well as in management of natural resources. Indigenous knowledge is also very useful in local primary health care; preventive medicine and psychosocial care as well as in procreation. Recently, it has taken centre stage in poverty alleviation through community savings and lending, confection of clothing and tools as well as construction and maintenance of shelter (Kaino 2013).

For thousands of years, the African indigenous knowledge systems existed and have their own education systems, long before Western education was introduced by the European colonialists and missionaries. Thaman (2014) posits that it is very misleading when indigenous knowledge is separated from the modern education, since the content of education has value underpinning it and is associated with a particular culture. The introduction of Western education meant that learners faced the conflicting demands of the new education and those of their home cultures, because the purpose, content, and processes of knowledge transmission conflicts with those of indigenous education (Thaman 2009). Thaman notes that the artifacts that are available
in the traditional environments are important tools that can be used to bridge the gap between what is usually taught in the classroom and what exists outside in the society. Additionally, it is argued that education cannot exclude cultural knowledge, since the content of education has value underpinning it and is associated with a particular culture.

However, despite its highly proclaimed importance and sound pedigree of recognition for strengthening native communities’ preservation of social and traditional capitals towards more independence (Chahine & Kinuthia, in press), no clear effort has been cited that magnifies and exposes the contributions of indigenous cultures to the mainstream knowledge and epistemologies. There are many issues that come under play to effectively design and implement indigenous or culturally responsive curricula as pointed out by (Herbert 2006). Some of the issues include; application of IK, teachers’ perception towards integration of IK, learners' knowledge of IK, strategies of integrating IK and many challenges, ranging from language, resources, beliefs (both for teachers and students) and theoretical frameworks for the implementation of indigenous curricula.

1.1.2 Application of Indigenous Knowledge

Many African objects used in daily life embody mathematical concepts and a mathematical knowledge of forms, shapes, and symmetries. They reveal knowledge of the properties and relations of circles, angles, rectangles, squares, regular pentagons and hexagons, cones, pyramids and cylinders (Kaino 2013). African geometrical exploration developed hand in hand with artistic and aesthetic exploration and the connection between beauty and geometrical exploration was a cultural value common throughout Africa.
A scan across several indigenous cultures reveals elements of knowledge, practices, artifacts that are closely associated with Science and technology, but colonialists did not often recognize them as worthwhile contributions to the global collection of knowledge and practices. Ocholla and Onyancha (2005) in their study, processed infometrics on indigenous knowledge which cover a wide range of indigenous knowledge practices such as agriculture, environment, biodiversity, health and nutrition, just to mention a few. However, the low profile accorded to indigenous knowledge (although much) rendered such contributions valueless and resultantly, such knowledge never features as a commodity.

Hence, indigenous people have reaped nothing out of their contributions. Instead, they suffered some disruptions in their productive practices, since the Western knowledge deskilled them and immediately after deskilling them they had to reskill in order to become functional again. It was imperative for indigenous people to develop new skills under the changed socio-economic demands while living under colonialist governments (Katz, 2004; Maurial 1999).

The greatest reason for neglecting indigenous knowledge was power. Since knowledge is power, money, and prestige (McKinley, 2005; Ocholla & Onyancha, 2005; Shizha 2006), some schools of thought contended that recognition of indigenous knowledge (on the part of colonialists) would give indigenous people power to act or as an agency for identity. Therefore, to maintain power, the colonial masters’ knowledge and voice had to remain superior to those of indigenous people.

Thus, such scholars lay pointers to or indeed reassemble the almost obliterated ideas, practices, and artifacts (produced by indigenous people) that are of scientific relevance (Sundar, 2002) while advancing the claim that Western Science is not a unilateral
practice for the Westerners alone but a universal practice for all people in the world (Sithole, 2004). Indigenous knowledge is, however, locked up in spirituality because it “encapsulates the common good-sense ideas and cultural knowledge of local people concerning everyday realities of living”, according to (Dei 2000).

Any type of Mathematics, including ‘Western’ Mathematics, is greatly influenced by ideas and activities that are important in specific cultures and therefore, should be respected and not taken as primitive. It is only when one comes closer to the people, interacts with them and establishes closer links that one can really appreciate the importance of what they are doing or involved in. Some of the mathematical skills observed at grass-root level are often taken for granted, and not considered important or appreciated. Such skills can be witnessed from the day-to-day activities taking place in the environments where uneducated people are continuously involved in income generating initiatives from local resources.

The Mathematics teachers apply ranges from simple to complex concepts without them being overtly aware of it. The importance of the cultural aspects of Mathematics in such cases can only be realized if studies are done on such activities and published. It should thus not be ignored that people in societies or cultures that do not use Mathematics in the way it is done in the formal education systems, also do engage in many cultural mathematical activities that require complex reasoning about space, time, and number.

1.1.3 Teachers’ Perceptions Towards Integration of IK.

As cultural mediators, teachers in the African context occupy an important but culturally ambiguous position. While their professional training commits them to the rationale and practices of a Western-derived school curriculum, their personal
identities, together with those of their learners, are rooted in their own cultures and traditions. At school, teachers often de-emphasize the values of the students’ home cultures, especially if they conflict with the values that the school is trying to promote (Thaman 2009).

Unfortunately, most teachers (in most parts of the World) were never trained on how to teach culturally appropriate curricula. Hence, Herbert (2006) statement that languages and teacher’s pedagogical knowledge and theoretical frameworks are likely to pose challenges to those who are just joining the process of indigenizing their curriculums like Malawian primary Science teachers.

The consideration of cultural backgrounds of the learners in planning and teaching Science has informed much recent discussions in making teaching more learner-centered. In many countries today, formal education continues to be Euro-centric in outlook and academic in orientation, reflecting Western scientific cultures rather than the cultures of learners and the teachers (Abah, Mashebe, & Denuga 2015). This phenomenon is a major concern in developing countries, where formal education does not put into consideration the way the majorities of learners communicate, think and learn. Learners’ underachievement in school has been attributed to the ‘cultural gaps’ between the expectations of school curriculum and those of the environment in which the learners are socialized.

In Kenya, this gap also exists for majority of the teachers and thus, raises the question of whose and what knowledge is considered worthwhile? The current euphoria for market driven economies and education development make issues such as cross cultural transfer of knowledge, globalized curricula integration and appropriate teaching-learning strategies critically important for consideration. While commendable
efforts are being made to better align educational curricula with indigenous realities, the interrelationship and balance between these two different ways of learning remain delicate (UNESCO 2010). This research will capitalize on the role that IK play in successful and meaningful learning of Mathematics in conventional and non-conventional contexts which cover contents and contexts that incorporate mathematical artifices.

1.1.4 Learners Understanding of Indigenous Knowledge.
Consequently, the learners’ prior knowledge becomes detached from the idea being promoted by the school curriculum and in order to progress with the school system (passing and being promoted to the next class), most African children tend to memorize the theory but lack the application expected to differentiate the educated and non-educated citizens in a society. It is important that African education developers evolve strategies such as integrating the indigenous knowledge system in the teaching of Mathematics which has the potential to make education culturally-inclusive and make the teaching and learning of Mathematics easier for both teachers and the learners (UNESCO 2010).

Indigenous knowledge, especially if extended to the teaching of Mathematics and Science, has the potential to lay the educational foundation for the development of a technological society in any African country that seriously undertakes such action. Such an achievement could be brought about by Mathematics and Science teaching being made more culturally relevant to the learners, thus encouraging more of them to choose those subjects in preference to the general arts subjects who a majority of African students in tertiary education currently choose to study.
In addition, the learners' grounding in culturally-relevant Mathematics and Science would help stimulate creativity at an early age, laying the foundations for the development of an innovation, technological potential that would be linked to local needs and realities and which could subsequently be directed to the search for practical, home-made solutions to their country's development problems (UNESCO 2010). Such creativity could prove to be contagious.

Mathematical creativity thus stimulated could well spill over into, and influence, other areas of educational and economic activity, acting as a general catalyst and stimulus to the society. An educational approach that is rooted in, and inspired by, indigenous knowledge would be more relevant to the learners' life experiences and thus more capable of arousing their interest. Far from alienating them from their socio-cultural environment as much modern education in Africa presently does, it would instead reinforce their links with their environment. It is with such methods that the modern school system in Africa could be revitalized and empowered to play the central role any effective educational system should have in the life of the community (Abah, Mashebe, and Denuga 2015).

The discovery, by learners, of indigenous mathematical thinking and concepts in their own traditions and living culture concepts that are generally considered to have originated with intellectually advanced cultures would improve their confidence in themselves which is absolutely essential for stimulating their creative faculties. That approach would also serve to establish mutually enriching linkages between the school and the community; helps anchor education firmly in African culture, and reduce or eliminate the current alienation of parents in rural Africa from their children's education (Howden 2001). Therefore the study sought to find out if learners have an
understanding of indigenous knowledge and whether the concept of IK is being integrated in teaching mathematical concepts.

1.1.5 Strategies of Integrating Indigenous Knowledge.

Several authors have submitted that in order for schools and curricula to positively respond to the need to make teaching and learning more culturally inclusive; there will be a need for a paradigm shift from the current predominantly Euro-centric curricula and school systems of African (Johannson 2006). However, it was opined that this paradigm shift is a challenge for teachers who are expected to mediate the interface between the different cultural systems of meanings and values that continue to exist in their schools (Thaman 2009).

Given the current acculturation and development of cosmopolitan communities (Makhubu 1998; Semali 1999) individual members perceptions may differ significantly on specific ways of doing things. Central questions that need to be explored when integrating indigenous knowledge in the curriculum reforms are: What aspects of indigenous knowledge need to be incorporated in the integration process? What related features of indigenous ways of knowing and modes of learning are common across the diverse Kenyan indigenous cultures and which ones are unique to particular ethnic groups? Answers to these questions would act as a guide to identifying those features of indigenous knowledge that can be made visible during the process of curricula development.

Kenyan indigenous education systems are highly hierarchical, hence top-down diffusion of knowledge becomes the norm, creating unequal power relations between those in subordinate positions of authority such as in the case of teachers and students Scott & (Miller, 2002). Therefore, students and teachers may find themselves in
situations of dilemma and contradictions due to conflicting value orientations based on their perceptions of knowledge construction. For example, African students who have been immersed within a conservative cultural setting that value authority of elders may find it challenging to express divergent views from their teachers, hence limiting the process of dialogue in the classroom and instead promoting the authoritarian and what (Freire, 1994) refers to as the banking models of teaching.

The on-going global focus on knowledge commodification promotes competition, contradictions, and dilemmas for educators and teachers in the implementation of the integration of indigenous knowledge into the curriculum. At the same time the interface between school and indigenous knowledge is rarely a focus for most Kenyan educators and policy makers. Unfortunately the transfer of indigenous knowledge from everyday life to schoolwork is not always valued or recognized by teachers (Dei, 2002; Mwenda, 2003; Semali, 1999), and it is therefore necessary for teacher education programs to rethink ways in which to prepare teachers for effective integration of multiple forms of knowledge when designing and implementing the teacher education curriculum.

1.1.6 Challenges Facing Integration of Indigenous Knowledge.

Challenges are encountered in effectively incorporating indigenous knowledge in Mathematics primary schools teaching in Kenya. Shizha, (2007) conducted a study using qualitative research methods. Ten teachers were purposively selected and interviewed to gain their insights into problems faced in incorporating indigenous knowledge into teaching. The study found that the problems were attitudinal, institutional, and systemic. In order to address both overt and hidden biases against indigenous knowledge in schools, teachers must first address their own personal attitudes. Because they are strong role models for children, they must be particularly
aware of their underlying preconceptions of indigenous Mathematics knowledge. To successfully implement a multicultural curriculum, teachers need to recognize their own biases, be free of cultural biases, and be schooled in cultural awareness. Bias was detected when teachers were asked how they incorporated indigenous knowledge, culture, traditional beliefs, and customs into their Science lessons (Shizha, 2007).

Also part of the problem stems from the realities of living in a developing country; most indigenous people live in rural and marginalized areas where modern forms of communication are relatively unavailable. This problem is compounded by high levels of ignorance and illiteracy (Mbeva, 2000). Issues pertaining to the recognition, protection and appreciation of IK are therefore very crucial at national level. Awareness of this led to the South African government’s involvement with the establishment of IKS policy and a dedicated IKS office. The same cannot be said for Kenya, where there is no known IKS policy or legislation.

As Mbeva, (2000) observes, the current Intellectual Property Rights (IPR) system in Kenya does not adequately recognize or protect the indigenous people and local communities’ rights in terms of their knowledge and innovations. Findings suggest that there has not been any extensive information and knowledge-based study on integration of IK in teaching mathematical concepts conducted in Kenya more so Vihiga County. Most existing studies have mainly focused on environmental conservation (Muhando, 2005).

**1.2 Statement of the Problem**

A number of studies in the field of Indigenous knowledge have been carried out to find out if traditional knowledge is relevant in teaching of Mathematics and Science concepts. Use of indigenous knowledge in teaching and learning in the classroom
makes pupils experience a school that feels close to their home lives giving them confidence, self-esteem life skills and more so an opportunity to develop talents and abilities to compete in class. Also the studies show that community’s knowledge is not separable from the taught Western knowledge and the relevance was linked to the people’s survival.

However, many developing nations including Kenya have focused more on Western based knowledge which is perceived to be too abstract, not relevant, and more examination oriented, which leads to low levels of attainment in Mathematics education. There are several reasons for this situation, among which are; the manner in which Mathematics is generally taught in African schools, the learners' feeling of alienation from the subject on account of its perceived "foreign" nature and because they see it as having little practical use. To overcome this important obstacle, Mathematics need to be revised in a way that would make it culturally relevant to learners while persuading them at the same time of its utility since Mathematics is a core subject in achieving Kenya’s Vision 2030.

Notwithstanding the extensive literature that urged the utilization of cultural immersion experiences as means of increasing cultural sensitivity for learners across disciplines, little appears to have been done to document the integration of indigenous knowledge in school curriculum in Kenya. UNESCO, 2010 indicate that, education curriculum in Kenya has been based mainly on Western values which is misleading because when indigenous knowledge is separated from the modern education, learners from disadvantaged backgrounds cannot see the connection between the education they receive at school and their everyday experiences. This gap in knowledge between formal and indigenous knowledge is believed to contribute to the high failure rate in Mathematics as well as the perceived difficulty of Mathematics (Mbeva, 2000) which
is reflected in the poor performance of Mathematics at the K.C.P.E level in the primary schools in Vihiga County, Kenya. Table 1.0 shows the county’s mean score in Mathematics as from 2011-2016 (Source; Vihiga County Education Office)

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<td>Mean</td>
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Source; Vihiga County Education Office

To bridge the gap between what is usually taught in the classroom and what exists in the society and to socialize learners with mathematical concepts, this study sought to document initial, firsthand field experiences of how Indigenous Knowledge may or may not be integrated in the existing primary school mathematics curriculum.

1.3 Purpose of the Study

The purpose of this study was to explore the integration of indigenous knowledge in teaching of mathematical concepts in primary schools in Vihiga County, Kenya.

1.4 Research Objectives

This study sought to achieve the following objectives:

(i) To identify the extent to which existing indigenous knowledge practices are applied in teaching of mathematical concepts.

(ii) To find out teachers’ perception towards integration of indigenous knowledge in teaching of mathematical concepts.

(iii) To determine learners’ knowledge about indigenous knowledge that can be integrated in classroom mathematical concepts,
(iv) To explore the strategies used in integrating indigenous knowledge in teaching of mathematical concepts.

(v) To document the challenges faced by teachers while incorporating indigenous knowledge in teaching of mathematical concepts.

Objective (i), (iii), (iv) and (v) are more qualitative in nature hence research questions are stated below while objective (ii) is quantitative in nature hence a hypothesis together with a research questing formulated.

1.5 Research Questions

i. To what extent is existing indigenous knowledge practice applied in teaching of mathematical concepts?

ii. What are teachers’ perception towards integration of indigenous knowledge in teaching of mathematical concepts.

iii. What are the learners’ knowledge about indigenous knowledge that can be integrated in classroom mathematical concepts?

iv. Which strategies can be used in the integration of indigenous knowledge in teaching of mathematical concepts?

v. What are the challenges faced by teachers while incorporating indigenous knowledge in teaching of mathematical concepts?

1.6 Hypothesis

This study sought to test the hypothesis for objective two (ii) which is quantitative in nature.

HO1: There is no significant relationship between teacher’s perception on indigenous knowledge and teaching of mathematical concepts.
1.7 Significance of the Study

For many years, education in African countries including Kenya has been based mainly on Western values. This has contributed to the fact that many learners from disadvantaged backgrounds cannot see the connection between the education they receive at school and their everyday experiences. The study hopes to enlighten and inform key decision and policy makers and also act as a single point of reference for all researchers and stakeholders (including the government) in the field of IK. It is envisioned that the study may be used as a blue print for management matters pertaining to IK in order to encourage its production, generation, storage, preservation and dissemination.

Results from this study has the potential to inform the curriculum developers and also teacher educators of Mathematics on the importance of using indigenous knowledge to promote the teaching of Mathematics in multicultural classes and strategies to adopt in order to incorporate indigenous knowledge in mathematical concepts.

Also curriculum developers may use the results to decide on the strategies from IK to include in the Mathematics curriculum as the country goes through the change of education system from 8.4.4 system to 2.6.3.3.3 system. Furthermore, findings from this study would inform other stakeholders (or countries) who aspire to embrace the integration of indigenous knowledge about issues that need attention in the design and implementation of such a curriculum.

The approach adopted in the study may be used as a benchmark by others when carrying out related studies, or may be customized to suit their situations. The potential of tacit knowledge cannot be underestimated when taking into account that knowledge has become the foremost basis on which competitive advantage. The nature of the
study therefore lays the foundation for other organizations that intend to evaluate their intangible assets in order to know their real wealth.

1.8 Justification of the Study

This study was justified on the grounds that a handful of research has shown the importance of integrating cultural practices that resonate with learners’ ethnic and background experiences in everyday instruction hence teaching and learning in classroom makes pupils experience a school that feels close to their home lives giving them confidence, self-esteem life skills and more so an opportunity to develop talents and abilities to compete in class (UNICEF, 2004).

Again, this study focused on filling the gaps in practical literature pertaining challenges and strategies of incorporating indigenous knowledge in Mathematics curriculum since most literature shows theoretical justification for integration of indigenous knowledge and there are not as many primary studies on indigenous knowledge and the possible content or pedagogical insights that would help teachers implement indigenous knowledge inclusion in Mathematics curriculum in Kenya.

Furthermore, the literature obtained on Mathematics, Science and technologies tend to be studies conducted elsewhere, they may only reflect problems and solutions that are specific to those areas hence need to find out the challenges and strategies in Kenya specifically Vihiga county which can help improve mathematics performance in this county.

While considerable national and international effort in the field of education is devoted to promoting literacy in Africa, virtually little is accorded to numeracy. Mathematics is, however, a crucially important subject for any country that hopes to develop scientific and technological capacity. It is also a key subject for any country that
wishes to see its population develop a level of numerical skills that would allow it to take full advantage of the new information technologies. African cultural traditions can make a significant contribution to the teaching of Mathematics and to the promotion of numeracy in the general population.

1.9 Scope and Limitations of the Study

This section provides information on the delimitation and limitations of the study. It puts forth information concerning the extent and range that was dealt with in this study. The limitations provide information concerning the challenges and restrictions that the researcher is likely to face in the course of inquiry.

1.9.1 Scope of the Study

This study did not go into all the factors that could influence the IK practices, instead, it opted to focus on integration of indigenous knowledge within Mathematics curriculum in primary schools in Kenya. As the objectives show, the study investigated the extent to which existing indigenous knowledge is integrated in Mathematics curriculum, teachers’ perception and learners knowledge towards integration of indigenous knowledge, challenges and strategies of integrating indigenous knowledge in teaching of mathematical concepts.

This study was carried out in selected public primary schools in Vihiga County, Kenya and the units of analysis for the study included class six Mathematics teachers and class six learners. Data collection tools included; questionnaires for the teachers, focus group discussion guide for the pupils and observation checklist for class observation. The study adopted a concurrent triangulation design that was cross sectional in nature (cross-sectional study involves a one-time interaction with groups of people).
1.9.2 Limitations of the Study

Limitations are the shortcomings, conditions or influences that cannot be controlled by the researcher that place restrictions on methodology and conclusions. Furthermore a limitation is an aspect of a research that may influence the results negatively and affect the generalizability of the results but over which the researcher has no control (Mugenda & Mugenda, 2003).

The study was conducted within Vihiga County which is one locality among many others in Kenya. This size of study makes it hard to make generalizations out of its findings because IK vary from one region or group to the other. However, the researcher increased the size of participants so as to increase the capacity to reveal issues being researched.

Also the study report was done on a small scale study in which a small sample was used in order to enhance the richness of qualitative data. Thus, the results cannot be generalized to apply to all class six learners. However the processes followed in this study was utilized to adapt learners to classroom environments that allow them responsibility for making sense of what is being learnt.

Secondly, IK in Kenya has been marginalized because there have been no proper national policies and legislation to safeguard it. Due to the disparity of information resources on IK schools lacks efficiency and effectiveness in its enhancement. Illiteracy and lack of cohesive information on IK are major drawbacks to the development and promotion of IK

In addition, this study did not go into all the factors that could influence the IK practices in Kenya. Instead, it opted to focus on integration of indigenous knowledge within Mathematics curriculum in primary schools in Kenya. A study on all the factors
that influence IK would be highly complex. Even here, problems were encountered in
the overlap of the characteristics of IK and the factors influencing IK. This was
addressed by sticking to the specific objectives of the study.

Since the research had to observe the classroom presentation four times, some head
teachers and teachers were not cooperative to allow the research do the observation
repeatedly. Also, some students were passive during the focus group discussion and
some teachers did not fill all the items in the questionnaire. Limited time and resources
availe to the research were also other challenges encountered.

1.10 Assumptions of the Study
The study was based on the following assumptions;

(i) That the participants would co-operate and provide adequate dependent data
   free from biases.

(ii) There are no significant differences in existing IK across Vihiga County as far
     as teaching and learning of mathematical concepts are concerned.

(iii) That all the teachers selected understand the concept of indigenous knowledge.

1.11 Theoretical Perspective
The theoretical perspective adopted in this study is the constructivist theory of
knowledge.

Bruner (1990) and Piaget (1972) are considered the chief theorists among the cognitive
constructivists, while Vygotsky (1978) is the major theorist among the social
constructivists.

Constructivism is an epistemology, or a theory, used to explain how people know what
they know. The basic idea is that problem solving is at the heart of learning, thinking,
and development. As people solve problems and discover the consequences of their actions through reflecting on past and immediate experiences they construct their own understanding.

Constructivism is the philosophical and scientific position that knowledge arises through a process of active construction (Mascolol & Fischer, 2005). Learning is thus an active process that requires a change in the learner. This is achieved through the activities the learner engages in, including the consequences of those activities, and through reflection. Each learner generates their own "rules" and "mental models," which are used to make sense of experiences. In the world of learning theories, Constructivism would lay on the opposite end of the spectrum of that of Objectivism. Objectivism deals more with measurable outcomes while Constructivism deals with the cognitive processes in which the learner develops his or her knowledge. Constructivism is also a very broad conceptual framework with many variations perspectives.

1.11.1 Jean Piaget's Theory of Constructivism (1972)

Piaget advocates that, learners build their mental representation of their world through progressively reorganizing prior active manipulation of an environment. Piaget theorized a hierarchy of skills that are developmentally aligned, which could be attained based on readiness (sensorimotor, preoperational, concrete operational and formal operational skills). One outstanding observation raised by Piaget was the fact that learners come to school with a great deal of knowledge, termed prior knowledge which determines the reception or processing of information when they undergo school lessons. All theoretical dimensions in Piaget’s theory involve the individual learner (Woolfolk, 2005). He suggested that through processes of accommodation and assimilation, individuals construct new knowledge from their experiences.
Constructivism theory of knowledge argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas. It has influenced a number of disciplines, including psychology, sociology, education and the history of Science.

The theory is linked to this study because the researcher considers that learners construct new knowledge based on what is already known to them from their society and culture (indigenous knowledge). Therefore it is important for learners to be exposed to learning opportunities that link mathematical concepts and principles with their applications encountered in everyday experience. Also, engaging the constructivist approach to learning, implicitly or explicitly creates a link to local people’s knowledge (indigenous knowledge) that comes under play in a child’s process of learning as purported under the constructivist learning paradigm (Stanley & Brickhouse, 2001).

In addition to this theory’s argument, learners are assumed to construct their mathematical conceptual understandings as they participate in cultural practices (Indigenous knowledge) and whilst interacting with each other and also connections to the world outside of schools. In Mathematics areas in the classroom, constructivist teachers provide opportunities for active learning, discovery learning, and knowledge building, which promote a learner's free exploration within a given framework or structure. The teacher acts as a facilitator who encourages learners to discover principles for themselves and to construct knowledge by answering open-ended questions and solving real-world problems using indigenous knowledge.
1.11.2 Vygotsky's Theory on Social Constructivism (1978)

Lev S. Vygotsky believed that culture is the principal determinant of cognitive progress. In Vgostsky's theory on constructivism, knowledge leads to further cognitive development. The societal configuration of intelligence states that the individual growth could not be comprehended without indication to the societal and cultural context where the aforementioned evolution is entrenched mind development is continuous. Vygotsky focuses on the actual mechanism of the development. He excludes discernible stages of development as theories and assumptions. Vygotsky's theory on constructivism does not adhere to the idea that a single abstract principle is able to explain cognitive development. As a substitute to Piaget's constructivism, he argues that knowledge is internalization of social activity.

Vygotsky and Piaget's theories are often contrasted to each other in terms of individual cognitive constructivism (Piaget) and social constructivism (Vygotsky). Some researchers have tried to develop a synthesis of these approaches, though some, such as Michael Cole and James Wertsch, argue that the individual versus social orientation debate is over-emphasized. To them, the real difference rests on the contrast between the roles of cultural artifacts. For Vygotsky, such artifacts play a central role, but they do not appear in Piaget's theories.

Vygotsky believed that learning takes place within the Zone of Proximal Development. In this, students can, with help from adults or children who are more advanced, master concepts and ideas that they cannot understand on their own. This model has two developmental levels:

1. The level of actual development – point the learner has already reached & can problem-solve independently.
2. The level of potential development (ZDP) – point the learner is capable of reaching under the guidance of teachers or in collaboration with peers.

The ZDP is the level at which learning takes place. It comprises cognitive structures that are still in the process of maturing, but which can only mature under the guidance of or in collaboration with others.

The theory is linked to this study because the researcher considers that learning environments should involve guided interactions that permit children to reflect on inconsistency and to change their conceptions through communication. Also the researcher agrees that social constructivism or socioculturalism encourages the learner to arrive at his or her version of the truth, influenced by his or her background, culture or embedded worldview.

1.11.3 Jerome Bruner's Theory on Constructivism (1990)

Jerome Bruner was one of the most influential constructivists. Bruner’s theory of Constructivism was influenced by the earlier theoretical research of Lev Vygotsky, and Jean Piaget. His theoretical framework supports the belief that learners construct new ideas or concepts based upon existing knowledge. The process of learning is active and involves transformation of information, deriving meaning from experience, forming hypotheses, and decision making. Through his work he presented the idea that children could be active problem solvers and were capable of exploring more difficult subjects of instruction.

Bruner’s theory of Constructivism falls into the cognitive domain. Learners are considered to be creators and thinkers through the use of inquiry, and the role of experience in learning. The process of which how learners construct knowledge rather than the output of information is heavy in focus. Opportunities are provided for
learners to construct new knowledge and new meaning from authentic experiences. Bruner developed three stages of representation which are enactive, iconic, and symbolic. None of the stages are age specific to the learner compared to Piaget’s research which has a specific age for each stage.

In the enactive stage, knowledge is largely in the form of motor responses. Students may be able to perform a physical task better than describing the exact same task that has just been accomplished. This shows that the learner is more in the enactive stage of representation. In the iconic stage, knowledge is largely more in visual images. When presented with new information, it is sometimes more helpful to people who are in the iconic stage of representation to have a diagram in order to visualize concepts being taught.

When in the symbolic stage, knowledge is mostly in the form of arbitrary words, mathematical symbols and other symbol systems. Mathematical symbols possess meaning s in mathematics and language. The symbol x and both mean multiply but can also have a different meaning in another discipline such as language. Bruner does acknowledge that learners go through various stages of development but he does not specify learner’s age at which these stages will take place as Piaget does in his theory of Genetic Epistemology. Bruner (Constructivist Theory) and Piaget agree that the learner must find the lesson useful and relevant. Piaget’s learners progress from one stage to the next while Bruner’s learners must extrapolate from the known to the unknown. It is very possible for an adult to switch from iconic to symbolic or even from enactive to iconic or symbolic as opposed to going from formal operational to sensory motor. The instruction will dictate the stage learners utilize when constructing interpretations of the concept.
The theory is linked to this study because the researcher considers that, by suing a spiral curriculum, learners build on previous construction of knowledge to formulate more useful associations and authentic meanings. Also, the learner will take pieces of their past knowledge and experiences and organize them to make sense of what they know, then base further concepts and solve additional problems based upon a combination of what they already processed and what they think should be processed next. The teacher resources used should be focused on that of encouragement, aiding and allowing the student to uncover the main principles on their own.

1.12 Conceptual Framework

The study was based on the following framework which conceptualizes the integration of indigenous knowledge in teaching mathematical concepts by highlighting the independent variables, dependent variable and the intervening variables. Since acquisition of indigenous knowledge is through interaction with daily experiences of the realities of the world reflecting capabilities, priorities, and value systems, the researcher sought to address the following independent variables; the extent to which existing indigenous knowledge practice are applied, teachers’ perception toward integration of indigenous knowledge, learners’ knowledge about indigenous knowledge that can be applied in mathematics, strategies of integrating indigenous knowledge in teaching of mathematical concepts and documenting the challenges faced by teachers while incorporating indigenous knowledge in teaching of mathematical concepts.

The dependent variable based on mathematical concepts in class six such as; numbers and numeration, measurement, geometry and algebra. The intervening variables such as teachers’ experience and teachers’ qualifications was controlled by enlarging the study sample. In this study it is argued that indigenous knowledge influence learning
of mathematical concepts. Figure 1.0 shows the conceptual framework of how independent variables, dependent variables and intervening variables intertwine.

**Independent Variables**  
**INTEGRATION OF INDIGENOUS KNOWLEDGE.**

- Existing Indigenous Knowledge
- Teachers’ Perception Towards Integration of Indigenous Knowledge
- Learners’ knowledge about Indigenous Knowledge that can be applied in math
- Challenges of integrating Indigenous Knowledge
- Strategies of Integrating Indigenous Knowledge

**Dependent Variable**  
**TEACHING OF MATHEMATICAL CONCEPTS.**

- Numbers and Numeration
- Measurement
- Geometry
- Algebra

**Intervening Variables**

- Teachers’ experience
- Teachers’ qualification

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Figure 1.0 Conceptual Framework

Source; (researcher, 2016)
1.13 Operational Definition of Terms

The terms used could have different meanings in other contexts, or, could be written differently. Therefore, the researcher explains what the terms mean as used in this study.

**Indigenous knowledge (IK):** specific forms of knowledge that is local and specific to place.

**Indigenous Knowledge Systems (IKS):** the totality of the knowledge that a community holds. IKS includes worldview, and is therefore broader than IK.

**Indigenous artifacts:** specific forms of tools that is local and specific to place.

**Strategies:** These are the tactics a teacher should know and use in presenting information to learners (Kafu, 2010). It is used in this study to refer to the art of the teacher of planning the best way to incorporate indigenous knowledge in teaching of mathematical concepts.

**Perception:** a way of regarding, understanding, or interpreting something; a mental impression.

**Integration:** the act or process of uniting different things

**Knowledge Integration:** is the process of synthesizing multiple knowledge models (or representations) into a common model (representation).

**Western knowledge:** knowledge accumulated over many centuries from both European and non-European cultures and has been modified to better fit the ways of knowing of Western knowledge.
1.14 Summary of the Chapter

This chapter has presented background to the study which has outlined the case of the study. The chapter has also identified the problem of the study, purpose of the study, research objectives, research hypotheses, significance and justification of study, justification of the study, scope and limitations of the study, assumptions of the study, theory that guide the study, conceptual framework and operational definition of terms. The next chapter will present literature review.
2.0 Introduction
Understanding aspects of indigenous knowledge (IK), with respect to its characteristics, production, maintenance, adaptation, transmission and its use, is crucial for one to make coherent relationships between IK and Mathematics and indeed in making a sound analysis of all propositions about the need for Mathematics teaching to embrace indigenous knowledge. This chapter gives discussion on related literature review on this topic.

2.1 Understanding Indigenous Knowledge
Indigenous knowledge is often perceived as historical and ancient practices of the African peoples, which is a problematic perception. The word indigenous has often been used to refer to specific groups of people defined by ancestral territories, collective cultural configuration, and historical locations (Angioni, 2003; Dei, 2002; Purcell, 1998; Turay, 2002). In this context indigenous knowledge is a multifaceted body of knowledge, practices, and representations that are maintained and developed by peoples with long histories of close interaction with the local natural environment.

Semali and Kincheloe, (1999) described the term “indigenous” as ambiguous because it has various meanings. Its former meaning, as construed by colonialists during colonialism era, is different from the current perception by some of the colonized people in the neocolonialism era. From colonial masters’ perspectives, the term indigenous was associated with the primitive, the wild, the ignorant, and the natural. All the descriptors of bearers of the term indigenous were implicated with condescension from the Western observers (as depicted in most anthropological studies conducted earlier by Western anthropologists): An element that postcolonial
theorists reveal to be a causal factor that leads to little appreciation of indigenous insights and understandings that indigenous people offered to the colonial masters’ pool of knowledge (Carter, 2006; McKinley, 2005; Semali & Kincheloe, 1999).

The term “indigenous” is loaded with meanings (traditional, local, natural, and primitive), just like the term knowledge connotes different things to different people. A combination of the two words (indigenous knowledge) obviously presents a huge task in constructing a single concept. Hence, some people say, “the meaning of indigenous knowledge is difficult to pin down” (ICSU, 2002, Maurial, 1999). Since we are going to use these terms frequently, it is necessary to discuss aspects of indigenous knowledge, in general, through which the linkages with Science can be discerned. Prior to analysis of “indigenous knowledge” as a unitary concept, let us put the terms indigenous and knowledge in the limelight.

Indigenous Knowledge, therefore, denotes that the knowledge is typical and belongs to peoples from specific places with common cultural and social ties. Thus, indigenous knowledge is a process of learning and sharing social life, histories, identities, economic, and political practices unique to each cultural group. This reflects the uniqueness of ways that specific societies make meaning of the world and how such forms of knowledge address local problems and solutions that are context specific. In this paper indigenous knowledge is framed as the complex set of activities, values, beliefs and practices that has evolved cumulatively over time and is active among communities and groups who are its practitioners. It remains so as long as the groups and communities who are its practitioners are committed to sustaining, creatively developing, and extending its potential enrichment within a specific setting (Carter, 2006; McKinley, 2005).
All people that Westerners labeled as indigenous were viewed as inadequate and the more the indigenous people saw themselves in that position, from implicit or explicit experiences, the more they accepted their knowledge and capabilities as lower in value. This trend led to attenuation of some forms of practices and knowledge that indigenous people used for thousands of years prior to the arrival of expansionist Europeans (Ocholla and Onyancha, 2005). However, as Semali and Kincheloe, (1999) pointed out, some indigenous people do not share this subjugated view of their indigenous knowledge. Especially the millions of indigenous peoples of Africa, Latin America, Asia, and Oceania...some of such indigenous knowledge have been named native ways of knowing through which elements of local Science, Mathematics and technology are highlighted.

A scan across several indigenous cultures reveals elements of knowledge, practices, artifacts that are closely associated with Science and technology, but the colonialists did not often recognize them as worthwhile contributions to the global collection of knowledge and practices. In their study, Ocholla and Onyancha, (2005) processed infometrics on indigenous knowledge which cover a wide range of indigenous knowledge practices such as agriculture, environment, biodiversity, health and nutrition, just to mention a few. However, the low profile accorded to indigenous knowledge (although many) rendered such contributions valueless and resultantly such knowledge never featured as a commodity. Hence, indigenous people have reaped nothing out of their contributions. Instead, they suffered some disruptions in their productive practices, since the Western knowledge deskilled them and immediately after deskilling them they had to reskill in order to become functional again. It was imperative for indigenous people to develop new skills under the changed socio-
economic demands while living under colonialist governments (Katz, 2004; Maurial, 1999).

The greatest reason for neglecting indigenous knowledge was power. Since knowledge is power, money, and prestige (McKinley, 2005; Ocholla & Onyancha, 2005; Shizha, 2006), some schools of thought contended that recognition of indigenous knowledge (on the part of colonialists) would give indigenous people power to act or agency for identity. Therefore, to maintain power, the colonial masters’ knowledge and voice had to remain superior to those of indigenous people. Thus, such scholars lay pointers to or indeed reassemble the almost obliterated ideas, practices, and artifacts (produced by indigenous people) that are of scientific relevance (Sundar, 2002) while advancing the claim that Western Science is not a unilateral practice for the Westerners alone but a universal practice for all people in the world (Sithole, 2004). Indigenous knowledge is, however, locked up in spirituality because it “encapsulates the common good-sense ideas and cultural knowledge of local people concerning everyday realities of living”, according to (Dei, 2000).

African indigenous ways of knowing are as diverse as approximately the forty two ethnic communities in Kenya especially in the rural areas. Given that most of the inhabitants of Kenya live in rural areas, thus depending directly on natural resources for their livelihood, it can be inferred that indigenous knowledge systems, which relate to such resources are still very much in use and remain important to these communities. It is also important to note that such practices have evolved over time and regions, as a response of individuals and communities needs to adapt to challenges posed by their social and natural environments. As stated by Dei, Hall, and Rosenberg (2002), knowledge cannot be perceived as fixed categories, experiences, and social practices. Wane (2002), reiterates this dynamic nature of indigenous knowledge by
noting that indigenous forms of knowledge have accrued over time, which is a critical aspect of cultures. Wane has argued that in the process of learning the old knowledge, new knowledge is discovered and this is what makes indigenous knowledge more dynamic. Therefore, when analyzing indigenous knowledge forms in Kenya, there is need to realize the complexities of its evolution due to its transition, enrichment, and its devaluation during the colonial era.

Indigenous knowledge is developed and sustained through traditional education, which provides skills, trade training, and socialization avenues for many youths in Kenya today who never attended or dropped out of the formal school system. Common features in the process of knowledge transmission among most ethnic communities in Kenya occur within the context of family, community, clan tribe, and cultural age groups. It is a lifelong learning process involving progression through age groupings, seniority, and wisdom of elders (Mudimbe, 1988; Mungazi, 1996; Wangoola, 2002). Among certain ethnic groups for example the Luhyas of Western Kenya, knowledge and wisdom is perceived to advance with the age of individuals based on their experiences with life.

Acquisition of this form of knowledge is through interaction with daily experiences of the realities of the world reflecting capabilities, priorities, and value systems of members of the community. The purpose of indigenous education is to place knowledge within the context of the user (Dei, Hall & Rosenberg, 2002; Wane, 2002). In pre-colonial era, most Kenyan ethnic communities like other parts of Africa were guided by worldviews and value systems where spirituality became the guiding force for all human activities and development (Dei, et al, 2002; Wangoola, 2002). This is reflected in the communities’ proverbs that are a source of indigenous knowledge from which we can learn or reaffirm certain valuable realities such as peace, harmony, and
love for life, respect for individuals, property and the environment. In this case, environmental preservation is key in human activities since the presence of God is manifest in the typology.

Indigenous education practices among Kenyan ethnic communities are holistic as it integrates all activities including rituals and skills required to sustain cultural practices, life of the family, and community. The aim is to prepare individuals for communal responsibility and interpersonal relationships as key components of the learning process. Therefore, combining specific skills acquisition with good character has been considered as virtues of being well educated and a well-integrated member of the society (Mungazi, 1996; Semali, 1999). As stated by Mungazi, an individual’s “place in society was determined more by his contribution to its well-being. The individual had to be trained to remain sensitive to the needs of the community as a whole and others as individuals”. Cultivation of individuals’ responsibilities to their communities becomes a dominant objective of the teaching and learning process in indigenous education. Among conservative communities living in rural, arid and semi-arid parts of Kenya that have not been significantly influenced by Western education, individuals do have rights as individuals but primarily are held highly accountable to their communities. For example accumulation of individual property or wealth does not automatically accord status to the individual. Wealthy people who want status recognition must demonstrate their social consciousness and responsibility by contributing to their community’s welfare.

Indigenous knowledge is handed down from one generation to another through symbols, art, oral narratives, proverbs, and performance such as songs, storytelling, wise sayings, riddles, and dances (Dei, 2002; Mudimbe, 1988; Semali, 1999; Turay, 2002). In most rural, arid, and semi-arid parts of Kenya, especially in communities
where formal education has had insignificant impact, oral art remains the most important means of transmitting knowledge and skills as a way of maintaining societal continuity from one generation to the next. For example, during initiation into adulthood among the Kikuyu, Maasai, Luhya, and Kalenjin communities, the elders prepare youths for their transitional roles and responsibilities in adulthood. In a way, this is formal education for the age sets.

Methods used in indigenous education are aimed at integrating character building, intellectual training, manual activities, and physical education. Specific trade skills are learnt through apprenticeship and youths’ observation of the practices modeled by adults or trainers. In the case of specialized knowledge such as indigenous medicine and spirituality, specific members of the family are identified as custodians of the knowledge and mentored through exposure to the practice by those who are specialized in the field from the family or clan (Dei, Hall & Rosenberg, 2002; Mudimbe, 1988; Turay, 2002).

Experiential knowledge is always acquired through personal exploration and practicality based on everyday lived experiences. Indigenous education involves the expertise of multiple teachers given the multiple natures of roles and responsibilities in life through which the youths need to be mentored and guided. This is summed up by a proverb that is commonly used across Kenyan ethnic communities, which states, “it takes a whole village to educate a child”. The communal responsibility of education forms the basis for indigenous pedagogy in most Kenyan ethnic communities especially in some parts of the rural, arid, and semi-arid areas (Dei, Hall & Rosenberg, 2002).
Efforts to understand indigenous knowledge is thwarted by several reasons ranging from ambiguity of terms, obscure forces that act on conception of ideas and processes surrounding indigenous peoples, socio-cultural lives (power, politics, and socio-economic factors), and lack of background knowledge (among teachers) to identify relevant or irrelevant bodies of knowledge in the process of planning and teaching Mathematics that embraces indigenous knowledge. For teachers, who largely depend on knowledge that they learned from college, dealing with indigenous knowledge may look like far out of reach. In other words, ordinary minds do not usually worry about processes that shift the position of things in a society (Wane, 2002).

### 2.1.1 Indigenous Knowledge in Kenya

IK in Kenya Although Kenya does not have a national policy dedicated to IK, there have been various initiatives by some institutions, the most notable being the National Environmental Management Authority’s (NEMA’s) report highlighting the status quo of IK within the country with respect to the available related legal frameworks (NEMA, 2006). The report also revealed the various laws and policies that lay the foundation for the implementation of programmes that touch on IK such as: National Policy on National Heritage and Culture; Traditional Medicine and Medicinal Plants by the Ministry of Planning and National Development; Legislation on IK folklore, Genetic Resources by the Attorney General (AG) Chambers; and The NEMA Act, Sections 43, 50f and 51f.

A major initiative by the Kenyan government took place in 1998 when an audit was taken in collaboration with a number of stakeholders, including the Centre for Indigenous Knowledge Systems and By-Products (CIKSAP), Indigenous Information Network (IIN), and the National 6 Museums of Kenya (NMK). They formed the
Kenya Indigenous Knowledge Working Group (KIK-WG) and proposed a strategy for mainstreaming IK into development policy.

Regionally, Kenya is party to the following conventions:

- The Treaty of the Establishment of East Africa (EAC)
- Inter-Governmental Authority on Development (IGAD)
- Common Market for East and Southern Africa (COMESA)
- The African Model Law for the protection of the rights of the local communities, farmers and breeders and for the regulation of access to biological resources Lake Victoria Environment Management Program designed to holistically address environmental problems within the lake and its catchment.

Globally, Kenya is part of the following:

- Convention on Biological Diversity of 1992
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- The Convention on Wetlands or Ramsar Convention (for international cooperation)
- The Union for the Protection of Plant Variety (UPOV) (1978&1991)
- The Cantagena Protocol on Biosafety
- The International Treaty on Plant Genetic Resources for Food and Agriculture
- The World Trade Organization (WTO)
- Trade Related Aspects of Intellectual Property Rights (TRIPS)
The United Nations Framework Convention on Climate Change (UNFCC)
United Nations Convention to Combat Desertification (UNCCD)
SPS the Agreement on Sanitary and Phytosanitary Measures (SPS Agreement)
The Convention for the Protection of World Cultural and Natural Heritage of 1972
The Convention on the Conservation of Migratory Species of Wild Animals of 1979
The Born Guidelines

Chapter five outlines and highlights the various laws and policy guidelines that are in place in Kenya (some are still in draft form).

On the 27th of August, 2010, Kenya promulgated a new constitution that superseded the old one. The new constitution gives IK prominence in terms of recognition, appreciation, promotion and protection evident in the preamble of the constitution where IK is recognized as the foundation of the nation. More on IK is also found in the whole of clause 11, the Bill of Rights in chapter four (clause 19, 44, 45), and chapter five (clause 61 – part 1, clause 63 - part 1 & 2, clause 69.

The World Trade Organization’s Trade-Related Aspects of Intellectual Property Rights (IPRs) covers intellectual property rights in patents, geographical indications, undisclosed information (trade secrets), and trademarks. IPRs do not pay special attention to IK (Ngetich, 2005). The Convention on Biological Diversity (CBD) on the other hand, makes special reference to the protection of IK by assigning the ownership of biodiversity to indigenous communities and individuals (ibid). The following are two articles that are directly relevant.
Article 8 (j): State parties are required to: Respect, preserve and maintain knowledge innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote the wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices.

Article 18.4: Contracting parties should:-Encourage and develop models of cooperation for the development and use of technologies, including traditional & indigenous technologies." Ayayo, in a UNEP meeting report (2004), outlines some examples of the application and use of IK that were (and still are) prevalent in Kenya:

Fish conservation. Fish breeding periods and the places and behavior of fish-eagles were closely studied to make it possible for fishermen to identify the possible movements of schools of tilapia and other types of fish and recognize different types of winds and their directions.

Land use conservation. This involved shifting cultivation to prevent land from overuse or repetitive cultivation throughout the season. Land was normally left uncultivated for manure accumulation. Mixed crop cultivation was also practiced for the restoration of nitrogen to the soil for other crops. IK enabled the farmers to understand their seasons well enough to know when to expect long and short rains, hence enabling them to plan their planting.

Biodiversity conservation. IK enabled people to appreciate and understand the importance and relationship of local birds, local trees and bushes and the knowledge that destroying such natural elements would endanger the community by leaving them without ecological indicators of the natural environment.
**Disaster management from various perspectives:** Wind patterns - IK of storm routes and wind patterns enabled people to design their disaster management practices in advance through the construction of appropriate shelters, wind break structures, walls and homestead fences. Preparing for hydrological disasters was a key issue. Cloud and rain patterns - knowledge of local rain patterns enabled people to prepare for storms. They would know the intensity of rain by cloud colour, when to expect a prolonged drought, and use messages from different birds’ cries for them to take appropriate action. Animal behavior - knowledge of an impending calamity, for instance a large swarm of butterflies was a sign of army worm infestation and famine, thus they would plant drought resistant crops like potatoes and cassava. The migration of bees would mean an oncoming dry season, pushing livestock herders to migrate to higher or lower ground in search of grass and water.

Indigenous knowledge is embedded in culture, which makes it very difficult to isolate. However, various scholars, for example Kaniki and Mphahlele (2002), Mutula and Kok (2005), identify forms in which IK is represented. These forms fall into three categories, namely ecological, spiritual and astrological (Ikoja-Odongo, 2004). IK in Africa is often reflected in a community based on its religion and/or culture, ancestral worship and the belief that the ancestors can communicate with individuals (Kaniki and Mphahlele, 2002). Many African communities also believe that sacrificing cows, goats and sheep symbolizes cleansing (Kok, 2005). Frazer, (2005) provides this example of the Kikuyu, who reside in the central province in Kenya.
2.1.2 Indigenous Knowledge Exchange

Since IK is embedded in the culture of a particular community, its transfer is also restricted to the same (World Bank, 1998/99:8). The exchange process of IK can be classified into six stages as highlighted by the (World Bank 1998/99):

**Recognition and identification.** This process is important because it identifies the type of IK and its strategy or technology. This stage proves rather challenging because it is sometimes difficult to isolate IK from day-to-day life, and to some extent even the practitioners themselves may not be aware of their IK.

**Validation stage.** This involves seeking the significance and relevance of IK, its reliability, functionality, and its effectiveness and transferability. The community should be involved at the original site of application. This is because IK is in tacit form and may prove difficult to apply since it would involve direct practice and apprenticeship. Other factors such as appropriate technology will depend on the cultural, political and economic situation and the level of technical competence of the recipients. It is also advisable to pilot test any new technologies with the recipients.

**Recording and documenting.** The scope is determined by the intended use of the information. Documentation may be in the form of audiovisual technology, taped narration, drawings, and other types of codifiable information.

**Storage.** For example in retrievable databases, involves categorization, indexing services relating to IK to other information, and accessing, conserving, preserving and maintaining IK for future retrieval. Retrieval should be user-friendly and could include electronically stored and indexed abstracts, directories of experts or applications. Retrievable forms should also include tapes, databases and IK practitioners.

**Transfer.** This process goes beyond conveying the information to new recipients. Factors such as testing the knowledge in a new environment, economic and technical feasibility, social and environmental impacts and other criteria need to be examined by
the recipients. It can stand the test or be rejected. All stakeholders must be involved and support must be accorded by the government and donor agencies. For a successful transfer, careful selection of cooperating partners and potential beneficiaries in a participatory process is necessary.

**Dissemination.** This stage is achieved after the successful transfer and adaptation of IK. Dissemination includes public awareness campaigns, public broadcasting, advertisements, seminars, workshops, distribution of information, publications, and IK incorporation into extensive programs or curricula. These activities could target a specific group or the general public.

### 2.1.3 Ethnomathematics

For decades school Mathematics was taught as a ‘culture free’ subject. It cannot be denied that much of the teaching that goes on in the classrooms still portrays Mathematics as culture free. However, the realisation that Mathematics exists in cultural activities and that Mathematics can be learnt outside of the official school situations has led to the emergence of ‘ethnomathematics’. Barton’s (1996) define “Ethnomathematics as the field of study which examines the way people from other cultures understand, articulate and use concepts and practices which are from their culture and which the researcher describes as mathematical”. The term ‘cultural Mathematics’ will therefore mean the mathematical ideas, knowledge and practices that can be identified in socio-cultural contexts through the study of ethnomathematics.

Mathematics that is learnt in schools will be referred to as ‘school Mathematics’. Mathematics that takes into consideration the culture in which it has arisen, is known as ethnomathematics. In order to gain a deeper understanding of the cultural aspects, which encompass mathematical structures, one needs to consider ethnomathematics as the development of structures and systems of ideas involving numbers, patterns, logics,
and spatial configurations. This further involves the examination of the origins of such concepts and how these are used in various cultures (D'Ambrosio, 1985). More specifically then, ethnomathematics is Mathematics as practiced among identifiable cultural groups, such as national-tribal societies, labour groups, children of a certain age bracket, professional classes, and so on. Its identity depends largely on the foci of interests on motivation and on certain codes and jargons, which do not belong to academic Mathematics (D'Ambrosio, 1985).

Many people are unconsciously applying mathematical skills in everyday life without realizing its importance. There is a great probability that such skills, if transferred to schools, could advance the teaching and learning of Mathematics. The main reason why Mathematics is taught at schools is to sharpen real life practices such as counting, ordering, sorting, measuring, weighing, etc. (Ascher, 1991). Therefore, the skills of those applying Mathematics in their cultures, without any formalized training, could contribute positively towards better performance by the learners in the classroom. This simply means that the teaching and learning processes in Mathematics would benefit greatly if cultural mathematical forms of each society or ethnic group are appreciated, without being underestimated or regarded as primitive, and transferred to schools. The pedagogical potential of, for example, design, counting, geometry, metric systems, weighing, etc. used in cultural mathematical activities are very important, and are closely associated with the beliefs in everyday life of various ethnic groups.

Any type of Mathematics, including ‘Western’ Mathematics, is greatly influenced by ideas and activities that are important in specific cultures and therefore, should be respected and not taken as primitive. It is only when one comes closer to the people, interacts with them and establishes closer links that one can really appreciate the importance of what they are doing or involved in. Some of the mathematical skills
observed at grass-root level are often taken for granted, and not considered important or appreciated. Such skills can be witnessed from the day-to-day activities taking place in the environments where uneducated people are continuously involved in income generating initiatives from local resources. The Mathematics they apply ranges from simple to complex concepts without them being overtly aware of it. The importance of the cultural aspects of Mathematics in such cases can only be realized if studies are done on such activities and published. It should thus not be ignored that people in societies or cultures that do not use Mathematics in the way it is done in the formal education systems, also do engage in many cultural mathematical activities that require complex reasoning about space, time, and number (Gerdes, 1986).

There are many ways to use the cultural aspects found in Mathematics. Examples range from the study of arithmetical relationships, symmetry and similarity among others. Some human activities that require forms of Mathematics are found in architecture, soap making, weaving, sewing, agriculture, games. For example in architecture, construction of houses, other buildings, bridges, terraces, etc. are involved. In soap making, mixing and cooking fat with some chemicals, cooling and cutting into small pieces of soap are involved. Making of textiles and baskets, with or without design and ornaments are found in weaving. In sewing, flat pieces of cloth or animal skins are turned into clothing or shoes that fit. In agriculture, e.g. devising calendars to mark seasons, planning for quantity and storage facilities, layout of gardens and fields, counting animals and other properties are found. Games reveal a highly developed Mathematics. Products from wires such as toy cars and other products are made by using right angles and other mathematical principles (Gerdes, 1999).
Mathematics taught in most schools has had its origins from the cultural findings that mainly emphasized the Greek, ancient Egyptian and the Western cultures. All these cultural findings provide a rich source of material about numbers, numeration systems, written numerals, computational methods, and applications (D’Ambrosio, 1985). A growing awareness of the societal and cultural aspects of Mathematics and mathematical education worldwide began to emerge within the ranks of mathematicians in the early 1970s. Wilder, (1974), who intensively investigated the cultural influence in the teaching and learning process of Mathematics, spearheaded the understanding of culture to describe the processes of mathematical development in the West.

During the mid-1970s, these processes were intensively developed by the Brazilian, Ubiratan D'Ambrosio, who coined the term "ethnomathematics", and has since made important theoretical contributions as well as laid down research guidelines in ethnomathematics (Gerdes, 1996). D'Ambrosio (1985), also known as the father of ethnomathematics, described the mathematical practices that include symbolic systems, spatial designs, practical construction techniques, calculation methods, measurement in time, space, and specific ways of reasoning, which can be translated into formal mathematical representations within identifiable cultural groups. With these efforts, D'Ambrosio, like Zaslavsky (1990), attempts to enhance the understanding of cultural diversity of mathematical practices, and to apply this knowledge to the development of teaching and learning of Mathematics.

Gerdes’ (1999) work explores mathematical concepts found in the context of handicrafts such as basket weaving, woodcarving, and symmetrical metal grate patterns found in cultural products and paintings in Mozambique. He discusses the more abstract mathematical principles found in counting practices and mental
arithmetic. He further examined how some of the ideas invented by the Sona women from Angola in the Lunda Region can be related to the Pythagorean Theorem and acknowledges the diversity, richness, and pleasure of mathematical ideas found among the Tchokwe people.

Gerdes, (1999), also proposes that the school curricula should be multicultural in order to improve the quality of Mathematics education. This realization forces Gerdes to opt for educational systems that are more firmly grounded in traditional African experiences and practices that emphasize the importance of cultural compatibility in pedagogical methods.

Fasheh, (1980), has advocated for ethnomathematics as an approach to Mathematics pedagogy that may be more appropriate for the needs of students. He deals with the interaction between Mathematics instruction and established cultural patterns of belief, thinking and behaviour in the Third World countries.

Fasheh points out the importance of culture in influencing the way people see things and understand concepts, as well as the importance of using culture in making the teaching of Mathematics more effective and meaningful. He further points out that in the developing countries, Mathematics is usually taught as a set of rules and formulas that students have to memorise, and consists mostly of a set of nonsensical problems that students have to solve. Based on this point, one can assume that the main reason for studying Mathematics for most students in the developing countries is to pass examinations, irrespective of whether the content was understood or had a meaning to their day-to-day activities. This is where the misconception in Mathematics teaching is, that Mathematics can be taught effectively and meaningfully without relating it to
culture or to the individual student’s cultural experiences, where it can be used to stress one's own culture with its special characteristics.

**2.1.4 Factors to Consider when Integrating IK in the Curriculum**

Despite the stated value and potential of indigenous knowledge in providing solutions to some of the problems inflicting Kenya’s communities, educators need to examine what implications the inclusion of this form of knowledge has for pedagogy and its sustainability in the current classroom settings. This is because of the diverse nature of Kenya’s ethnic communities and centuries of dominance of the country’s education system by Western epistemologies. First, educators and curriculum developers need to be cautious and avoid bundling together the diverse Kenyan ways of knowing under one category of indigenous knowledge. This is because such generalization may lead to separating these forms of knowledge from their specific contexts (Angioni, 2003, Semali, 1999), a condition that may lead to oversimplification and superficial implementation. Also, such homogenization is likely to jeopardize the potentially unique and important contribution that specific forms of indigenous knowledge can make to development within specific localities and among local groups who embrace such knowledge.

At the same time educators need to recognize the fact that the uniqueness of indigenous knowledge in a particular culture does not necessarily mean that there is internal consensus or that all members of the same ethnic group adhere to the same knowledge base in their socio-economic and political decision-making process. Given the current acculturation and development of cosmopolitan communities (Owuor 1998; Semali, 1999) individual members perceptions may differ significantly on specific ways of doing things. Central questions that need to be explored when integrating indigenous knowledge in the curriculum reforms are: What aspects of indigenous
knowledge need to be incorporated in the integration process? What related features of indigenous ways of knowing and modes of learning are common across the diverse Kenyan indigenous cultures and which ones are unique to particular ethnic groups? Answers to these questions would act as a guide to identifying those features of indigenous knowledge that can be made visible during the process of curricula development.

Secondly, most Kenyan indigenous education systems are highly hierarchical, hence top-down diffusion of knowledge becomes the norm, creating unequal power relations between those in subordinate positions of authority such as in the case of teachers and students (Scott & Miller, 2002). Therefore, students and teachers may find themselves in situations of dilemmas and contradictions due to conflicting value orientations based on their perceptions of knowledge construction.

For example, African students who have been immersed within a conservative cultural setting that value authority of elders may find it challenging to express divergent views from their teachers, hence limiting the process of dialogue in the classroom and instead promoting the authoritarian and what Friere, (1994), refers to as the banking models of teaching. Yet students living in cosmopolitan settings who have been exposed to Western perspectives through the media and information technologies bring into the classroom a more critical perspective to learning. This might not be appreciated by conservative teachers who maintain traditional beliefs on the central role of teachers in the legitimacy of knowledge construction based on their cultural beliefs on ownership of knowledge and authority in the classroom. This normally results in conflict with conservative teachers not being able to promote democratic classroom environments limiting analytical and critical thinking among students, which should be key ingredients to education process.
Thirdly, the Western-based schooling system recognizes teachers’ professionalism as central in facilitating the process of classroom knowledge construction. This does not provide any space for classroom dialogue in which the experiences of members of local communities such as the role of elders can be incorporated in formal classroom knowledge construction. Yet African indigeneity cultivates respect for the authority of knowledge of community elders due to their wisdom, accumulated knowledge, and their closeness to the ancestral world (spirituality) (Dei, 2002; Mudimbe, 1988). Such knowledge based on intuition and experiences of life have been devalued as lacking in scientifically based methods and findings from empirical research. This poses challenges to the current debates of endogenous approach to education, which features discourses on possibilities of effective involvement of indigenous community members in the integration of indigenous knowledge into the formal education system (Mwenda, 2003; Semali, 1999; UNESCO, 2006) as facilitators of the learning process.

Fourthly, indigenous knowledge is highly engendered and therefore, men and women usually have different and often complimentary societal roles and responsibilities resulting in different social constraints. If educators do not examine this aspect of indigenous knowledge, there is likelihood that the integration may override the ongoing government’s efforts and strategies aimed at addressing gender disparities through incorporating gender inclusive pedagogy and curriculum in the school system. Thus, Integrating African Indigenous Knowledge 29 despite the Kenya government’s commitment to integrating indigenous knowledge in the formal school curriculum, the process has been faced with a lot of challenges as discussed in the following section.

2.2 Rationale for Valuing IK in Kenya’s Formal Education

The Western concept of formal education was introduced in Kenya by the missionaries and subsequently by the colonial government. The purpose of education during the
colonial period was mainly for religious conversion, economic exploitation, and the assimilation of Africans into the Western cultures, values, and practices. This eroded Kenyan ethnic communities’ indigenous learning structures a condition that denied individuals their cultural identity and sense of the past (Ominde, Report, 1964; Kelly & Atbach, 1984; Ngugi, 1981; Woolman, 2001).

As stated by Kelly and Atbach “education in colonies seems directed at absorption into the metropole and not separate and dependent development of the colonized in their own society and culture”. This undermined African values, cultural practices, and imposed Western capitalist mode of production, disrupting to a large extent indigenous African commerce, industry, technology, and social fabrics (Dei, 2002; Ngugi, 1981; Wangoola, 2002). Ngugi reiterates that colonial education “was far from giving people the confidence in their ability and capacities to overcome obstacles or to become masters of the laws governing external nature as human beings and tends to make them feel their inadequacies and their inability to do anything about the conditions of their lives”.

The formal Western oriented education system inherited after independence not only cultivated among the elites a sense of denial to their indigenous heritage but also impacted individuals’ sense of self-confidence in expressing and appreciating their native values and cultures. It is within this background that after independence, the government of Kenya has continued the struggle to reconstruct the country’s formal curricula in order to incorporate the multiple indigenous ways of knowing into the formal school system to help students develop a sense of self worth grounded in their own authentic cultural systems of knowledge construction (Ominde Report, 1964).
IK is important to the livelihood of people, a fact that has been demonstrated and argued by the World Bank on a number of occasions (1998). The DST (website) has also reaffirmed its position on IKS in the following statement: In recognition of the importance of Indigenous Knowledge Systems and the wealth of this knowledge in South Africa, the Department of Science and Technology has been playing a leading role in the affirmation, recognition, protection and promotion thereof. Apart from the establishment of the Indigenous Knowledge Systems Unit in the Department in 2002, it has also been actively supporting research through the provision of funding to Science Councils and Tertiary Institutions as well as support to non-governmental structures working in the area of IKS.

Promoting greater awareness of IK is not enough; its application creates and elicits more meaning, hence debates of preservation can be entertained because it makes no point to preserve non-used knowledge. Taking the example of the Samburu district in Kenya, the pastoralists rely heavily on their own knowledge of the environment and have to manage it in order to survive (Onyango, 2000). Onyango uses such examples to argue that it is of the utmost importance to first learn the knowledge of the community before any attempts to improve their situation are made through participatory activities. This is especially true when one considers that some of these communities do not have access to external information. Local knowledge is therefore the starting point for work directed towards the health of their animals, livestock production and environmental conservation. For example, at one stage tsetse flies posed a major problem in Kenya (1998), leading to the creation of community-based programmes in each village to trap them. Traditional healers in the district were involved in the project, which documented local remedies and disseminated this knowledge to local secondary schools.
Onyango further elucidates how this ethno-veterinary knowledge has also been incorporated into training modules for decentralized animal health. This led to a workshop held in collaboration with the International Institute of Rural Reconstruction (IIRC) that helped the healers and veterinarians of the country accept each other’s professions. The workshop’s outcome was a book entitled, Ethno-veterinary medicine in Kenya, which has helped to increase the value of ethnoveterinary knowledge and interest in veterinary practice.

Kinama, (2004), also highlights the diverse opportunities brought about by IK, one of them being IK as the basis for problem solving strategies in local communities, especially among the poor. He provides examples of how farmers in the semi-arid areas of Eastern Kenya prefer to plant their local maize variety (Machakos local white) as opposed to the recommended maize composite (Katumani maize). When planting their maize variety, they were observed to use wider rows and spacing than they would with the Katumani composite. Their preferred variety produced a higher yield than the recommended variety, taking into consideration the low and unreliable rainfall the community/region has experienced over generations.

In a study carried out in the Ekiti State in Western Nigeria on whether IKS was being applied by farmers, Kolawole, (2004), revealed that: About 72.0 % of the farmers utilized trash burning; 58.0 %, shifting cultivation; 45.2 %, mulching; and 28.0 %, crop rotation. Only about 20.4 % and 8.0 % utilized bush fallow and organic manure application, respectively. The inference was that most farmers utilized trash burning in conserving soil fertility in Ekiti State, Nigeria. Reasons for utilizing IKS: Majority (80.0 %) of the farmers utilized IKS in conserving the fertility of the soil because they were easy to practice. Also, about 72.0 % of the population used IKS because inorganic fertilizers were not easy to come by. About 60.0 % of the farmers also
reported that they utilized IKS because facilities for such practices were always available to them. Benefits of IKS utilization: Most (80.0 %) farmers were of the opinion that IKS practices were cheaper than modern methods. It was also believed that IKS practices were economically advantageous (80.0 %) and ecologically sound (30.0 %).

Although the above may have a positive bearing on IKS, the use of ‘poor’ does not augur well for IK. ‘Poor’ as a description also features on the NUFFIC website, as cited by Persens, (2005), IK is an important part of the lives of the poor. It is a key element of the social capital of the poor, their main asset to invest in the struggle for survival to produce food, to provide for shelter or to achieve control of their own lives. The suggestion here is that IK is only for the poor and is not of any benefit to anyone else.

IK represents an important component of global knowledge on developmental issues. The World Bank (WB) agrees that IK is an underutilized resource in the development process. According to the WB report (1998/99:3), knowledge and not capital is the main impetus behind sustainable social and economic development. The first step in recognizing this would be building on local knowledge, the basic component of any country’s knowledge system. This is because IK provides the basis for the acquisition of new knowledge. For example, the Maasai of Kenya and Tanzania are known to have treated foot-and-mouth disease effectively without killing the animals (Ridley in Chisenga, 2000).

The importance of IK is comprehensively covered by the former Tanzanian president, Mkapa, (2004), who summarized the functions of IK by citing various examples in which IK has been used to benefit communities: to reduce hunger and poverty in India;
improve primary education and enrollment by using local language as a means of instruction in West Africa; enabled men in Senegal to understand the impact of female circumcision on women and empowered women to move towards eradicating the practice; helped to reduce child mortality in Eritrea and maternal mortality in Uganda; provide primary healthcare to millions of Africans; has helped communities in Mozambique manage their coastal natural resources; and has helped to build partnerships between the weak and the strong in Ghana to re-distribute wealth.

Therefore, integration of indigenous knowledge and practices in the Kenyan education system is not then a new concept. The focus of education reforms since independence in 1963 has been to reconstruct the curriculum at all levels of the education system to reflect the diverse indigenous ways of knowing, and to promote social change and the empowerment of Kenyans (Ndegwa Report, 1971; Republic of Kenya, 2005; Ominde, Report, 1964).

Reclaiming cultural identities rooted within the authentication of indigenous traditions has been perceived as a way forward to decolonizing Western dominated school curricula, hence making education more relevant and practical in addressing the needs of Kenyans. An examination of education reports indicates the Kenya government’s full recognition of the importance of integrating indigenous knowledge in formal education system (Ndegwa Report, 1971; Ominde Report, 1964; Republic of Kenya 1965; Republic of Kenya, 1970). The reports emphasized that one of the objectives of education system should be to respect, foster, and develop the country’s rich and varied cultures.

The objective of curriculum reconstruction has been to explore alternative solutions by utilizing local resources as a way towards addressing socio-economic and political
problems that face Kenya as a country. Hence, the importance of curriculum reforms, education, and training policies aimed at integrating indigenous knowledge and Western knowledge into the school system (Ominde Report, 1964; Republic of Kenya, 2005) cannot be overstated. Curriculum reconstruction process involved the inclusion of Kenyan diverse cultures, histories, geography, oral literature in high schools, and innovation in teaching that would incorporate indigenous knowledge and methods into the curriculum (Ominde Report, 1964).

Mudimbe, (1988), argued that positively integrated education reforms in Sub-Saharan Africa should entail a reflection in the school curriculum that includes the history, principles, and concepts of practices, tools, and technology of communities from within the country and from other African countries. Education goals as indicated in the Kenyan policy guidelines are much oriented towards the development of an all rounded individual (Republic of Kenya, 2005).

The guiding national philosophy of African socialism and the policy of Education for Self-reliance formed the framework through which the government of Kenya framed its ideology to localize the curricula by emphasizing practical orientation especially in rural schools. The philosophy of African Socialism was based on the premise that all planning including education in post-independent Kenya must draw on the best of the African traditions and must be able to adapt to new and rapidly changing circumstances of the communities (Republic of Kenya, 1965).

The framework for integrating indigenous knowledge in the education curriculum was articulated in the first Kenyan education report developed after independence (Ominde Report, 1964), which basically was guided by the national philosophy of African socialism as stipulated in the Sessional Paper No 10 of (1965). This report formed the
basis for policy frameworks that has guided curriculum innovations and education change at all levels to date. The formulation of this report was based on the premise that education needed to be more accessible and relevant to the social, economic, and political needs of students and their communities. Therefore, integrating African indigenous knowledge and ways of teaching and learning has been perceived as necessary in de-emphasizing the current curriculum that has been viewed to be too abstract, not relevant, and more examination oriented.

Curriculum reconstruction in post-colonial Kenya became part of the process aimed at reclaiming cultural identity with deeper roots in authenticating African traditions. The main concern of the government has been the empowerment of the citizens through the social, economic, and national reconstruction of the society (Republic of Kenya, 2005). Education has since then been perceived to function as an agency of cultural transmission, economic, and political development. Thus, the education system in Kenya is expected to play a mediating role in the relationship between the diverse cultures, the national culture, and the global needs of the nation (Lillis, 1985; Ominde Report, 1964; Republic of Kenya, 2005; Semali, 1999; Kenyatta, 1965).

Jomo Kenyatta, the first president of Kenya viewed education as a tool for maintaining the traditional structures of family, kinship, gender, and age groupings as another way of ensuring the stability of African ethnic communities Kenyatta, (1965). Without stability of these communities through the process of education, Kenyatta foresaw the onset of the disintegration of the social systems. In his book facing Mount Integrating African Indigenous Knowledge Kenya, Kenyatta advised teachers: “To promote progress and preserve all that is best in the traditions of the African people and assist them in creating a new culture, which through its roots are still in the soil, is yet modified to meet the pressure of modern conditions”. This reflects the perceived value
of education as a way to achieving a holistic approach to the societal development at the face of changing times.

The current global discourse on the value of incorporating indigenous knowledge in formal education systems in Sub-Saharan African countries, has been a central theme by scholars, African governments, and the United Nations Organizations (Angioni, 2003; Dei; 2002; Government of Kenya, 2005; Purcell, 1998; Semali, 1999; UNESCO, 2006) particularly its potential contribution to sustainable development at the micro level and poverty alleviation. It is argued that if African states are to play a central role in directing the goals of education for sustainable development, then there is need to integrate the African perspectives of knowledge as a reciprocal body of knowledge to Western education in order to ensure relevance and practicality in addressing local problems affecting societies especially the devastating effects of HIV/AIDS pandemic (Dei, 2002; Mudimbe, 1988; Shiva, 2000; UNESCO, 2006).

According to these studies and report, problems afflicting the African continent and Kenya in particular, are based on complex realities that not only can but also should be approached at different levels (macro and micro) and by employing different methods and forms of knowledge. Dei, (2002), intimates that in order for local governments and international communities to find solutions to socioeconomic problems facing African states, there is a need to explore the contribution of the culturally based knowledge resources as alternatives to local sustainable development. This requires understanding the capability of indigenous knowledge in the development process of communities, and ways in which indigenous people strategize their own survival within specific settings.
2.2.1 Functions of Indigenous Knowledge

Indigenous Knowledge is gradually gaining greater research support because of its functions and importance. With the embodiment of IK within the system of its people, Gupta (nd:6-7) outlines some of its functions. The functions highlight the nature of IK and the strong bond it has with this system. Gupta (2000) divides its functions into six categories:

IK is semiotic:-meaning that it is communicated through symbols, arts forms, crafts, etc. In Uganda, it is always easy to distinguish one community from another through their arts and crafts. Culture manifests itself through music, painting, dance, folklore, language and literature, traditions, beliefs and values, and also through its traditional legal systems, its processes of governance and participation, including the intricate links and transactions that define a society's character, as well as its pattern of human and economic development (Magara and Ikoja Odongo, 2005).

Institutional – Providing rules coded in rituals and/or other cultural and social sanctions. Some of these rituals and cultural sanctions institutionalize incentive measures for the use of traditional knowledge just as IPRs do. These sanctions can be material, such as fines or penalties, or ethereal, such as the fear of God. Each community in Africa has its rules coded deeply in rituals and other cultural and social sanctions. For instance, the Embu people in the Eastern province of Kenya had a Muthamaki (leader) and a ground for the Kwanyi dance. The Athamaki (leaders) looked after the overall welfare of the people by providing laws and regulations covering issues such as marriages, beer-drinking, etc. There were Njama (group) who went to bigger gatherings of the Embu and brought information from the Embu to the leaders. The Njama in turn summoned the other members of the community within its reach and briefed them.
Configurational — This is where the arrangement of various life processes and stages are performed according to traditional norms, leading to (more or less) predictable social outcomes. Almost all communities have certain stages and processes that are followed in the lifecycle of an individual. This was part of communal life and included rites of passage like circumcision, marriage and naming. These formed part of the traditional norms and led to the prediction of social outcomes.

Utilitarian Knowledge:-The use of utilitarian knowledge about various plants or animal products for various food, nutritional or health needs. Most communities were very well versed with their environment and knew which plants and animals they could consume and which provided various treatments. There exists a fundamental relationship between people and their land which is dependent on the nature and characteristics of the land, as well as on cultural variables such as the needs, values, traditions, and beliefs of the people who occupy it. The authors suggest that indigenous people have knowledge about all aspects of their physical and spiritual environments, including weather systems, stories of creation, and astronomy. Indigenous peoples' traditional reliance on the land for subsistence and survival implies that knowledge about the land is heavily intertwined with these other forms of knowledge. Thus the boundary between indigenous knowledge in general and indigenous knowledge of the land is difficult to establish (Magara and Ikoja-Odongo, 2005).

Situational – During emergencies or other contingencies, codes of conduct may be specified to maintain social order and responsibility towards other life forms, including wildlife. Different situations called for the best actions to be taken differently from normal day-to-day routines. Weather systems were at times induced, especially in cases of inadequacy or late occurrence. Inducement was also done for reasons such as clarification in cases of theft, argument or denial of an action, and wickedness and
punishing people, for instance during a power-tussle. Weather systems that were often induced include rainfall, thunderstorms and windstorms. The occurrence of these systems could also be prevented if they were not needed (Ajibade and Shokemi, 2003). Religious and spiritual functions which may or may not involve material objects. Since society has to adapt to new trends from time to time, traditional systems of culture, technology and social exchange provide some scope for experimentation, deviance and variation. The same set of incentives may not help in nurturing each of these functions.

An extension of the functions of IK can be expressed through its importance. The World Bank, (2004), highlights the importance of IK as follows

Indigenous knowledge provides the basis for problem-solving strategies for local communities, especially the poor;

It represents an important component of global knowledge on development issues.

IK is an underutilized resource in the development process. Learning from IK, by investigating first what local communities know and have, can improve understanding of local conditions; provide a productive context for activities designed to help the communities;

Understanding IK can increase responsiveness to clients; adapting international practices to the local setting can help improve the impact and sustainability of development assistance;

Sharing IK within and across communities can help enhance cross-cultural understanding and promote the cultural dimension of development and most importantly, investing in the exchange of IK and its integration into the assistance programs of the World Bank and its development partners can help to reduce poverty”.

2.3 Existence of Indigenous Knowledge

In various tribes around the world, there exists indigenous knowledge that can be integrated into the school curricula. The artifacts that are available in the traditional environments are important tools that can be used to bridge the gap between what is usually taught in the classroom and what exists outside the classroom, that is, in society. The indigenous knowledge that exists in society has historically been ignored, from the colonial times to present regimes, where the school curricula are designed without including such knowledge. In his study, Kaino, (2013), on the knowledge of traditional artifacts used by the Tchokwe tribe in Angola explored and then related to the mathematical content learned in the classroom. The activities show how the indigenous knowledge can be structured and get related to the mathematical knowledge taught in primary school.

The knowledge that can be derived from various forms of the Tchokwe tradition is abundant in traditional decorations, paintings, story-telling and many others. The development of mathematical patterns to form particular sequences in natural and odd numbers, gives students the opportunity to derive knowledge from the local artifacts they are familiar with and relate these to Mathematics content learnt in class. For grade 7 learners, the structures developed to establish patterns and sequences can provide them with prior knowledge before they develop more advanced knowledge of proving the formulas for determination of the sums of natural and odd numbers when they join secondary schools.

The approach provided in these activities is spiral in approach, that is, the topic at each stage has pre-knowledge elements of the previous activity that have connection with traditional artifacts introduced at a lower level. Thus, the introduction of the process to learn about Pythagoras theorem would not be new to students at secondary schools to
develop the patterns and prove the Pythagoras formula by relating to the squares formed. The visualization of the beauty of developed patterns in the activities illustrated, gives students an appreciation of the explorations of the cultural practices. Appreciation of the material learned stimulates interest among students to learn. This approach of teaching means students access the mathematical knowledge that exists in their traditions by reflecting on the traditional practices to learn mathematical concepts. It would not be necessary for all students to have experienced the traditional materials from their own localities to use them in learning. The approach should be to use these materials to encourage and stimulate students to explore and learn mathematical knowledge that exists in the environment related to content taught in the classroom. The process of teaching the concepts in these topics would provide students with long term retention of mathematical knowledge (Kaino 2013).

Rosa & Orey, (2014), reported in their study on a theoretical discussion to reveal the principles of culturally relevant education in an ethno mathematical perspective that, the implementation of Culturally Relevant Education helps to develop student intellectual, social, and political learning by using their cultural referents to acquire knowledge. It uses prior experiences of minority students to make learning more relevant and effective in order to strengthen their connectedness with school. Culturally relevant schools contextualize instruction and schooling practices while maintaining academic rigor. In these schools, school leaders, teachers, and staff members are able to recognize and build upon the strengths of students by applying instructional strategies that are culturally relevant. Culturally relevant leadership is grounded in the belief that minority students are able to excel in academic endeavors. Thus, it is necessary to enable the implementation of culturally relevant pedagogy into school curricula, which is designed to fit together school culture with students’ cultural
backgrounds to help them to conceptualize knowledge. Ethno Mathematics and culturally relevant pedagogy-based approaches to Mathematics curriculum are intended to make mathematical content relevant to students. The objective of this theoretical article is to discuss the principles of culturally relevant education according to an ethno mathematical perspective.

Among the existing indigenous knowledge integrated in teaching mathematical content includes games. The word ‘game’ is usually associated with recreation, competition, sportsmanship, winning, losing, enjoyment, and many other similar and related notions. Qualitative research was used in this study. Nkopodi & Mogege, (2009), conducted a study entitled “preparation of using indigenous games in the classroom” specified activities necessary before indigenous games can be used in the Mathematics classroom which include: Identification of indigenous games according to the potential of their use in the curriculum; Analysis of games (applying mathematical concepts, principles and processes) of any game reveals the extent to which mathematical concepts are embedded in the game. The focus of culturally relevant pedagogy brought with it sound pedagogical practices which participating teachers and learners perceived as empowering them into ways of reading and understanding cultural activities with mathematical lenses. If Mathematics education continues to fail to connect Mathematics to learners’ cultures, it will continue to fail to socially empower learners (and teachers) into ways of examining real-life activities. Therefore, in order to best address these pitfalls and create individuals which most intended Mathematics curricula claim to be producing, teachers need to embrace, implement and share ideas that promote critical pedagogy.

Morabaraba is a traditional two-player strategy board game played in South Africa, Botswana and Lesotho. The following mathematical concepts are found in the analysis
of *morabaraba* game: Identification of various quadrilaterals (squares) and the similarities and differences between them; Ratio and proportion between the lines and the squares making the complete *morabaraba* board; Symmetry: Symmetry is observed in at least three different instances, namely, the various sides of the board; within each side of the board; the placement of tokens and repetitive movements of the tokens on the board; Logical deductions in the execution of the various steps of the game; Counting of the tokens; Addition and subtraction of the tokens until a game is won on the basis of the remaining number of tokens. Therefore, the current study will identify existing games in the Vihiga county public primary schools that may be integrated in the teaching of Mathematics concepts.

Cohrssen *et al.*, (2015), reiterated that the over-arching goal of early childhood education is to provide optimal learning opportunities for children. Implementation of a suite of play-based early childhood Mathematics activities provided early childhood educators with the resources needed to support and extend preschool children’s mathematical thinking and mathematical language. Implicit in this process is ongoing formative assessment of children’s learning. The study findings showed that the provision and enactment of a purposefully designed suite of play-based Mathematics activities may enable educators to develop increasing confidence in the intentional teaching of Mathematics in early learning environments. This is encouraging evidence of the potential impact of an evidence-based, play-based, validated early childhood Mathematics curriculum. Finding ways to challenge educators’ beliefs and to encourage new ways of thinking about Mathematics teaching and learning are crucial if educators are to meet the demands of early childhood education and the future learning needs of learners.
When teachers perseveres with play-based activities that clearly set out the intended Mathematics learning and provided examples of questions for teachers to ask to suit learner’s emerging understanding, their confidence increased. It appeared that this was a collaborative and iterative process: reviewing the objectives of each activity familiarized the educators with the underpinning mathematical ideas and supported their ability to recognize when learners achieved the learning objectives. As their confidence grew, and spurred on by children’s enthusiastic response and observed learning gains, activities were enacted more frequently. When the suite of activities was enacted with reasonable fidelity and frequency, children’s made gains in learning, (Cohrssen et al., 2015).

Ogunkunle & Nchelem, (2015), employed a quasi-experimental research design to investigate the effects of integrating ethno Mathematics into secondary school Mathematics curriculum for effective artisan creative skill development in Abia State, Nigeria. This study presented two experimental groups and one control group. Experimental group 1 was taught (raffia weaving) and experimental group 2 (pottery) by integrating ethno Mathematics teaching approach into the conventional teaching approach via demonstration and discussion respectively. The control group was taught (traditional building) without integrating ethno Mathematics teaching approach. The population for this study was 407 Junior Secondary two students in all the public junior secondary schools in Isiala Ngwa Area of Abia State. A simple random sampling technique was used to select 117 JS2 students. The findings revealed that students taught by integrating ethno Mathematics instructional approach via practical had the greatest mean gain in the acquisition of creative skills. Consequently, the researcher will identify existing indigenous knowledge within the classroom and find out if there is a corresponding improvement in the learning of mathematical content.
According to Brokensha, Warren, and Werner, (1980), the emergence of indigenous knowledge in the academy was triggered by ethnographic studies conducted in nation-states that were once colonized by Europeans during their expansionist agenda. Through such studies, it was noted that prior to colonization some local people sustained themselves better when they owned locally developed knowledge than was the case after the colonial era. The aftermath of colonialism (in the twentieth Century) is thus viewed as having negatively transformed some of such nations to the extent that they lost vitality of their agricultural and other survival systems (Semali & Kincheloe, 1999, Katz, 2004).

For example, Thomson, (2003) mentions the Republic of Congo (formerly Zaire) that experienced a downturn in its capacity to produce cereals due to the disruption of colonialism. Resultantly, Zaire reached a point where the local people’s cereal civilization (once upon a time a star cereal civilization) became almost dysfunctional and people could no longer sustain their food requirements. Through several of such critical anthropological studies it was realized that reverting to the use of some indigenous knowledge and practices, that sustained people many years before colonization, was a gateway to revamping some colonial country’s ailing sustainable living systems among indigenous people. Through consideration of such examples, and across the continent, the momentum for the indigenous Science/knowledge debate has grown in strength at local, regional and global scales, and scientists have become active participants of this debate (ICSU, 2002; Iseke-Barnes, 2005).

Possible use of Mathematical Knowledge and Concepts used at Cultural Villages in Mathematics Classroom Settings to enable all learners to achieve to their maximum ability can be done through setting outcomes to be achieved at the end of a process. These outcomes will encourage a learner-centred and activity-based approach. One of
the developmental outcomes in Mathematics will envisage learners who will be culturally and aesthetically sensitive across a range of social contexts. Exposure to activities that take place at various cultural villages goes a long towards ensuring that this developmental outcome is attained. It is therefore possible that some of the artifacts that are found at the cultural villages may be brought to classroom and analysed by the educators and learners together to reveal related mathematical concepts embedded in such artifacts. As they do so they will also be more about the communities in which they live. In fact, the use of various artifacts provides an opportunity for the community members knowledgeable in various artifacts and cultural activities to interact with the educators and learners.

Knowledge of working with beads is passed on by grandmothers and mothers to their daughters. This is one way of ensuring that indigenous knowledge in the communities does not become extinct but is used appropriately to link what happens within Mathematics classroom and activities outside the classrooms. The examples from the Luhya cultural villages in Kenya reveal a use of various mathematical concepts activities. The mathematical concepts that have been identified in the making of a grass container and the beadwork as shown in the interviews above are: Counting; Estimation; Straightness of Lines; Shapes and Patterns; Angles; etc. Many other mathematical concepts may be found when an analysis of the various activities and processes is done. This calls upon the educators to play an important role of linking what happens at the cultural villages to various Mathematics curriculum requirements. As Graven, (2000), correctly points out current curriculum change demand that teachers (educators) use a learner centred approach and understand Mathematics as a learning area which includes the following identity of Mathematics as a school subject: Mathematics as a useful subject for everyone, it is both relevant and practical and is
applicable to everyday life. Teachers are appropriately placed due to their mathematical knowledge to create linkages between various activities embedded with mathematical concepts to ensure that learners’ experiences are enriched through daily experiences of what they encounter outside the classroom.

Educators can therefore help to close the gap that seems to be always there between classroom activities and activities outside the classroom, ensuring that mathematical concepts learned in classrooms is not done in isolation but takes into account daily experiences of workers in various settings, including cultural villages. Some of the mathematical found in various artifacts in the Luhya community Vihiga include;

- **Counting:** This they clearly illustrated when they explained how they had to count the number of layers or turns to make before making a particular design in their beadwork.

- **Repetitive Cycles:** There are instances in the designs when they have to repeat a specific part for purposes of adding similar designs or creating a similar pattern.

- **Similarity in Figures:** These show themselves in most of the mural decorations that the Ndebele communities are well known for. Repetition of a specific geometric figure leads to specific types of patterns and the creation of a particular mural decoration.

- **Symmetry:** This is also shown in a variety of artifacts. The knowledge they have gained has made them to be aware that there are mirror images and these mirror images tend to create a different effect than in the artifacts where it has not been used.
This growing pressure for legitimization of indigenous knowledge has so far made international organizations such as UNESCO, World Bank and many others to seriously consider using indigenous knowledge when pursuing development and education support endeavors for some developing nations. However, among the articles written on indigenous knowledge, there are varied opinions about the role of indigenous knowledge in education or use in development because of its nature. This turns us back to the earlier mentioned aspects of indigenous knowledge which include; characteristics, production, maintenance, adaptation, transmission, and its use.

2.3.1 Characteristics of Indigenous Knowledge

Indigenous knowledge is characteristically orally produced from everyday experiences (e.g. hunting, fishing, farming, and social interactions such as music) of all people in a community that are shared as narratives representing myths, beliefs, ceremonies, and pragmatic practices. Some narratives involve accurate observation and inquiry but others are from past experiences. Hence, indigenous knowledge is produced differently from Western knowledge. It is important to point out that IK is not confined to tribal groups or the original inhabitants of an area; nor is it confined to rural people. Any community possesses IK, whether rural or urban, settled or nomadic, original inhabitants or migrants. It is based on ideas, experiences, practices and information that have been generated either locally or elsewhere, and subsequently been transformed by local people and incorporated into their way of life (Ina Hoi Riwa Foundation, 2000) and/or expressed in local languages (Langill, 1999).

It is therefore difficult to transmit IK to those who do not share the languages, traditions and cultural experiences of a group or community (UN, 1997). Thus IK is local because it:

Is anchored in a specific community;
Is established within the boundaries of broader cultural traditions but still
developed by a specific community;

Often consists of intangible knowledge that is not easily codified and is
conveyed orally;

Consists of experimental knowledge as opposed to theoretical knowledge;

Is learnt through repetition;

Changes continuously—created and recreated, discovered and lost—even
though outsiders believe it to be static (World Bank, 1998: 9).

IK is embodied in various forms through which it is represented and expressed. For
example, according to Kok (2005), IK is mainly expressed through beliefs, medicine,
knowledge technology, education, communication, agriculture, food technology, arts
and crafts. Indigenous knowledge is produced in an ongoing manner and accumulated
from everyday experiences. Revision of knowledge is ongoing and all people
accomplish this through direct use of knowledge. All people are actors in indigenous
knowledge, both young and old. This is why Ocholla and Onyancha (2005) say,
“indigenous knowledge is tacit or tangible knowledge which is inseparable from
realistic knowledge” and laments that it is unfortunate that due to “ignorance and
arrogance, indigenous knowledge has been neglected, vindicated, stigmatized,
illegalized, and suppressed among majority of the world communities.”

However, Ocholla and Onyancha (2005) jubilate for the fact that indigenous
knowledge has recently been brought back to the front because of interventions by
governments and civil societies through legislation and policies that pertain to
intellectual property rights, research, alternative medicines, nutrition, sports, and
business. These developments ease the fears that increasingly mounted due to
globalization pressures and also increasingly fostered melting down of traditions and cultures as well (Ocholla & Onyancha, 2005).

Since indigenous knowledge is oral by nature and passed on from adults to younger generations, one would expect this kind of knowledge to remain exclusively historical. However, this is not the case. Reynar (1999) in his article, entitled, “Indigenous people’s knowledge and education: Tools for national development?” discusses how indigenous knowledge has kept evolving and improving to the extent that the past fifteen years have noted an increase in indigenous knowledge systems. This is observed through a phenomenal increase of literature (Ocholla & Onyancha, 2005); thereby signifying that indigenous knowledge has the capacity for adaptation. Although early ethnographers mostly described indigenous knowledge with negative connotations, time has shown that some of the knowledge is worthwhile.

The International Council for Science (ICSU) (2000) recognizes the value of indigenous knowledge of the local peoples of the world. Today, this international Science organization agrees that some of the Science contributions like classification of animals was partly adapted and adopted from indigenous people, whereby, the local people’s extensive knowledge of plants and animals were a source for compiling the extensive list for classifying living organisms and not a sole invention of Linnaeus. In the same token, the ICSU (2000) report indicates that the indigenous people accumulated knowledge about medicines, some of which have been upgraded using scientific techniques. Furthermore, recognition has been made that some indigenous people have their own Science covering astronomy, meteorology, geology, ecology, botany, agriculture, physiology, psychology and health. The only difference is that indigenous knowledge tends to come as a whole set of knowledge (holistic) and not compartmentalized as done in the Western knowledge.
It is well known that Science and technology education are key to development in both developed and developing nations in the world (Bridgestock, Burch, Forge & Laurent, 1998). In the advent of integration of indigenous knowledge in Mathematics teaching, some educational policies that are tailored to national development are likely to favor accommodation of indigenous knowledge: if the policy makers could get the sense of using indigenous knowledge in promoting the learning of Science, Mathematics and technology or socio-cultural benefits. Policy makers are likely to get the feeling of what indigenous Science can offer through advocacy systems if they could be clearly convinced about what it can offer. However, indigenous knowledge itself is a construct that needs cleaning up because there are many views about what it means. The persistent association of indigenous knowledge with spirituality, cultural values, and myths casts some shadows of doubt on its alignment with Science, Mathematics and technology due to lack of evidence of this kind of knowledge. Interestingly, this is where some scholars feel that Western knowledge may be missing out on an area worthy understanding (Corsiglia & Snively, 2001; McKinley, 2005).

So far, only indigenous peoples are still heavily associated with spiritual and value laden knowledge while the Westerners are said to have departed from such valuation system. Actually, spirituality and the oral transmission of such knowledge are relegated to primitivism. But, the intriguing part of this debate is that even the Westerners once believed in spirituality and still do to date. Historically, traces of spirituality and engagement in beliefs, prejudices, and magic have not spared Westerners (Bauspies, Croissant, & Restivo, 2006). It was from such understanding that those who hold multicultural and socio-cultural views feel that it is not strange to have cultural difference. However, what matters is that teaching and learning should tap this kind of knowledge in order to assist learners coming from particular cultural
backgrounds that may assist or block their understanding of Science, Mathematics and technology (Aikenhead, 1999; Stephens, 2001).

McKinley (2005) & Stephen (2001), while talking about a culturally responsive curriculum, noted that a “culturally responsive curriculum attempts to integrate native and Western knowledge systems around Science topics with goals of enhancing cultural well being and Science skills and knowledge of students.” Due to the foregoing discussion, it may be noted that anyone who endeavors to transact with indigenous knowledge and practices ought to have a clear picture of its nature in order to properly align this kind of knowledge and practices to the broader scientific body of knowledge. An understanding of indigenous Science in relation with Western Modern Science is only the beginning of getting to know why indigenous Science is being advocated and being proposed to be part of school Science. Since indigenous knowledge is up-coming and by nature not developed exactly like Western knowledge, many educators receive this notion with questions that seek its compatibility. Therefore, there is need to clarify what it is and even explain the theoretical frameworks that support its consideration for integration in school curriculum.

2.4 Extend to which IK Practices are Incorporated in Teaching Mathematics

As with other curricular areas, there is growing recognition that education should be culturally responsive, and Mathematics is no exception. Recent work on curricular resources in Mathematics by Nicola & Jovanovich, (2011) demonstrates that the learning of Mathematics can be approached through a culturally relevant lens by: the willingness of educators to see themselves as learners, and seek to develop their own understandings first; Understanding that education systems are not value neutral. Instead what is taught, and how it is taught reflects cultural values. Helping learners understand this may help them navigate through differing cultural beliefs; ensuring
meaningful inclusion of Indigenous content and/or perspectives in all curricular areas (without appropriation); Because of this, it is important to understand that teaching resources that might be appropriate and relevant in one community might not be appropriate for another community or school district; starting local. When deciding upon content that will be incorporated into the school or classroom, begin by checking with any local first nation’s communities or Aboriginal organizations. Some may be able to help provide resources that are appropriate; recognizing that local Aboriginal people can also be effective resources.

Mathematics and culture are often interconnected, making school Mathematics intimately linked to the society in which it is taught. In response to this connection, Mathematics educational reform policies indicate that learners should be getting an education which is connected to their cultures. Contexts are seen to be useful in so far as they provide access to school Mathematics. Madusise and Mwakapenda (2014) while conducting a study using a case study approach of inquiry entitled “using School Mathematics to Understand Cultural Activities: How Far Can We Go?” the qualitative data in search of understanding the extent to which school Mathematics could be used to understand cultural activities. The sample in this case study consisted of three Mathematics teachers from one middle rural school in the North West Province of South Africa and their Grade 9 learners (218 learners in all), cultural dancers (these included some of the 218 learners) and the trainer of cultural dancers.

The mathematical contents identified were: knowledge of bounded sequences was used to understand the need for limiting the number of dances in each dance. Nkopodi & Mogege (2009) in their study observed that, the basic dancing styles in most dances were using constant sequences, for example the sequence 5;5;5;5; .... Where 5 was representing the number of footsteps made by each dancer before changing direction.
This led to convergent sequences. However, as the dances got more and more advanced and complex, modeling them got more and more complex as well. The advanced nature of the dance needed more advanced mathematical knowledge possibly to respond to the complexity of the practice. The required mathematical knowledge needed to be scaffold by familiarity and deeper understanding of the activity. Some advanced styles led to periodic sequences where dancers were making a different number of steps forward, backward and sideways, leading to periodic sequences such as 4;5;3;4;5;3;... in some cases. However, to come up with the sequences the researchers had to replay the videos taken at the cultural village several times to familiarize themselves with the dances.

According to participating teacher the knowledge of properties of shapes and different transformations can be used to read and understand the decorations on Ndebele paintings and beadings and Venda traditional clothes. For example, from the pictures which were in the classroom, learners identified shapes representing different transformations. This led to deeper understanding of the paintings and beadings. By applying their school knowledge of transformations and shape properties, learners managed to describe the patterns and transformations on pictures of the Ndebele huts used during the lessons. This led to an appreciation and understanding of the mathematical skill(s) being applied by the painters. Some learners reiterated that they were going to use their school mathematical knowledge in coming up with their own different beading designs without being coached. In a study conducted by Unodiaku, (2013) to ascertain the effect that the ethno-mathematic achievement test was effective in enhancing students’ achievement in measurement with particular reference to volumes of cylinder and hemisphere. Indigenous knowledge should also aid the
learning of mathematical concepts like patterns, shapes and geometrical figures among
the learners.

Zingiswa, (2015), while conducting a qualitative, studying the use of indigenous
materials in the teaching and learning of Geometry in which the main data was
collected through semi-structured interviews of a sample of five grades nine learners
from a population of forty-eight learners in the classroom. Learners were observed and
interviewed at different intervals of their designs whilst they drew the figures and
constructed their artifacts representing double-storey buildings. Five learners were
selected on the basis of the drawings and designs made and interviewed using open-ended
questions to extract the procedures for in the drawings. The observations in the
design and construction of the learners’ artifacts bring up evidences of: the use of
Geometry, the reflection and explanations in various steps of the process, the use of
particular geometric shapes, and the strategies in the drawings. Learners displayed
knowledge of congruency, parallelism, estimations, similarity and perspective drawing
as geometric representations used without prior formal instruction. In their own non-
academic language they convinced.

The idea of which house to represent depended mostly on houses that some of them
saw and admired in the nearby town. One such house is displayed in Figure 1 as drawn
by one of the learners. The drawing was good but the learner struggled to preserve
length while using available material to form an artifact. This drawing shows that it is
easier for the learner to draw an existing artifact than to create one from a given
drawing. Language as a necessary tool for communication has been used for the
construction and negotiation of shared meanings that lead to mathematical knowledge.
Learners used measurements based on a chosen scale to produce finished double-
storey model houses which revealed the use of Geometry. Observations at the different
orientations of the diagrams, some parts of their drawings were shaded to bring out the perspective as clearly as is possible. This often included witnessing the learner trying to visualize and orient a model in the same way as the diagram on paper. The geometric manifestations in the drawings and finished artifacts were evident. Learners used arguments in their explanations that revealed knowledge of Geometry. They used mathematical conventions, rules and techniques to build arguments that could not be refuted, in explaining why they constructed and drew diagrams the way they did.

Learners used proportional contractions to represent the actual double-storey houses on size papers. In the size change process, shape is preserved, the pre-image of the house and image were similar. Similarity covers comparison of triangles, quadrilaterals and circles in the grade nine learning scope. At this stage the fact that similar triangles are equiangular is still underemphasized. This attribute was clearly revealed in the learners’ drawings. The activities in which the learners were engaged in during the course of this study involved a combination of cultural aspects using indigenous material and an allowance of learners to work in classroom environment freely allowing learners to apply their insights and experiences. Geometric properties like effective scale reduction and expansion were accurately and properly combined and revealed how delighted each learner was in making his/her own model. This has also been recommended by some scholars as a way to bridge the gap between what is taught in school and what happens in the environments in which the learners live, (Kaino 2013).

Thus, a bridge exists between what the teacher knows, what the learners can do and some of the Mathematics the teachers would like them to learn. The idea of transformation in the mind becomes a tool that a teacher can use, a tool that does not dehumanize learning because it corresponds to one aspect of the voluntary activities of
the child. This has been evident in this study as learners gathered information on how they could build the double-storey house and what material was available for use in the process. They accessed information regarding the size of the artifact, recorded measurements and predicted the different walls to be constructed before the others were done. They identified the congruent faces of the building, compared similar sides and used scale drawing to represent their creativity in the form of drawings. Management of scarce resources, knowledge and skills related to graphics, for example, use of colour, rendering techniques, two and three dimensional drawings, planning, sketching, drawing, calculations and construction of models were done by learners on their own. Furthermore they justified the choices made in each stage of the drawings and constructions. This is Geometry enriching reasoning skills.

2.5 Teachers’ Perceptions Towards Integration of IK in Teaching

Teachers’ attitudes toward and beliefs about the value and potential contribution of indigenous knowledge to sustainable development define how they integrate this form of knowledge into the formal school curriculum (Gachanga, 2007). Some of the challenges in the integration of indigenous knowledge in formal education arise from teachers’ lack of faith that such a curriculum can actually contribute significantly in addressing the socio-economic needs of the country (Dei, 2002; Gachanga, 2007; Mwenda, 2003; Semali, 1999). Teachers’ inability to integrate indigenous knowledge in their practice may also be resulting from limited knowledge on what aspects to integrate. Somjee (1996) noted that although teachers are entrusted with the responsibility of fostering indigenous knowledge in the learning institutions of Kenya, “there is no guidance on what aspects of culture are to be integrated into the curricula. The syllabus only tells teachers what they must do and should do, but not explain how
to do it” (p.6), indicating the limitations that Kenyan teachers are bound to phase when implementing such a curriculum.

In teacher education this means preparing pre-service and in-service teachers to reflect on their own philosophies of education and ways in which these values support or inhibit their ability to integrate multiple ways of knowing and methodologies into their own classroom practices (Dei, 2002; Mwenda, 2003; Semali, 1999; UNESCO, 2006). The focus is for 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 practices, they must confront the emerging challenges from within themselves and the environment in which they are operating.

In order for educators and teachers to effectively integrate indigenous knowledge into curriculum content, there is a need to transform individuals’ perceptions of what constitutes legitimate and valuable school knowledge, learning, and teaching. Teachers and educators need to examine their practices and develop ways to authentically engage and legitimise indigenous knowledge forms into the formal education system. As Mwenda (2003) asserts, “it is time that Kenyan educators come to the realization that Western diagnosis for development does not reflect Africa’s realities”. The purely Western models of education and economy are not capable of addressing the current socio-economic problems at the micro level, especially in the rural regions of Kenya. Hence, there is a need to revitalize the presence of ethnic indigenous ways of knowing, pedagogy and practices in the educational system if Kenyans are to redefine and re-shape their own socio-economic framework within their own terms of development at the micro level.
In problematizing what has been accepted in Kenya’s schools as universal valid knowledge and standards for industrialization and economic development (Dei, 2002; UNESCO, 2006), the following questions would form aspects of a useful guide: What knowledge is of worth and in whose interest does the knowledge operate? How can indigenous knowledge and pedagogy be integrated in a reciprocatory way with Western knowledge in the formal school system? Who counts as experts or innovators in this process? It is only when 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 indigenous knowledge base that students bring with them into the classroom settings. Unfortunately many teachers and educators still privilege Western ways of knowing and interpretation of the world over indigenous knowledge especially in the face of globalization (Dei, et al., 2002; Shiva, 2002).

When children regularly spend many hours in the company of an early childhood educator, the early childhood educator is a proximal and highly influential element of the child’s evolving social and cultural ecology (Bronfenbrenner, 1979, cited in Cohrssen, Church & Tayler (2016)). Early childhood educators’ attitudes are pervasively important: positive, enthusiastic attitudes to problem solving are likely to engender enthusiasm and positivity in children’s approaches to learning, but the corollary holds true as well negative attitudes and avoidance of concepts are likely to lead to negativity and avoidance in children (Ramirez, & Levine, 2010; Connor & Neal, 2014).

In the context of early childhood education, this influence occurs very early in a child’s learning trajectory and thus potentially affects children’s perception of their own abilities as they continue into formal school-based education (Lake & Kelly, 2014) and onwards. Changing beliefs and attitudes requires an individual to make personal,
cognitive adjustments to incorporate new ideas. This is particularly difficult in the teaching environment if the changes do not align with the individual’s personal beliefs and goals for learners (Curby et al., 2009). The resistance may be a personal response to negative memories rather than denial that supporting children’s mathematical thinking is in children’s interests (Ginsburg, Lee, & Boyd, 2008). This is important, because studies have found a connection between educators’ attitudes to Mathematics and the attitudes of their students to Mathematics (Connor & Neal, 2014; Kalder & Lesik, 2011).

In exploring the mechanisms at work that contributed to the change in teachers’ attitudes Cochrssen, Church & Tayler (2016) employed a multiple case study on early childhood educators’ implementation of a suite of play-based Mathematics activities with children aged 3 to 5 years in six different early childhood education and care programs in Melbourne, Australia. Potential participants were selected according to room-level Instructional Support scores recorded for educators employed at early childhood education and care (ECEC) centers in the state of Victoria during the first round of E4Kids’ data collection. Educators approached the enactment of the activities differently; however, those educators who used the activities reasonably frequently and with attention to the underpinning mathematical concepts reported an increase in their self-confidence in supporting children’s mathematical thinking. For these educators, increasing self-confidence, in conjunction with children’s enthusiasm, led to increased frequency and further gains in self-confidence. Some educators did not implement the activities and no change in attitude was observed. New ways to support early childhood Mathematics teaching practice, as a means to challenge entrenched attitudes and beliefs, are needed.
Lama, (2014) conducted an ethnography research. Geometry is a very important part of Mathematics in school level. It affects achievement of Mathematics but most of teachers and students feel difficulty in teaching and learning geometry. To address the issue, the dissertation concerns attentions the exploration of ethno-geometrical knowledge and its possibility to incorporate in curriculum development. As well as, the study was for the purpose of exploring the ethno-geometrical practices in Tamang community and its relevance with school curriculum.

Previous studies of teacher conceptions about Mathematics noted that views about the nature of Mathematics fall into variations of an internal and external continuum (Dossey, 1992). External views regard Mathematics as an externally existing body of knowledge, facts, principles and skills available in syllabi or curriculum material while internal views regard Mathematics as a personally constructed or internal set of knowledge, where Mathematics is a process or a creation of the mind. There is a third perspective which states that mathematical knowledge (facts, concepts and skills) results from social interaction that relies heavily on context (Dossey, 1992; Bishop, 1985 & 1988).

Similarly, the study found that there were several ethno-geometrical knowledge in socio-cultural activities of Tamang community such as cultural foods Aalum, Goleng weaving, sketch of Thangka, Bonbo and Buddha la kewa re, that enabled to incorporate in school curriculum and the government also has kept positive attitudes regarding ethno-knowledge on the basis of mother tongue based education. The study showed that context of the Nepal, students are from multilingual and multi-cultural background. And being under developed country, Nepal should use cultural diversity as opportunity of curriculum resource and teaching materials which are got by students ‘foreground’ and ‘background’ of knowledge. Ethno-mathematical knowledge or
curriculum can guide for this. This kind of curriculum can play main role for enhancing students emotional, intellectual and deeper understanding of Mathematics phenomena from their own lived experience, local and cultural activates. Moreover, it improves teacher, student and parents fair relation as well helps students to build confidence from dominant group.

Thus, to complement the integration of indigenous knowledge in formal education, it is important to inquire into teachers’ and learners’ perceptions of indigenous knowledge with a view to understanding their capability in developing appropriate pedagogical approaches and materials for implementation of such curriculum reforms. 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.

2.5.1 Teachers’ Knowledge about Indigenous Knowledge

Shumba (1999) carried out a quantitative research study in Zimbabwe, whose objective was to measure the extent to which secondary Science teachers are oriented towards traditional culture and how their orientation towards indigenous culture is related to instructional cultural ideological preferences. Shumba’s (1999) study design assumed that teacher’s commitment to indigenous cultural values and beliefs would bear a relationship with their instructional ideology preferences. The study found that secondary school teachers were not strongly traditional but maintained a fairly traditional posture with regards to aspects of traditional authority, religion, view of nature, and social change. Additionally, the study revealed that secondary school teachers shifted further off from tradition with regards to sex roles, causality and problem solving. In summary, this study revealed a transformation of secondary school
teachers in Zimbabwe (a former British colony) that led to loss of some traditional values.

Thomson (2003) contends that all indigenous cultures are harboring tones and tones of knowledge in their languages. However, he laments that unfortunately schools never think about teaching using local languages, which would unlock the buried knowledge. Again, Thomson’s (2003) documentation of Keiyo knowledge of snakes revealed that local people knew more snake species than Western scientists did. Although the stories that he collected about snakes were mixed up with myths and legends, valuable information was discerned from the stories. Spirituality and beliefs were also reflected in many stories that he collected. Thomson was surprised to discover that students were not being allowed to learn about the local snakes. In that study, the researcher also realized the need for Science educators to become researchers in order to document indigenous knowledge and its development for classroom learning which is lacking in many locales.

Michie (2002) also pointed out that teachers, especially in secondary schools, tend to lack knowledge on indigenous Science. This is why teachers are encouraged to conduct research in communities surrounding their schools as a way of upgrading their background knowledge in indigenous knowledge as also recommended by Gonzalez, Moll and Amanti (2005). Michie (2002) further contended that secondary schools might not be a good site for indigenous knowledge since the content, at that level, is more compartmentalized than holistic. For Michie, the best site for indigenous knowledge is primary schools, which tend to have integrated curricula.
2.6 Challenges of Integrating IK in Formal Education in Kenya

Challenges are encountered in effectively incorporating indigenous knowledge in Mathematics primary schools teaching in Kenya. Shizha, (2007) conducted a study using qualitative research methods. Ten teachers were purposively selected and interviewed to gain their insights into problems faced in incorporating indigenous knowledge into teaching. The study found that the problems were attitudinal, institutional, and systemic. In order to address both overt and hidden biases against indigenous knowledge in schools, teachers must first address their own personal attitudes. Because they are strong role models for children, they must be particularly aware of their underlying preconceptions of indigenous Mathematics knowledge. To successfully implement a multicultural curriculum, teachers need to recognize their own biases, be free of cultural biases, and be schooled in cultural awareness. Bias was detected when teachers were asked how they incorporated indigenous knowledge, culture, traditional beliefs, and customs into their Science lessons (Shizha, 2007).

Some teachers in my study undervalued the effectiveness of indigenous knowledge in developing techno-scientific skills applicable to scientific principles that can lead to sustainable use of indigenous resources in rural development. In their view, given the globalization and internationalization of English and Western Science, indigenous knowledge was retrogressive. Nkopodi & Mogege, (2009) posited that for many years, education has been based mainly on Western values. This has contributed to the fact that many learners from disadvantaged backgrounds cannot see the connection between the education they receive at school and their everyday experiences. This may well have contributed to the high failure rate amongst Mathematics learners as well as the perceived difficulty of Mathematics. It is believed that indigenous knowledge, in general, can be used to promote the teaching of Mathematics. English has been
positioned on a higher language pedestal than all indigenous languages. This has given
it official importance that is not accorded to any other language. The importance with
which examinations are viewed makes teachers stick to what is considered factual
information: what is going to be tested at the end of the primary school education
level? Examinations do not test indigenous knowledge or indigenous ways of knowing,
as a result, teachers makes little reference to the local indigenous knowledge in their
teaching.

Closely related to the question of examinations is the issue of teaching and learning
materials, especially textbooks, which are used by teachers and students as the key
source of Mathematics knowledge in school. Textbooks validate knowledge and define
and determine what is to be learned and how it is to be learned. A teacher feels
confident of and comfortable with their teaching when they had textbooks to which
they could refer for information. The methods employed and attitudes that teachers
hold toward the teaching of Mathematics derive partly from their pre-service training
at teachers’ colleges. Shizha, (2007) reported that teacher preparation and courses
taken in teachers’ colleges do not incorporate indigenous knowledge in Mathematics
curriculum and pedagogical practices.

At independence, integrating indigenous knowledge in a British structured model of
education created great challenges to Kenyan policymakers and implementation
process due to limited capacity of indigenous teachers and curriculum developers. This
was because as at that time of Kenya’s independence in 1963, the impact of indigenous
teaching force had not evolved sufficiently to create a critical mass of African
educators who were equipped with the right skills and knowledge to support the
process of curriculum change Lillis, (1985); Ominde Report, (1964). This was
compounded by the fact that the colonial government did not see the need to train indigenous educators given their focus of education for economic exploitation.

As stated by Abdi (2006) “colonial programs of education were designed and put into place to maximize all possible returns for colonialism”. Thus, lack of capacity of trained indigenous educators became a hindrance to the curriculum implementation. Hence the dominance of foreign teachers in post-colonial education system under the auspices of British aid to education continued to influence the process of curriculum innovations posing great challenges to the indigenization of the Kenyan school curriculum Lillis (1985). Lillis asserts that, “as teachers, course writers, project developers, disseminators, and inspectors of schools, expatriate educationists dominated these areas of curriculum while Africans played a subordinate role”. Thus, the absence of indigenous personnel to take charge of their own curriculum reconstruction process meant continued presence of foreign assumptions about what constituted valid school knowledge and valid means of assessing such knowledge therefore, implementing the stated education objective of integrating African indigenous knowledge within the curriculum is superficial (Mwenda, 2003 and Lillis, 1985).

An example is the inherited British education system at the secondary school level that was based on the Cambridge Examinations and certification. This was examined in the United Kingdom until 1968 when the East African Examination Council (EAEC) was formed (Woolman, 2001). Despite the formation of an East African examining body, the curriculum was still modeled around the Cambridge Examination of the United Kingdom and continued to be manned by expatriates, mainly from Britain, who ensured the dominance of a European curriculum in the Kenyan education system.
In other instances where positions of educational decision-making process had been Africanized such as the political and civil service, the dominant presence of elites who are products of and valued Western conceptualizations of knowledge preferred to maintain the status quo Lillis, (1985); Mwenda, (2003); Ngugi, (1981); Woolman, (2001). The Kenyan elites visualized Western education and Eurocentric modernization as having potential for economic development and a way forward to industrialization and economic progress. Thus, the Western mode of economic development was accorded more preference over indigenous modes of economic development by ensuring a continued reliance on macro planning. This approach ignored local conditions, local development needs, and the role of indigenous knowledge in developmental activities within regions such as rural, arid, and semi-arid areas of Kenya, which basically relies in this form of knowledge (Makhubu, 1998; Semali, 1999).

Moreover, most elites did not wholly embrace their cultural heritage, given their aculturalization of Western values that influenced their focus towards nationalistic perceptions of cultural development rather than solving economic problems at the local and communal levels (Owuor, 2007). The interface between school and indigenous knowledge apparently has created a lot of dilemmas and contradictions for Kenyan educators and policy-makers. The dilemmas have been on how to achieve the targeted integration, a condition that requires the involvement and commitment of all stakeholders of education. These include the policy makers, teachers, educators, parents, and community members who might not necessarily hold common perspectives on the value of indigenous knowledge in addressing issues of socio-economic development (Dei, 2002; Mwenda, 2003; Lillis, 1985; Republic of Kenya, 2005).
Therefore, lack of consensus in recognizing and validating the contribution of indigenous knowledge, practices, and innovation remains a challenge to achieving successful practically oriented relevant educational changes that addresses the needs of learners and their communities. The genesis of all this can be viewed in the light of Kenya’s experiences with colonial education where such forms of knowledge were delegitimized and devalued (Owuor, 2007).

The idea of organized curricula based on a highly Western economic model, contradicts the traditional approach in which learning is basically integrated into the communities’ socio-economic activities Mwenda, (2003); Republic of Kenya, (1998). Incorporating indigenous knowledge and pedagogy into the formal schooling therefore involves confronting power, authority and prestige of the existing Western dominant culture and destabilizing the status quo Angioni, (2003); Dei, (2002); Semali; (1999), a condition that is likely to create dilemmas and challenges for teachers, educators, and curriculum developers given their Western oriented education background. Thus, an overarching socio-economic issue that Kenya shares with other Sub-Saharan countries is the challenge of modernizing the society by integrating indigenous traditions of knowledge that is largely based on subsistence economy and local specificities with the Western development model with its reliance on market forces and Western epistemologies.

Other challenges to the integration process arise from the complex nature of indigenous knowledge and practices, which involve their incorporation into individuals’ way of life, making it invisible, hence not easy to identify the components to be implemented in innovations (Semali, (1999); Mwnenda, (2003); Woolman, (2001); Republic of Kenya; (2005). The invisibility is due to its embeddedness into the day-to-day socioeconomic activities. For example, among the Luyha of Western
Kenya, emphasis in indigenous education is placed on learning by doing through repeated practice over time rather than observation and replication. Thus, the knowledge is passed on in the context of personal relationships between the learners and mentors actively involved in the everyday interaction with the natural environment and activities necessary for survival. Individuals are practically engaged in activities such as fetching firewood, water, gardening, construction, trades, herding cattle, and physical activities among other things.

Today one can argue that in most Kenyan communities, there are fewer adults who possess the skills that need to be passed on to the youth that would support the capacity for integration of indigenous knowledge in formal education. At the same time the move among young people away from hereditary activities has made transmission and impartation of indigenous knowledge impersonal and disembodied from context. Disembodiment of indigenous knowledge is as a consequence of the replacement of traditional local authorities, demographic changes, urbanization, technological changes, modernization, commercialization, commodification of living resources, and the policies of external assistance agencies. These forces continue to pressurize the world to adopt Western perspectives to the detriment of indigenous ways of knowing, practice, and technology (Owuor, 2007).

The national dependency syndrome on external donors to support education reforms also contradicts education policies in the reform process. Dependence on foreign assistance to support Kenyan education reforms has led to education policies being influenced by external agents, forcing the government to focus on meeting the goals of globalization above the local needs and interests. Therefore, attracting donor funding to support research in education that would provide adequate information for implementation of the integration of indigenous knowledge in formal education has
suffered setbacks Gachanga, (2007); Lillis, (1985); Mwenda, (2003); Republic of Kenya, (1998). In most cases donors are inclined toward the support of research in education that is based on their conception of what constitutes education or what they validate as important topics and approaches to education. Yet findings from such forms of research are not likely to provide relevant information that would appropriately support the integration of indigenous knowledge into the formal school curriculum.

As stated by Gachanga (2007), despite acknowledgement of the important role indigenous knowledge plays in sustainable development and peace building, many governments, donors, and NGOs appear to make little use of this valuable resource. Their recognition of indigenous knowledge often amounts to little more than lip service, seldom translating into action or funding. This has resulted in lack of empirical studies to provide informed policy decisions and resource deficiency limiting the development of learning materials and professional development, which are key components for successful curriculum transformation (Government of Kenya, 1998). An example is the superficial implementation of the local languages as a medium of instruction in the lower levels of elementary schools, which continue to be positioned in subordination to foreign languages such as English and Kiswahili in the classroom as a medium of instruction.

The Kenya government’s efforts to incorporate indigenous knowledge into the formal education curriculum in the post-colonial era has partly been aimed at confronting power, authority, and prestige of Western knowledge which subordinates indigenous forms of knowledge in formal schooling. This approach is one of the ways in which the government has tried to empower its citizens to take control of their own development (Ominde Report, 1964). Incorporating indigenous knowledge in formal
education signifies the recognition of the power of the role of both the individual and collective agency of change that is found in the potential of using multiple forms of knowledge in solving current problems inflicting Kenyan communities. The pluralistic approach to knowledge systems requires that different forms of knowledge and methods be authenticated and embraced in the school system and that no one system be used as a benchmark for other knowledge forms (Mwenda, 2003; Semali, 1999; Shiva, 2002). Yet the integration takes place in the school environment that already privileges Western epistemologies against indigenous epistemologies, a condition that continues to create hegemony in Kenya’s school knowledge construction. This has often created contradictions between what is intended by the curriculum reforms and what is actually implemented in classrooms, resulting in incongruence between students’ indigenous experiential knowledge and formal school knowledge (Mwenda, 2003; Semali, 1999; Woolman, 2001).

Therefore, attempts to indigenize the curriculum in Kenya have met with little success and have been implemented superficially. Among all the pervasive forces is the legacy of colonialism that peripherally influences theories of knowledge construction and development of education programs in former colonized countries. Thus, Eurocentric values continue to dominate the Kenyan school system, creating contradictions to traditional values, as the priorities of scientific methods, research, and development dominate the knowledge construction process that inform Kenyan education practices. As stated by Abdi (2006) “the expansion of Western formal education created a situation where traditional education in colonized societies was portrayed by colonial powers as ineffective in managing the lives and welfare of colonized peoples and communities”. This is because knowledge hegemony constructs dominance and sustains power inequalities privileging and promoting cultural capital of the dominant
Western knowledge (Dei, et al, 2002; Ngugi, 1981) privileged by Kenyan elites who are the policy makers, curriculum developers, and implementers. At the same time, education stakeholders such as parents, curriculum developers and policy makers, have difficulty coping with the demands and obligations of indigenous practices vis-à-vis expectations of emerging global economies, commercialization and commoditization of knowledge which acts as a force in defining Kenyan education policies.

The dominating belief that prosperity means Westernized development and Western education continues to undermine the authenticity and legitimization of indigenous ways of knowing in Kenya’s formal education (Mwenda, 2003). As stated by Mwenda, what results is a “system of education that is in itself a form of governmentality where the individuals absorb dominant ideologies that construct imaginary pictures of prosperity that are shaped by foreign styles”. This indicates how teachers, educators, and curriculum policy makers who embrace Western perspective of what constitutes valid knowledge are likely to discern indigenous values, knowledge, and methods of teaching or may embrace it superficially, enabling the dominance of Western values to take precedence. Therefore, the legacy of colonialism continues to prevail upon Kenya’s educational and economic growth creating the need to change the discourse on indigenous knowledge especially with regards to indigenous education versus Western ways of knowing. Revitalizing the value of indigenous knowledge through curriculum reforms are vital if communities are to engage in sustainable economic development that is oriented to their local needs (Dei, 2002; Mudimbe, 1988; Mwenda, 2003; Shiva, 2002). This becomes necessary if Kenya and other Sub-Saharan countries are to reshape their own education framework in order to determine terms of development within the macro and micro levels.
The on-going global focus on knowledge commoditization promotes competition, contradictions, and dilemmas for educators and teachers in the implementation of the integration of indigenous knowledge into the curriculum. At the same time the interface between school and indigenous knowledge is rarely a focus for most Kenyan educators and policy makers. Unfortunately the transfer of indigenous knowledge from everyday life to schoolwork is not always valued or recognized by teachers Dei, (2002); Mwenda, (2003); Semali, (1999), and it is therefore necessary for teacher education programs to rethink ways in which to prepare teachers for effective integration of multiple forms of knowledge when designing and implementing the teacher education curriculum.

The foundation of all knowledge systems is local, but due to unbalanced power relations stemming from colonialism and other forms of imperialism, other nations and cultures have universally imposed their knowledge systems, cultures, and languages (wa Thiong’o 1986; Walter 2002; Smith 2002). However, due to globalization, many problems – such as climate change, poverty, and environmental degradation – are global. This raises important questions about how African Indigenous Knowledge Systems (AIKS) can contribute to the global knowledge economy. It is suggested that the sustainability of AIKS, given these global challenges, necessitates the convergence of African indigenous worldviews – embedded in African social practices through orality in their indigenous languages and knowledge systems – with other ways of knowing and knowledge production embedded through literality (Moodie 2003; McCarthy 2004).

In the context of this discussion on revitalizing African indigenous ways of knowing and knowledge production, the rationale for interfacing knowledge systems is twofold. It facilitates an intra- and intercultural dialogue between ways of knowing, knowledge
production, and value systems. It also enables local African communities to better understand the differences and interactions between AIKS and other knowledge systems in order to reconstruct their own knowledge systems and to make better-informed decisions about which knowledge (internal or external) is appropriate for their sustainable future (Ntuli 1999; Seleti 2010).

A founding principle for fostering positive interactions between AIKS and other knowledge systems is that collaboration must be initiated between equal partners. It must be built on mutual respect and understanding, transparent and open dialogue, and informed consent and just returns for the Indigenous Knowledge holders and practitioners through the flow of rewards and benefits. While efforts should be made to combine the best of both AIKS and other knowledge systems, there is an increasing emphasis that intercultural learning should be based on local experiences as a necessary prerequisite and a first step towards intercultural dialogue of knowledge systems for the sustainable development of AIKS and its contribution to the global pool of knowledge (Odoro-Hoppers 2002; Lander 2002).

For example, in his discussion on the symbiosis between modern Science and traditional knowledge for enhancing food security and climate change adaptation in Kenya, Mbuku (2013) looks at the use of indigenous knowledge in drought monitoring by pastoralists. He reveals that pastoralists usually derive Indigenous Knowledge-based forecasts just before the beginning of the farming season. He cites that, in northern Kenya, the Rendille pastoralists utilize a number of indicators – like local temperature, humidity, and wind conditions – to the presence or absence of certain types of clouds, rainfall patterns, and rain amounts. These weather indicators are also used in formal climate monitoring. When predicting prolonged drought, the Rendille pastoralists observe the flora and fauna for any unusual behaviour, paying specific attention to the
noises made by certain bird species, the appearance of sparrow weavers, bees migrating, emaciated livestock species when there is plenty of pasture, the invasion of certain ants, the making of noise by crickets at night, and unusual flowering of certain trees (e.g. *Lonchocarpus sp. sterile*).

Astrological constellations, like the position of the sun and moon, are also observed in great detail by the Rendille and Gabra pastoralists. Speranza et al. (2009) show that a number of these indicators have also been used for drought monitoring in other communities, such as the Kamba pastoralists of Kenya. Nkondo (2012) states that, in spite of the various contentions on the effectiveness of the indicators used by indigenous communities around the world, Indigenous Knowledge Systems have increasingly attracted the attention of many observers in both developed and developing countries. Practitioners are starting to realize the importance of recognizing and working with Indigenous Knowledge Systems, which builds on generations of experience, to best support the adaptive capacity and strategies of rural communities (Orlove *et al.*, 2010). There is increasing acknowledgement that indigenous forecasting methods are locally relevant and needs-driven, focus on the locality and timing of rains, and are “communicated in local languages and by local experts known and trusted by the people themselves.”

The above discussion has implications on the current educational system in Africa – a system that remains predominantly Eurocentric and dominated by European worldviews. This is exemplified by the teaching of social Sciences in African higher education institutions, where social theory is still entrenched in the methods, concerns, beliefs, and experiences of Western Europe and North America. Its irrelevance to Africa lies in the fact that it is quite inappropriate to attempt to fit African social history and social thought into the confines of a social and political structure that
reflects the organisation of Europe 300 years ago (Schutte 1999). The implication is that African educational institutions, especially in higher education, have reduced themselves to the reproduction of the intellectual outputs of Western social thinkers, including their theories and methodologies for prioritizing research. There is little attention given to African indigenous literary and philosophical traditions, as they tend to be viewed as primitive and unscientific, as well as improper sources for social theory and research development (Vilakazi 1999).

Nkondo (2012) reiterates the inability of African social scientists to generate their own indigenous concepts, definitions, theories, and methods which could guide the intellectual development in their research and academic fields. Smith (2002) adds that this leads to a lack of confidence among African scholars, as Western research models, theories, and concepts are uncritically adopted and applied in African cultural communities characterised by poverty, rendering them irrelevant to local settings. They tend to be elitist because they focus on the concerns of dominant groups in society, which marginalises the views and concerns of underprivileged social groups.

The integration of AIKS into the educational system in Africa provides the following opportunities for learners and their respective societies: (i) It provides learners with the opportunity to learn appropriate community attitudes and values for sustainable livelihood. This is due to the fact that African indigenous communities have lived in harmony with their environment and utilised natural resources without impairing nature’s capacity to regenerate them. AIKS in higher education can help to develop and promote these sensitive and caring values and attitudes for the environment. (ii) Learners will be able to learn through culture because AIKS are stored in various cultural forms – for example, folk stories, songs, folk drama, legends, proverbs, and myths. The use of these cultural resources in formal education can be very effective in
bringing AIKS alive for students. It enables them to conceptualise, practically, the theoretical knowledge acquired in the classroom. (iii) Involving community knowledge holders in research, teaching, and learning enables learners to learn across generations, hence making them appreciate and respect the knowledge of elders and other community members. In this context, higher education will be an agency for transferring culture from one generation to the next.

While there are prospects in interfacing African Indigenous Knowledge with other knowledge systems, a generic application of foreign ways of knowing and knowledge production – including technology systems in African cultural conditions is inappropriate. Knowledge systems should build on locally available resources, primarily the cultural and environmental experiences of the local people for relevance and sustainability. This has implications for African educational systems and sustainable community development: the necessity for direct collaboration between local communities and institutions of learning at all levels; intra- and inter-cultural education and research, which should be a collaborative effort of institutions of learning and local communities; and the dialogue and interface of ways of knowing and knowledge production, which can play an important role in re-indigenisation of educational systems in Africa. This will facilitate an intra- and intercultural dialogue between knowledge systems. However, this process requires reforming the education system in general to accommodate the new paradigm in ways of knowing, knowledge production, and value systems.

2.7 The Strategies of Integrating IK in Mathematical Concepts

Despite the stated value and potential of indigenous knowledge in providing solutions to some of the problems inflicting Kenya’s communities, educators need to examine what implications the inclusion of this form of knowledge has for pedagogy and its
sustainability in the current classroom settings. This is because of the diverse nature of Kenya’s ethnic communities and centuries of dominance of the country’s education system by Western epistemologies.

First, educators and curriculum developers need to be cautious and avoid bundling together the diverse Kenyan ways of knowing under one category of indigenous knowledge. This is because such generalization may lead to separating these forms of knowledge from their specific contexts Angioni, (2003), Semali, (1999), a condition that may lead to over simplification and superficial implementation.

Also, such homogenization is likely to jeopardize the potentially unique and important contribution that specific forms of indigenous knowledge can make to development within specific localities and among local groups who embrace such knowledge. At the same time educators need to recognize the fact that the uniqueness of indigenous knowledge in a particular culture does not necessarily mean that there is internal consensus or that all members of the same ethnic group adhere to the same knowledge base in their socio-economic and political decision-making process (Owuor, 2007).

Given the current acculturation and development of cosmopolitan communities Makhubu, (1998); Semali, (1999) individual members perceptions may differ significantly on specific ways of doing things. Central questions that need to be explored when integrating indigenous knowledge in the curriculum reforms are: What aspects of indigenous knowledge need to be incorporated in the integration process? What related features of indigenous ways of knowing and modes of learning are common across the diverse Kenyan indigenous cultures and which ones are unique to particular ethnic groups? Answers to these questions would act as a guide to
identifying those features of indigenous knowledge that can be made visible during the process of curricula development.

Kenyan indigenous education systems are highly hierarchical, hence top-down diffusion of knowledge becomes the norm, creating unequal power relations between those in subordinate positions of authority such as in the case of teachers and students Scott & Miller, (2002). Therefore, students and teachers may find themselves in situations of dilemmas and contradictions due to conflicting value orientations based on their perceptions of knowledge construction. For example, African students who have been immersed within a conservative cultural setting that value authority of elders may find it challenging to express divergent views from their teachers, hence limiting the process of dialogue in the classroom and instead promoting the authoritarian and what Friere (1994) refers to as the banking models of teaching.

Yet students living in cosmopolitan settings who have been exposed to Western perspectives through the media and information technologies bring into the classroom a more critical perspective to learning. This might not be appreciated by conservative teachers who maintain traditional beliefs on the central role of teachers in the legitimacy of knowledge construction based on their cultural beliefs on ownership of knowledge and authority in the classroom. This normally results in conflict with conservative teachers not being able to promote democratic classroom environments limiting analytical and critical thinking among students, which should be key ingredients to education process (Owuor, 2007).

The Western-based schooling system recognizes teachers’ professionalism as central in facilitating the process of classroom knowledge construction. This does not provide any space for classroom dialogue in which the experiences of members of local
communities such as the role of elders can be incorporated in formal classroom knowledge construction. Yet African indigeneity cultivates respect for the authority of knowledge of community elders due to their wisdom, accumulated knowledge, and their closeness to the ancestral world (spirituality) Dei, (2002); Mudimbe, 1988). Such knowledge based on intuition and experiences of life have been devalued as lacking in scientifically based methods and findings from empirical research. This poses challenges to the current debates of endogenous approach to education, which features discourses on possibilities of effective involvement of indigenous community members in the integration of indigenous knowledge into the formal education system Mwenda, (2003); Semali, (1999); UNESCO, (2006) as facilitators of the learning process.

Iman (2013) examined graduate students and mathematic teachers’ reflections on an immersion experience that facilitated first-hand observation of the mathematical ideas that emerge across indigenous cultures as creative expressions of human thought. The primary goal of this immersion was to offer students a trans-cultural experience where they can experience the realities of knowing and doing Mathematics amidst contextual challenges. The study found that students who participated in the immersion experience showed growth toward the belief that developing one's own point of view is important, and that it is important to seek an interdisciplinary approach to knowledge. Additionally, it was noticed that students returned home with a reduced tendency toward dualistic thinking and an inclination toward the related belief that there are no absolute right and wrong answers, good and bad information, as well as sources thereof. Overall, students felt that the immersion experience enriched them culturally, linguistically, academically, and personally. The perspectives students gained on the
nature of mathematical thinking were considered useful in informing their future instructional decisions and the range of experiences they offer their students.

The on-going global focus on knowledge commodification promotes competition, contradictions, and dilemmas for educators and teachers in the implementation of the integration of indigenous knowledge into the curriculum. At the same time the interface between school and indigenous knowledge is rarely a focus for most Kenyan educators and policy makers. Unfortunately the transfer of indigenous knowledge from everyday life to schoolwork is not always valued or recognized by teachers Dei, (2002); Mwenda, (2003); Semali, (1999), and it is therefore necessary for teacher education programs to rethink ways in which to prepare teachers for effective integration of multiple forms of knowledge when designing and implementing the teacher education curriculum.

2.8 Knowledge Gap

Indigenous knowledge, as portrayed in literature, tends to be all encompassing (holistic), like Yupiaq worldviews as described by Kawagley et al. (1998) and many others involved in the indigenizing discussion Klos, (2006); Michie, (2004); Semali & Kincheloe, (1999), Snively & Corsiglia, (2001). Various studies on IK (from diverse perspectives) have been carried out at both international and national levels. Examples of recent international studies have covered subjects spanning religion Clack, (2005), on religion; Joseph, (2005), on curricula; Lillejord, Sørede, (2003) & Mendoza, (2001), on culture; Gupta, (2000), on legal systems; Enwereji, (2000), on disability; Gerritsen, (2000), on agriculture and Vivekanandan (2004), on policy. International organizations have not been left behind and have instigated new IKS initiatives, such as those initiated by the World Bank and UNESCO.
Similar studies can be found in Africa covering agriculture (Ashley, 2000), curriculum development Gitari, (2003); Wyk, (2005), ICTs Ngulube, (2004); Cosijn et al., (2002); Chisenga, (2002), peace and development (Mascarenhas, (2004); Castiano, (2005), and knowledge management (Ocholla and Onyancha, (2004); Kaniki and Mphahlele, (2002), to name a few. Mapping and auditing IK studies continues to be a major challenge that we believe can be overcome with a proper IK recorded system. Such records can then be bibliometrically analysed.

Many theorists in the indigenizing movement also highlight the importance of myth and spiritual knowledge (Jegede & Aikenhead, 1999; Snively & Corsiglia, 2000) as part and parcel of the indigenous Science content. This study revealed that teachers lacked of connection to and understanding of indigenous knowledge. Also, Shumba (1999) carried out a quantitative research study in Zimbabwe, whose objective was to measure the extent to which secondary Science teachers are oriented towards traditional culture and how their orientation towards indigenous culture is related to instructional cultural ideological preferences.

A study that is closely related to the present study was conducted by Absalom (2008) in Malawi concerning the Integration of Indigenous Science in the Primary School Science Curriculum in Malawi. Absalom (2008) noted that it is high time the indigenous movement turned to the application of theoretical ideas expressed in recent literature. While it is true that there are post-colonial factors that are affecting people’s perceptions about worthwhile knowledge and living habits, there is high likelihood that indigenous people will continue using both Western ideas and their traditional viable scientific ideas in hybrid forms (Carter, 2006).
Another close study is by Kaino (2013) on the knowledge of traditional artifacts used by the Tchokwe tribe in Angola explored and then related to the mathematical content learned in the classroom. The activities show how the indigenous knowledge can be structured and get related to the mathematical knowledge taught in primary school. The knowledge that can be derived from various forms of the Tchokwe tradition is abundant in traditional decorations, paintings, story-telling and many others.

The foregoing discussions show that there is more to the thinking about integration of indigenous knowledge (IK) in school curriculum than the eyes can see. To gain better view of the association between indigenous knowledge and teaching of mathematical concepts, more researchers need to probe some of the many assertions that have been made in many position papers about indigenous knowledge. So far, the idea of inclusion of IK is accepted by the majority but to make it operational there is need to have many studies that can show; the effects of IK on students’ learning, the kind of content that fits the indigenous Mathematics paradigm, the nature of books that would support inclusion of IK, and whether IK is indeed unique to the indigenous masses that were formerly colonized or not. Despite emerging interests in IK, not enough is known about how IK is managed, particularly in developing countries like Kenya since no known study has been conducted to explore on the integration of indigenous knowledge in teaching of mathematical concepts, which is the main concern of this study, hence the research intends to fill this gap of knowledge by conducting this study.
2.9 Summary of the Chapter

This chapter has outlined and discussed various literature reviewed and studies related to different facets indigenous knowledge and its application. The literature discussed in this chapter sets the background necessary to examine ways of intergrading indigenous in teaching of Mathematics concepts. This chapter has further given an overview of related studies whose findings inform the present study.
CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

This chapter presents a number of related aspects of research design and methodology that enabled the researcher to achieve the following objectives; to identify the extent to which existing indigenous knowledge practice are applied in teaching of mathematical concepts, to find out teachers’ perception toward integration of indigenous knowledge in teaching of mathematical concepts, to find out learners’ knowledge of integrating indigenous knowledge in teaching of mathematical concepts, to document the challenges faced by teachers while incorporating indigenous knowledge in teaching of mathematical concepts and to explore the strategies of integrating indigenous knowledge in teaching of mathematical concepts. A detailed philosophical paradigm of the research is described in this chapter. This section also presents the study design, study area, the study population, sampling procedures, research instruments, research procedures, validity and reliability of research instruments as well as data analysis.

3.1 Philosophical Paradigm

Creswell, (2007) defines the term philosophical paradigm as looking at the world and interpreting what is studied. Willis, (2007) explains that: “A paradigm is thus a comprehensive belief system, world view, or framework that guides research and practice in a field”. From a philosophical perspective, a paradigm comprises a view of the nature of reality (i.e., ontology) - whether it is external or internal; a related view of the type of knowledge that can be generated and standards for justifying it (epistemology); and a disciplined approach to generating that knowledge (methodology). For educational researchers, there are several major paradigms that govern their inquiries into the policies and practices of education. Each paradigm
carries related theories of teaching and learning (or pedagogy), curriculum and assessment, professional development.

Understanding the philosophical paradigm underlying a research is very important, this study adopts a pragmatic paradigm. Pragmatic paradigm focus on the 'what' and 'how' of the research problem (Creswell, 2007). Pragmatism is seen as the paradigm that provides the underlying philosophical framework for mixed-methods research (Tashakkori & Teddlie, 2009; Somekh & Lewin, 2005). The pragmatic paradigm places "the research problem" as central and applies all approaches to understanding the problem (Creswell, 2003). With the research question 'central', data collection and analysis methods will provide insights into the question with no philosophical loyalty to any alternative paradigm.

Pragmatic philosophy was adopted in this research because it can accommodate the mixing of qualitative and quantitative methods and it focus on the 'what' and 'how' of the research problem. The pragmatic paradigm places "the research problem" as central and applies all approaches to understanding the problem (Creswell, 2003). With the research question 'central', data collection and analysis methods are chosen as those most likely to provide insights into the question with no philosophical loyalty to any alternative paradigm. Pragmatism appeals to mixed method approach of research and this study is based on pragmatism.

3.2 The Study Design

According to Bryman, (2008) a research design is a framework for the collection and analysis of data which is employed in a research project or study. This study used the Mixed-methods approach were several designs were adopted. A mixed-methods approach to research is one that involves gathering both quantitative and qualitative
information (Creswell, 2003). This method was used because of the nature of the research topic which calls for in-depth information from the respondents.

A mixed method approach has the advantage of what Bryman calls “completeness” which means that data that is not captured through quantitative instruments is likely to be captured through the qualitative research instruments (Bryman, 2008). Therefore, the researcher used three tools to collect data: observation schedules, focus group discussion guides and questionnaires. Triangulation of these tools enabled the researcher to collect in-depth data from the respondents.

The researcher used concurrent design while collecting data. In this design, qualitative and quantitative data were collected concurrently in one phase. The data was analyzed separately and then compared and/or combined. The researcher collected survey data and interviewed data at the same time and compared the results. This method was used to confirm, cross-validate or corroborate findings. It was used to overcome a weakness in one method with the strengths of another and also expanding quantitative data through collection of open-ended qualitative data.

Kumar, (2011) asserts that “…the main focus in mixed method research is to understand, explain, explore, discover and clarify situations, feelings, perceptions, attitudes, values, beliefs and experiences of a group of people.” The study was cross sectional in nature (cross-sectional study involves a one-time interaction with groups of people). Using cross-section survey design the researcher focused on understanding the extent to which IK is practiced, explaining teachers’ perception and learners’ knowledge, challenges and strategies of integrating Indigenous Knowledge in Mathematics curriculum.
3.3 Research Variables

A variable is anything that varies or changes from one instance to another (Zikmund et al., 2010). Research variables can further be classified as independent and dependent variables. Dependent variables are those that depend upon or are a consequence of the other variable, while the variable that is antecedent to the dependent variable is termed as the independent variable.

The study derived its variables from the topic ‘integration of indigenous knowledge within mathematics curriculum for primary schools in Vihiga County, Kenya’. The independent variable is ‘integration of indigenous knowledge’ while ‘mathematical curriculum’ as the dependent variable because it is affected by the independent variables mentioned above. The extraneous variables will be controlled by being held constant.

3.4 The Study Area

The study was carried out in Vihiga County. Vihiga County is an administrative region in the former Western Province of Kenya whose headquarters is at Mbale. The county has a population of 554,622 and an area of 563 km². The county has three sub-counties namely Sabatia, hamisi and emuhaya. The county borders Kakamega County to the North, Nandi County to the East, Kisumu County to the South, and Siaya County to the West.

The selection of this study area was because of the following main reasons; foremost, like many other parts of the country, very little known research in indigenous knowledge has been done in this area. Secondly, this county was selected because it is dominantly inhabited by one community which is believed to share cultural roots (indigenous knowledge) and characteristics likely to give a homogenous cultural
background of most teachers and learners hence a true representation of the variables
in this study.

3.5 Target Population

Zikmund et al. (2010) define population as any collection of specific groups of human
beings or of non-human entities such as objects, educational institutions, time units,
geographical area, prices of wheat or salaries drawn by individuals; a list of elements
from which a sample may be drawn. The selection of a population is the most crucial
stage in research. In a statistical sense, the term population means the aggregate of
persons or objects under study (Babbie, 2001).

In this study, the target population included teachers of mathematics in standard six
and class six pupils. Class six learners were deemed appropriate for they are a class in
the middle in upper primary were most basic mathematical concepts are presumed to
have been acquired leaving out class seven and eight to be mainly revision of work of
earlier learnt topics (KIE, 2002). In addition, class six learners are believed to have
acquired some insight about existing indigenous knowledge from the community
hence at this level they can apply explicitly in the Mathematics lessons.

Class six mathematics teachers and class six pupils were selected. However, teachers’
practices was the focus of the study because implementation of a curriculum is
dependent on their choices, knowledge, and skills. On the other hand, their skills
cannot be displayed in the absence of learners. Therefore, teachers’ capability to teach
was measured against their capability to engage pupils in learning the ideas stipulated
in the mathematical concepts as related with indigenous knowledge. This process of
selecting participants gives a typical sample according to (Fraenkel & Warren 2006).
3.6 Sample Size and Sampling Procedure

Sampling involves using a portion of a population to make conclusions about the whole population (Zikmund et al., 2010). Sampling is the process of selecting a sub-set of cases in order to draw conclusions about the entire set (Cohen & Manion, 2003). A sample is a small part of a large population, which is thought to be representative of a larger population. Any statements made about the sample should be true for the entire population.

Since it is not possible to involve the whole population in the study, only a representative sample was used. Gay (1992) notes that “…a researcher selects a sample due to various limitations that make it difficult to research into the whole population.” For this reason, small groups was drawn from the population to participate in the study. This was used as a means of providing reliable and detailed information and to save time, effort and finance. Basically, a sample is considered to be a subset of the population.

3.6.1 Sampling Procedures

The selection of a research sample has important consequences for the validity of research findings (Vaus, 2001). The major purpose of conducting the research is to be able to make some claim about the larger population. Therefore, it is essential to choose a sample that enables the researcher to generalize findings to that larger population. Selection is usually performed in different ways. Most data are collected through sample surveys and sampling is based on the theory of probability and inductive reasoning. Probability is the chance or likelihood of something happening. Through sampling, conclusions are derived about the characteristics of a larger entity by studying only a part of the sample which saves time, manpower and money (Hagood & Price, 1957).
There are many sampling techniques available to a researcher. Sampling techniques allow a researcher to collect the data from a subset or subgroup rather than the whole population and therefore reduce the amount of data to fit the purpose of the study. A good sample should possess the properties of the population from which it has been drawn. A sample is representative when it is an accurate, proportional representation of the population under study. For reliable conclusions to be drawn from the research, samples for research must be representative of the target group.

For the purpose of this study, the researcher used multi-stage sampling, where stratified sampling was followed by simple random sampling and then purposive sampling for teachers. Stratified sampling is where the target population is divided into layers or strata while random selection is a basic requirement to get better, comparatively accurate information (Babbie, 2001).

3.6.2 Sample Size

The sample size is simply the number of people or units available to be studied. In this study, Multi-stage sampling was used to get the sample size. A stratified random sample of 40 public primary schools was drawn, adopting the procedure of proportional allocation. This agrees with Neuman, (2007) who noted that a sample size of at least 10% to 30% is a good representation of the entire population. This gave a total of 40 schools from 400 public primary schools in the county. From each school, simple random sampling procedure using lottery technique was used to select 5-12 of class six pupils as required by group interview. All the Mathematics teachers of class six in the sampled schools were selected purposively.
Table 3.1: Sampling Frame

<table>
<thead>
<tr>
<th>Sub-County (Stratified)</th>
<th>Hamisi</th>
<th>Sabatia</th>
<th>Vihiga &amp; Luanda</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public primary schools</td>
<td>110</td>
<td>100</td>
<td>70</td>
<td>400</td>
</tr>
<tr>
<td>Proportionately selected schools-10% (simple random sampling)</td>
<td>11</td>
<td>10</td>
<td>7</td>
<td>40</td>
</tr>
<tr>
<td>Pupils-Simple random sampling (using lottery technique) 12 in each school</td>
<td>132</td>
<td>120</td>
<td>84</td>
<td>480</td>
</tr>
<tr>
<td>Teachers (Purposive sampling)</td>
<td>11</td>
<td>10</td>
<td>7</td>
<td>40</td>
</tr>
</tbody>
</table>

3.7 Research Instruments

Research instruments are the tools of collecting data from the selected sample. Positivist or post-positivist paradigm tends to predominantly use quantitative approaches (methods) to data collection and analysis, though not necessarily exclusively, while the interpretive/constructivist paradigm generally operates using predominantly qualitative methods (Silverman, 2000; Wiersma, 2000; Bogdan & Biklen 1998; Mertens, 1998; Burns, 1997; Cohen & Manion 1994; Glesne & Peshkin 1992). The pragmatic paradigm provides an opportunity for "multiple methods, different worldviews, and different assumptions, as well as different forms of data collection and analysis in the mixed methods study" (Creswell, 2003).

This study adopted a mixed method research using triangulation of tools where both qualitative and quantitative data was collected concurrently. Data tools included direct class observation schedule, questionnaire for teachers and focus group discussion schedule for pupils. A direct observation was used to obtain available indigenous artifacts/tools, strategies used to integrate ingenious knowledge in mathematical concepts and observe the challenges experienced by teachers while integrating
indigenous knowledge in the classroom. Questionnaires with open and closed questions focused on teachers understanding of the exiting indigenous knowledge, the extent to which the knowledge is incorporated in Mathematics lesson and their perception towards integrating indigenous knowledge and the focus group discussion schedule focused on learners understanding and their perception towards integration of indigenous knowledge.

In research, such a practice is referred to as triangulation; using more than one source of data to substantiate a researcher’s conclusion (Jerry et al., 1996; Cozby, 2001; Creswell, 2011). Robson (1993) expressing the validity of triangulation says that triangulation:

“Is an indispensable tool in real world inquiry...It provides a means of testing one source of information against other sources... If there is a discrepancy, its’ investigation may help in explaining the phenomenon of interest... the byproducts... are useful as its primary purpose is validating information. It improves the quality of data and in consequence the accuracy of findings.”

The use of triangulation allowed the researcher to capture a more complete, holistic and contextual portrayal and helped to reveal the varied dimensions to the phenomena under investigation. It is also valuable because of the increased quality control achieved by combining methods, theories and data sources (Denzin et al., 2005). Denzin et al. (2005) classified triangulation into four types: data, investigator, method and theory. This study considered data, methodological and theoretical triangulation. In using triangulation, biasness was minimized and validity enhanced. The selection of these tools was guided by the nature of data to be collected, time available for the study as well as objectives of the study.

3.7.1 Observation Schedule

Observation is a purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place (Kumar, 2011). Observation schedule
was used to collected data for **objective one** on the available indigenous knowledge applied in the classroom. Also the observation schedule collected data for **objective four** on the IK strategies teachers apply while teaching mathematical concepts in the classroom and **objective five** on the challenges teachers face in the classroom when integrating IK in Mathematical concepts.

The use of observation schedule was necessary to verify responses from the questionnaire.

Tape recording was used as a method of recording data in order to enable the researcher concentrate fully on what was going on in the classroom and a camera was used to capture pictures of the relevant indigenous artifacts/tools available in the classroom. The researcher combined three methods of recording data during observation; writing field notes, tape recording and taking pictures. Tape recording freed the researcher from having to write everything and taking detailed notes could lead to the researcher missing out on some of the classroom interactions (Hucker, 2005 & Kumar, 2011).

### 3.7.2 Questionnaire

A questionnaire is a research instrument that gathers data over a large sample (Kombo & Tromp, 2006). The questionnaires used in this research consisted of structured and unstructured questions. The structured questions complemented with the unstructured or open-ended questions which permitted the respondent to respond in his/her own way. The questionnaires was administered to teachers who were selected for the study.

A part from demographic information about teachers' gender, age, experience and academic qualifications, the questionnaires collected data for **objective one**, it focused on interrogating the extent to which existing indigenous knowledge practice are
applied in teaching of mathematical concepts and to identify indigenous knowledge/artifacts incorporated in mathematical concepts in the classroom (beadwork, weaving, decorations, constructions, games, storytelling).

In addition, the questionnaires collected data for **objective two** about teachers’ perception toward integration of indigenous knowledge in teaching of mathematical concepts. Also the questionnaire collected data on **objective four and five** which focused on the strategies of integrating indigenous knowledge in teaching of mathematical concepts and challenges faced by teachers while incorporating indigenous knowledge in teaching of mathematical concepts in the classroom. To measure the variables for objective one, two, four and five, the research prepared statement that were measured by likert scale.

### 3.7.3 Focus Group Discussion Guide

A focus group is a small group of five to twelve people led through an open discussion by a skilled moderator. The group needs to be large enough to generate rich discussion but not so large that some participants are left out (Koul, 1992). It provides an opportunity for the interviewer to question thoroughly certain areas of inquiry. Hucker, (2005) is of the view that “…though group interviews take longer to carry out than questionnaires, they make it possible for the researcher to explore issues in more depth if a good rapport develops as they can draw out reasons and explanations in a way that questionnaires cannot .” Interviews also allow the researcher to rephrase questions and ask additional ones to clarify responses and secure more valid results (Jerry et al., 1996; Creswell, 2011).

A focused group discussion guide prepared for class six pupils was used to collect data on **objective three** about pupils knowledge of integrating indigenous knowledge
in Mathematics curriculum. The interviewer recorded the responses by note taking and also recording. The interviews were done after observation. This exercise was necessary in order to triangulate data gathered from direct observation and questionnaires as part of the validity process by cross checking what respondents professed correlates or differs with actual actions in the classroom. Consistency of respondents’ responses was evaluated by restating some questions in slightly different forms at a later time in the interview (Best & Kahn, 1992).

3.8 Pilot Study

A pilot study is a small scale research project that collects data from respondents similar to those to be used in the actual study (Zikmund et al., 2010). It can also be the pre testing or ‘trying out’ of a particular research instrument (Baker, 1994). To ascertain dependability of instruments used in this study, a pilot study was carried out before the actual research. The instrument was pre-tested through a pilot study before actual data collection. This enabled the revision of the instrument before actual data collection in terms of their content. Also piloting was also done to find out whether respondents have the same understanding of the items, thus offering the required information and also to find out any problems related to the layout, content, language and relation of items in the instruments to the objectives of the study.

The pilot study was carried out in 4 schools in the same County, each school from each sub-county using a test-rest method. These schools were selected purposively to ensure that they bear the same characteristics as the schools in the study area. The feedback obtained from the piloted school helped the researcher in revising the instrument to ensure that they cover the objectives of the study adequately.
Test retest method was used in piloting to determine a reliability index. The instruments were taken to the selected schools and after two weeks the researcher returned the instruments and collected data. The piloting of the instrument was to identify faults hence improve its reliability. The pilot study generally helped to uncover the challenges that would arise from the instruments. This helped the researcher to revise the instruments by reducing the number of questions making them clear as well as arranging them in an orderly manner.

3.9 Quality Assurance: Reliability and Validity of the Research Instrument

The section presents the standardization of the instruments through reliability and validity. These are measures of the “relevance” and “correctness” of the instruments. Reliability and Validity is important because it determines the quality of research (Mugenda & Mugenda, 1999).

3.9.1 Reliability of the Instrument

Koul,(1993) states that the reliability of a test refers to the ability of the test to consistently yield the same result when repeated measurements are taken on the same individuals under the same conditions. He notes that to obtain reliable data the instrument must be carefully structured to give an assurance for the respondents’ answer. Joppe, (2000) further defines reliability as the extent to which results are consistent over time and an accurate representation of the total population under study. If the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. Reliability is the measure of the degree to which a research instrument yields consistent results or data after repeated trials (Mugenda & Mugenda, 1999, 2012).
Kirk and Miller (1986) identify three types of reliability referred to in quantitative research, which relates to:

i) The degree to which a measurement, given repeatedly, remains the same

ii) The stability of a measurement over time; and

iii) The similarity of measurements within a given time period.

According to Kathuri and Pals (1993), the reliability of the instruments ensures:

i) The responses are consistent across variables (consistency)

ii) Individuals do not vary in their responses if the instruments are administered a second time (stability)

Errors made during administration or scoring of the instruments are eliminated.

3.9.1.1 Reliability of Questionnaire Items

In this section, the researcher discusses how reliability tests were carried out on the four scales (constructs). The reliability of the questionnaire was tested using Cronbach’s Alpha coefficient. This was deemed to be appropriate because it requires only a single administration and provides a unique quantitative estimate of reliability for the given administration. It measures how well a set of items (variables) measures a single one-dimensional latent construct (Lapsley, 2006). It is considered to be a conservative (lower bound) estimate of reliability, meaning that the true relationship is likely to be not lower than this estimate (Lapsley, 2006). The value of the coefficient of reliability falls between 0 and 1. An instrument with no reliability will score 0 and an instrument with very high reliability will score close to 1.

In order to ensure reliability of the questionnaire, a test-retest piloting was carried out to determine a reliability index of the instruments. The SPSS computer software aided in working out the coefficient correlations. Creswell, (2003) indicated that if the
coefficient correlation is above the threshold of alpha of 0.7, the instruments is reliable. The four scales that were tested to determine their reliability are presented in Table 3.2.

Table 3.2. Overall Correlation between Variables in the Teachers’ Questionnaire

<table>
<thead>
<tr>
<th>Construct</th>
<th>Cronbach’s Alpha</th>
<th>No. of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic information</td>
<td>0.654</td>
<td>4</td>
</tr>
<tr>
<td>Existing IK</td>
<td>0.883</td>
<td>8</td>
</tr>
<tr>
<td>Teachers' perceptions towards IK</td>
<td>0.812</td>
<td>12</td>
</tr>
<tr>
<td>Strategies of integrating IK</td>
<td>0.725</td>
<td>18</td>
</tr>
<tr>
<td>Challenges teachers face while integrating IK</td>
<td>0.612</td>
<td>10</td>
</tr>
<tr>
<td>All</td>
<td>0.737</td>
<td>52</td>
</tr>
</tbody>
</table>

Table 3.2 indicate the reliability coefficient between variables in the teachers’ questionnaire. The Cronbach’s coefficient alphas of 0.654, 0.883, 0.812, 0.725 and 0.612 were obtained by using scores of 5,4,3,2,1 for the responses on items form teachers’ questionnaire. These coefficients are above average and seem to suggest that the items in the questionnaire hang together or measure the same construct. From the pilot study, the average reliability of the questionnaire yielded a Cronbach alpha level of 0.737. According to Plowright (2011), a reliability of at least 0.5 is normally accepted as a measure of reliability for the instruments. Therefore, the questionnaire was considered reliable and appropriate to collect the relevant data to answer the question posed.

3.9.2 Validity of the Research Instrument

Validity is concerned with whether the instrument measures what it is supposed to measure or it is the degree to which results obtained from the analysis of the data
actually represent the phenomenon under study. Frankel and Wallen (2000) say that “…it is the appropriateness, meaningfulness and usefulness in the specific inferences researchers make based on the data they collect.” Moser and Kalton (1992:355) describe validity as: “the success of the scale in measuring what it sets out to measure.” Mugenda and Mugenda, (2003) notes that validity has to do with how accurate the data obtained in the study represents the variables of the study and is a true reflection of the variables. It is only then that inferences based in such data would be accurate and meaningful.

Researchers generally determine validity by asking a series of questions, and will often look for the answers in the research of others. To ascertain validity of the questionnaire, interview schedule and observation checklist the researcher consulted experts, supervisors and experienced personnel in the research methodology from Moi University to make criticism and comments on the format of the instruments. Their comments were incorporated in the questionnaires before the final administration of the instruments on the participants of the study. This being a mixed method study, getting another person’s views/perceptions and triangulation of data sources was used to enhance validity (Brudenell, 2004, Creswell, 2009). The instruments were given to experts who included the researchers’ supervisors from the curriculum instruction and educational media department to ascertain how they met face and content validity. The suggestions given by the expert were used to effect the necessary changes to improve upon the validity of instrument.

In this study, triangulation of research methods was used to validate the research. Triangulation is use of two or more methods of data collection. According to Cohen et al., (2000) triangulation is a powerful way of demonstrating concurrent validity in qualitative and quantitative design. This assisted the researcher to check on the
content, construction of items and criterion of the research instruments. Triangulation is typically a strategy (test) for improving the validity and reliability of research or evaluation of findings. Mathison, (1988) elaborates this by saying. Triangulation has raised an important methodological issue in naturalistic and qualitative approaches to evaluation in order to control bias and establishing valid propositions because traditional scientific techniques are incompatible with this alternate epistemology.

Patton, (2001) advocates for the use of triangulation by stating “triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data, including using both quantitative and qualitative approaches”. However, the idea of combining methods has been challenged by (Barbour, 1998). She argues while mixing paradigms can be possible but mixing methods within one paradigm, such as qualitative research, is problematic since each method within the qualitative paradigm has its own assumption in “terms of theoretical frameworks we bring to bear on our research”. Even though triangulation is used in quantitative paradigm for confirmation and generalization of a research, (Barbour, 1998) does not disregard the notion of triangulation in qualitative paradigm and she states the need to define triangulation from a qualitative research’s perspective in each paradigm. For example, in using triangulation of several data sources in quantitative research, any exception may lead to a disconfirmation of the hypothesis where exceptions in qualitative research are dealt to modify the theories and are fruitful.


i) Is it appropriate for the chosen population?

ii) What psychological or underlying constructs are being measured?

iii) Does the instrument contain a good representation of the desired content?

iv) Does it measure other characteristics as well?
v) Could this test be used to make useful predictions?

vi) Does it look like it is measuring what it claims to measure?

The above questions were well addressed through the three instruments which were used to collect data in the study.

### 3.9.3 Trustworthiness of Qualitative Instruments

Since qualitative researchers do not use instruments with established metrics about validity and reliability, it was pertinent to address how qualitative researchers establish that the research study’s findings are credible, transferable, confirmable, and dependable. Trustworthiness is all about establishing these four things and to achieve this the researcher used **observation schedule** and **focus group guide**. In order to provide a different set for criteria that can be used for ascertaining the quality, (Lincoln & Guba 1985) created a corresponding set of criteria for trustworthiness of qualitative research as: credibility, transferability, dependability and confirmability. Qualitative research therefore requires far more documentation than quantitative research in order to establish trustworthiness.

#### Credibility

Credibility depends on the richness of the data and analysis and can be enhanced by triangulation (Patton, 2002), rather than relying on sample size aiming at representing a population. Credibility is the how confident the qualitative researcher is in the truth of the research study’s findings. This boils down to the question of “How do you know that your findings are true and accurate?” This study used triangulation to show the research study’s findings are credible. The researcher used Data triangulation (using different sources of data, e.g. from existing research) and Methodological triangulation (using more than one method, e.g. mixed methods approach, however with focus on qualitative methods)
Transferability

Transferability corresponds to external validity, i.e. generalizing a study’s results. Transferability can be achieved by thorough description of the research context and underlying assumptions (Trochim, 2006). With providing that information, the research results may be transferred from the original research situation to a similar situation. This study used thick description to show that the research study’s findings can be applicable to other contexts, circumstances, and situations. Purposive sampling was used to select class six Mathematics teacher since specific information was maximized in relation to the context in which the data collection occurred.

Dependability

Dependability is the extent that the study could be repeated by other researchers and that the findings would be consistent. In other words, if a person wanted to replicate your study, they should have enough information from your research report to do so and obtain similar findings as your study did. The study used inquiry audit in order to establish dependability, where an outside person reviewed and examined the research process and the data analysis in order to ensure that the findings are consistent and could be repeated. Dependability aims to replace reliability, which requires that when replicating experiments, the same results should be achieved (Lincoln & Guba, 1985).

Confirmability

Confirmability is the degree of neutrality in the research study’s findings (Lincoln & Guba, 1985). In other words, this means that the findings are based on participants’ responses and not any potential bias or personal motivations of the researcher. This involves making sure that researcher bias does not skew the interpretation of what the research participants said to fit a certain narrative. This was achieved by means of a confirmability audit that includes an audit trail of raw data, analysis notes,
reconstruction, and synthesis products, process notes, personal notes, as well as preliminary developmental information.

3.10 Data Collection Procedures

This refers to the collection or gathering of information to serve or prove some facts (Kombo & Tromp, 2006). The researcher first sought research approval from the school of Education, Moi University, and then proceeded to obtain research authorization from the National Council of Science and Technology (NACOSTI) before the process of data collection. The researcher also took time to familiarize herself with the study area before beginning to collect data.

The researcher went to the field to meet the selected respondents who responded to the instruments of collecting data. The researcher visited the Principal who later introduced her to the head of department and the teachers of Mathematics in class six. The teachers then introduced the researcher to class six pupils. In this case the teachers responded to the questionnaire and the researcher observed lessons in order to gather information using the observation guide. Prior to this, the researcher had to check the timetable to confirm when the lessons were scheduled on the timetable in order to make arrangements for observation of the lessons. The researcher further requested to conduct focus group discussion with pupils during their free time.

3.11 Data Analysis Method and Presentation

This refers to the examination of the coded data critically and making inferences (Kombo & Tromp, 2006). This involves ordering, structuring and giving meaning to the mass of data collected (Mugenda and Mugenda, 2003). This study was conducted as a survey that used both descriptive statistics and inferential statistics to analyse the data collected. The study utilised both quantitative and qualitative approach to collect
and analyse data. Data from the three instruments was analysed, interpreted and discussed concurrently according to objectives and conclusions made.

### Table 3.3: Data Analysis Plan

<table>
<thead>
<tr>
<th>Research Objective</th>
<th>Methods</th>
<th>Analysis techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ONE:</strong> To identify the extent to which existing IK practices are applied in teaching of mathematical concepts.</td>
<td>Questionnaire, Observation schedule</td>
<td>Descriptive statistical techniques, Explanations.</td>
</tr>
<tr>
<td><strong>TWO:</strong> To find out teachers’ perception towards integration of IK in teaching of mathematical concepts.</td>
<td>Questionnaires</td>
<td>Pearson Product Moment Correlation Coefficient, Explanations</td>
</tr>
<tr>
<td><strong>THREE:</strong> To determine learners’ knowledge of integrating IK in teaching Math.</td>
<td>Focus group guide Schedule</td>
<td>Narration and Explanations.</td>
</tr>
<tr>
<td><strong>FOUR:</strong> To explore the strategies of integrating IK in teaching of Mathematics.</td>
<td>Questionnaire, Observation schedule</td>
<td>Descriptive statistical techniques, Explanations</td>
</tr>
<tr>
<td><strong>FIVE:</strong> To investigate the challenges faced by teachers while incorporating IK in teaching mathematical concepts.</td>
<td>Questionnaire, Observation schedule</td>
<td>Descriptive statistical techniques, Explanations</td>
</tr>
</tbody>
</table>

#### 3.11.1 Quantitative Data

**Descriptive Statistics**

Collected data from likert scale was coded and entered into computer for analysis using the statistical package for social Sciences (SPSS Version 20.0). Descriptive statistical techniques included mean, frequency counts and percentages. Bell, (1993) maintains that when making results known to variety of readers, simple descriptive statistics such as percentages have a considerable advantage over more complex statistics, since they are easily understood.
Correlation Statistics

The inferential statistics adopted a correlation analysis to identify the relationship between the independent variables (teacher’s perceptions) on integration of indigenous knowledge and the dependent variables (teaching of mathematical concepts). With the help of statistical package for social Sciences (SPSS Version 20.0), Pearson Product moment correlation at (0.05 level of significance) was run since it is a parametric statistics (higher method of measuring hypothesis) and also it is used to test two or more than two independent variable.

3.11.2 Qualitative Data

The researcher transcribed data from the focus group guide, observation schedule and audio-tapes as suggested by (Dornyei, 2007), then, the information was analyzed and discussed and grouped according to its relevance to the objectives of the study.

3.12 Ethical Considerations in the Study

Ethical measures are principles which the researcher should bind himself or herself when conducting his/her research (Schulze, 2002). The ethical issues will be highly emphasized in order to protect the rights of the respondents’ and the researcher. The following are the ethical principles the researcher adhered to while conducting this research;

1) Permission to conduct the research: In this study, the researcher sought permission from the School of Education to apply for research permit from Ministry of Education, Science and Technology. An introductory letter was also presented to the relevant office so as to carry out the research.

2) Informed consent: Participants were given enough information pertaining to the study before the administration of the research instrument. The possible benefits and value of the study was also explained to the participants. De
Vos, (1998) postulates that informed consent relates to the communication of all possible information about the research as accurately as possible to participants. Consequently, the researcher provided information about the purpose of the study to the participants. This was done by attaching a covering letter to the questionnaire that stated the purpose of the study. Issues related to the research such as aims, procedures of investigation and possible advantages or disadvantages were shared with the participants.

3) **Confidentiality and Anonymity**: A researcher has to be responsible at all times and be vigilant, mindful and sensitive to human dignity. In this study, participants’ confidentialities was not be compromised, as their names were not used or appeared in the collection of data. No private or secret information was divulged since the right of confidentiality of the participants was respected.

4) **Rapport**: To establish good working relationship with the participants, the researcher endeavored to develop a rapport with them. The researcher took individual responsibility for the conduct and consequences of the research by adhering to the time schedule agreed upon with the head teachers and teachers.

5) **Voluntary participation**: The respondents consent to participate in the research was voluntary, free of any coercion or promises of benefits unlikely to result from participation (Hucker, 2005; Best & Kahn, 1992). Participation was strictly voluntary, with respondents having the freedom to withdraw at any time. This was explained to them before the research commenced.

6) **Respect**: All research participants were treated with respect (Grasso & Epstein, 1992). No teacher was forced to take part in the study. Participants had the right to refuse to participate in the study, and this right was respected.
7) Since this study involved prolonged observation and interviewing in the sampled schools, the researcher was cognizant of their impact. To minimize the intrusion on the flow of activities in the school, all focus group discussions were conducted after classes (Creswell, 2011).

3.13 Summary of the Chapter

This chapter has focused on the various details concerning research design and methodology that the study will employ. Details on specific study area, the target population and data collection methods have been given. Data analysis and ethical considerations have been presented. The purpose of this mixed method study was to explore on the integration of indigenous knowledge in teaching of mathematical concepts in primary schools in Vihiga County, Kenya.
CHAPTER FOUR
DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION

4.0 Introduction

This chapter presents the findings of the study based on the data obtained from the respondents. The purpose of this mixed method study was to explore the integration of indigenous knowledge in teaching of mathematical concepts in primary schools in Vihiga County, Kenya. Data collection was done using triangulation of various tools such as; questionnaires, class observation schedule and focus group discussion guide and analysis done concurrently. The questionnaires were administered to class six Mathematics teachers, class observation schedule and focus group discussion which were administered to class six pupils to ascertain the existing and use of indigenous knowledge. This study sought to answer the following question;

i. To what extent is existing indigenous knowledge practice applied in teaching of mathematical concepts?

ii. What are the learners’ knowledge of integration of indigenous knowledge in classroom mathematics?

iii. Which strategies can be used in the integration of indigenous knowledge in teaching of mathematical concepts?

iv. What are the challenges faced by teachers while incorporating indigenous knowledge in teaching of mathematical concepts?

This study also sought to test the following hypothesis;

HO1: There is no significant relationship between teacher’s perception towards indigenous knowledge and teaching of mathematical concepts.
4.1 Demographic Information of Teachers

This section discusses the demographic characteristics of the respondents based on question items Q1 (what is your gender?), Q2 (age), Q3 (how long have you been teaching Mathematics in Vihiga County?) and Q4 (what is the highest level of your academic qualification). The findings would assist the study categorize the respondents by demographic details.

4.1.1 Gender of Respondents

The gender of the respondents was sought since its findings would assist the study in categorizing respondents based on gender and their perception on indigenous knowledge and teaching of mathematical concepts. The findings are as shown in table 4.1 below.

Table 4.1: Teachers' Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>27</td>
<td>67.5</td>
<td>67.5</td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>32.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Source: Field Data 2018

Table 4.1 shows that majority of class six Mathematics teachers respondents 27 (67.5%) were male, while female teachers were 13 (32.5%). Male teachers are presumed to be many since they come from the community around the school. Collectively the body of literature available to date suggests that, first, despite lack of conclusive evidence, male teachers have positive perception towards Mathematics. The studies tend to stereotype Mathematics as a male domain subject. This leads us to believe that there are small, subtle, interactive and cumulative links between teachers' beliefs and gender differences in Mathematics education teaching which
also reflect on the perception of integrating indigenous knowledge in Mathematics curriculum (Brophy, J. 1985)

4.1.2 Age of the Respondents.

When asked about their age question item Q2 (what is your age?), the responses were as shown in Figure 4.1 which shows that, 13(32.5%) of the respondents were below 30 years, 18(45%) of the respondents were 30-50 years and 9(22.5%) of the respondents were above 51 years, making a total of 40(100%). This shows that most of class six Mathematics teachers are in the age bracket of 30-50 years due to the long period taken before they are employed after college.

![Figure 4.1: Teachers' Age.](image)

Source: Field Data 2018

Since majority of the respondents are over 30 years, it’s believed that they have acquired more knowledge and skills on IK through life experiences. Frelow, (2002) asserts that older teachers have interacted with pupils for a longer period hence they are able to connect with them due to continued interaction; as a result such teachers are able to understand pupils background.
4.1.3 Teachers’ Experience in Teaching Mathematics in Vihiga County

This section discussed question item Q3 (how long have you been teaching Mathematics in Vihiga County?). The findings are as shown in table 4.2.

Table 4.2: Teachers’ Experience in Teaching Mathematics in Vihiga County

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 5 years</td>
<td>12</td>
<td>30.0</td>
<td>30.0</td>
</tr>
<tr>
<td>6-10 years</td>
<td>23</td>
<td>57.5</td>
<td>87.5</td>
</tr>
<tr>
<td>Above 10 years</td>
<td>5</td>
<td>12.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Field Data 2018*

Table 4.2 indicates that 12(30.0%) of the teachers had taught Mathematics in Vihiga County in less than 5 years while 5(12.5%) of the teachers had taught for above 10 years. Majority of the teachers sampled 23(57.5%) had taught Mathematics in Vihiga County for 6-10 years making a total of 40(100%). This shows that most of the teachers had stayed in the county for a good period of time and therefore had understanding of indigenous knowledge.

The research believes that experiential knowledge is always acquired through personal exploration and practicality based on everyday lived experiences. Indigenous education involves the expertise of multiple teachers given the multiple natures of roles and responsibilities in life through which the youths need to be mentored and guided. This is summed up by a proverb that is commonly used across Kenyan ethnic communities, which states, “it takes a whole village to educate a child”. The communal responsibility of education forms the basis for indigenous pedagogy in most Kenyan ethnic communities especially in some parts of the rural, arid, and semi-arid areas (Dei, Hall & Rosenberg, 2002).
4.1.4 Academic Qualification of Teachers

Question item Q4 (what is the highest level of your academic qualification?) revealed the following findings as shown in figure 4.2.

![Figure 4.2: Academic Qualification of Teachers](chart)

Source: Field Data 2018

On the teachers academic qualifications the responses in figure 4.2 revealed that majority of the teachers 21(52.5%) of the teachers had certificate qualification 8(20.0%) of the respondents were diploma holders, 8(20.0%) were degree holders and 3(7.5%) of the respondents were master’s degree holders.

These findings show that most teachers are qualified to teach Mathematics in primary schools. Few of the teachers have masters but with time and the changing trends most teachers are likely to be holders of Masters Degrees in a few years to come. The study
noted that the primary schools have employed and retained trained staff since their activities requires the use of knowledge, skills and abilities obtained during training.

4.2 Application of Existing Indigenous Knowledge

Objective one sought to identify application of existing indigenous knowledge in mathematical concepts in the classroom. The respondents were asked the following question items; Q5 (Can you find existing indigenous knowledge in from you community that could be incorporated in teaching of mathematical concepts?), Q6 (If yes, to what extent is the existing community indigenous knowledge is incorporated in teaching of mathematical concepts?) and Q7 provided respondents with various statement on the indigenous knowledge/artifacts that are believed to incorporated. The statements included; (Beadwork: Used when pupils have to count the number of layers or turns to make before making a particular design in their beadwork. - counting), (Weaving: Used when pupils have to make repeated patterns of selected designs-circles, squares, triangles), (Decorations: Used when pupils have to visit mural decorations which create specific geometric patterns), (Construction: Used to apply to the concept of Symmetry when constructing traditional house, granaries), (Games: Used when pupils participate in recreation, competition, sportsmanship and many other similar and related notions) and (Story telling: Used to pass over knowledge onsets (algebra) through stories and riddles)

4.2.1 Existing Indigenous Knowledge in Vihiga County

This section discussed question item Q5 (Can you find existing indigenous knowledge in from you community that could be applied in teaching of mathematical concepts?) The findings are as shown in figure 4.3.
Figure 4.3 shows that 32(80%) of the respondents agreed that there is indigenous knowledge in Vihiga County that could be incorporated in teaching of mathematical concepts in primary schools. On the other side, 8(20%) of the respondents disagreed on the availability of IK in Vihiga County. This study was therefore more viable since the majority of the respondents agreed that there is IK that could be integrated in teaching mathematical concepts.

A scan across several indigenous cultures reveals elements of knowledge, practices, artifacts that are closely associated with Science and technology, but the colonialists did not often recognize them as worthwhile contributions to the global collection of knowledge and practices. In their study, Ocholla and Onyancha, (2005) processed infometrics on indigenous knowledge which cover a wide range of indigenous
knowledge practices such as agriculture, environment, biodiversity, health and nutrition, just to mention a few.

However, the low profile accorded to indigenous knowledge (although many) rendered such contributions valueless and resultantly such knowledge never featured as a commodity. Hence, indigenous people have reaped nothing out of their contributions. Instead, they suffered some disruptions in their productive practices, since the Western knowledge deskilled them and immediately after deskilling them they had to reskill in order to become functional again. Therefore, it is imperative for indigenous people to develop new skills under the changed socio-economic demands while living under colonialist governments (Katz, 2004; Maurial, 1999). Table 4.3 shows across tabulation for gender and application of existing Indigenous Knowledge in Vihiga County.

Table 4.3: Cross Tabulation for Gender and Application of Existing IK

<table>
<thead>
<tr>
<th>Descriptions</th>
<th>Can you find existing IK in your community</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Male</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total % of Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Source: Field Data 2018

Table 4.3, shows a cross tabulation on gender and existing indigenous knowledge in Vihiga County. It is apparent that 22(68.8%) of male teachers agreed that indigenous knowledge exists in Vihiga county while 10(31.2%) of female teachers agreed that indigenous knowledge exists in Vihiga county.
This finding agrees with a body of literature that suggest that male teachers have positive perception towards Mathematics which also reflect on the perception of integrating indigenous knowledge in Mathematics curriculum (Brophy, J. 1985).

4.2.2 Extent to Which Existing IK is Integrated in teaching Mathematics

The findings on question item Q6 (If yes, to what extent is the existing community indigenous knowledge incorporated in teaching of mathematical concepts?) are displayed in figure 4.4 below.

![Figure 4.4: Extent to Which Existing IK is Integrated in Mathematics](image)

*Figure 4.4: Extent to Which Existing IK is Integrated in Mathematics*

*Source: Field Data 2018*
On the extent to which existing indigenous knowledge is incorporated in teaching of mathematical concepts figure 4.4 indicate that 2(5%) of the respondents said that it is always incorporated, 16(40%) of the respondents said that it is rarely incorporated, 14(35%) of the respondents said that IK is never incorporated and 8(20%) of the respondents said that they don't know if IK is incorporated in teaching of mathematical concepts.

It is evident from the findings that indigenous knowledge that exists in society has historically been ignored, from the colonial times to present regimes, where the school curricula are designed without including such knowledge. In his study, Kaino (2013) on the knowledge of traditional artifacts used by the Tchokwe tribe in Angola explored and then related to the mathematical content learned in the classroom. The activities show how the indigenous knowledge can be structured and get related to the mathematical knowledge taught in primary school but most teachers rarely or never incorporated the concepts in teaching.

4.2.3 Indigenous Tools/Artifacts Integrated while Teaching Mathematics

Question item Q7 provided respondents with various statement on the indigenous knowledge/artifacts. Respondents had to agree or disagree whether the indigenous knowledge/artifacts are incorporated in teaching mathematical concepts in the classroom. The statements included; (Beadwork: Used when pupils have to count the number of layers or turns to make before making a particular design in their beadwork. -counting) (Weaving: Used when pupils have to make repeated patterns of selected designs-circles, squares, triangles), (Decorations: Used when pupils have to visit mural decorations which create specific geometric patterns), (Construction: Used to apply to the concept of Symmetry when constructing traditional house, granaries), (Games: Used when pupils participate in recreation, competition, sportsmanship and
many other similar and related notions) and (Story telling: Used to pass over knowledge onsets (algebra) through stories and riddles). The response are summarized in figure 4.5 below.

**Figure 4.5: Indigenous Tools/Artifacts Integrated while Teaching of Mathematics**

*Source: Field Data 2018*

Findings in Figure 4.5 indicate that 21(52.5%), 13(32.5%), 18(45%), 14(35%), 22(55%), and 12(30%) agree that Beadwork, Weaving, Decorations, Construction, Games and Storytelling respectively are incorporated while teaching mathematical concepts in the classroom.

On the other side the results shows that 19(47.5%), 27(67.5%), 22(55%), 26(65%), 18(45%) and 28(70%) of the respondents disagreed that Beadwork, Weaving,
Decorations, Construction, Games and Storytelling respectively are not incorporated while teaching mathematical concepts in the classroom.

Table 4.4: Use of Beadwork while Teaching Mathematics Concepts

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes Incorporated</td>
<td>21</td>
<td>52.5</td>
<td>52.5</td>
</tr>
<tr>
<td>Not Incorporated</td>
<td>19</td>
<td>47.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Field Data 2018*

Table 4.4 indicate that 21(52.5%) of the beadwork is used in the classroom while teaching mathematical concepts while 19(47.5%) of teachers don't integrate beadwork in mathematical curriculum. From the observation made by the researcher, topics such as place value, measurement, geometry and algebra are integrated in beadwork during explanation and giving of examples in the classroom.

The mathematical concepts that have been identified in the making of a grass container and the beadwork as shown in the pictures are: Counting; Estimation; Straightness of Lines; Shapes and Patterns; Angles; etc. Many other mathematical concepts may be found when an analysis of the various activities and processes is done. This calls upon the educators to play an important role of linking what happens at the cultural villages to various Mathematics curriculum requirements.

As Graven, (2000) correctly points out, current curriculum change demand that teachers (educators) use a learner centred approach and understand Mathematics as a learning area which includes the following identity of Mathematics as a school subject. Teachers are appropriately placed due to their mathematical knowledge to create linkages between various activities embedded with mathematical concepts to ensure that learners’ experiences are enriched through daily experiences of what they encounter outside the classroom.
The above figures display mathematical shapes such as rhombus, circles, triangles and rectangles.

**Table 4.5: Use of Weaving while Teaching Mathematics Concepts**

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes Incorporated</td>
<td>13</td>
<td>32.5</td>
<td>32.5</td>
</tr>
<tr>
<td>Not Incorporated</td>
<td>27</td>
<td>67.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Field Data 2018*
Table 4.5 indicate that 13(32.5%) of the teachers use weaving is used in the classroom when teaching mathematical concepts while 27(67.5%) of teachers don't integrate weaving in teaching of Mathematics. From the class observation the researcher identified some materials on weaving however teachers did not incorporation weaving in the classroom teaching of Mathematics.

![Image](image1.png)

**Figure 4.7: Pictures of Sampled Weaved Materials**

*Source: Field Data 2018*

The above figures of weaved materials display mathematical concepts such as parallel lines, cones and funnels.

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes Incorporated</td>
<td>18</td>
<td>45.0</td>
<td>45.0</td>
</tr>
<tr>
<td>Not Incorporated</td>
<td>22</td>
<td>55.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Field Data 2018*

Table 4.6 indicate that 18(45.0%) of teachers use decoration in the classroom while teaching mathematical concepts when 27(55.0%) of teachers don't integrate decoration in teaching of Mathematics. From observation the researcher did not identified any decoration artifacts that could be incorporated in classroom teaching of Mathematics.
Table 4.7: Use of Construction while Teaching Mathematics Concepts

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes Incorporated</td>
<td>14</td>
<td>35.0</td>
<td>35.0</td>
</tr>
<tr>
<td>Not Incorporated</td>
<td>26</td>
<td>65.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

**Source: Field Data 2018**

Table 4.7 indicate that 14(35.0%) of the teachers used construction in the classroom while teaching mathematical concepts while 26(65.0%) of teachers don't integrate construction in teaching of Mathematics. However, from observation the researcher did not identified any artifacts that could be incorporated in classroom teaching of Mathematics.

Table 4.8: Use of Games while Teaching Mathematics Concepts

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes Incorporated</td>
<td>22</td>
<td>55.0</td>
<td>55.0</td>
</tr>
<tr>
<td>Not Incorporated</td>
<td>18</td>
<td>45.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

**Source: Field Data 2018**

Table 4.8 indicate that 22(55.0%) of teachers use games in the classroom while teaching mathematical concepts while 18(45.0%) of teachers don't integrate games in teaching of Mathematics. Among the existing indigenous knowledge integrated in teaching mathematical content games is mostly used in the classroom.

The word ‘game’ is usually associated with recreation, competition, sportsmanship, winning, losing, enjoyment, and many other similar and related notions. Nkopodi & Mogege, (2009), conducted a study entitled “preparation of using indigenous games in the classroom” specified activities necessary before indigenous games can be used in the Mathematics classroom which include: Identification of indigenous games according to the potential of their use in the curriculum; Analysis of games (applying
mathematical concepts, principles and processes) of any game reveals the extent to which mathematical concepts are embedded in the game.

Table 4.9: Use of Story Telling while Teaching Mathematics Concepts

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes Incorporated</td>
<td>12</td>
<td>30.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Not Incorporated</td>
<td>28</td>
<td>70.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Field Data 2018*

Table 4.9 indicate that 12(30.0%) of teachers use weaving is used stories, riddles and proverbs in the classroom when teaching mathematical concepts while 28(70.0%) of teachers disagreed.

4.3 Teachers' Perception on Integration of IK in Mathematics Curriculum

Objective two sought to find out teachers’ perception towards integration of indigenous knowledge in teaching of mathematical concepts. To complement the integration of indigenous knowledge in formal education, it was important to inquire into teachers’ perceptions of indigenous knowledge with a view to understanding their capability in developing appropriate pedagogical approaches and materials for implementation of such curriculum reforms. At the forefront of any implementation process are the teachers, which is why the research examined teacher perception towards integration of IK within mathematical concepts.

4.3.1 Correlation Between Teachers’ Perception Towards Integration of IK and Teaching of Mathematical concepts.

In this section a correlation analysis was used to examined teachers' perception towards integration of IK within mathematical concepts. The researcher conducted Pearson product moment correlation coefficient so as to test the relationship between
teacher’s perception on integration of indigenous knowledge and teaching of mathematical concepts. Teachers perceptions were measured by eight items, after running the correlation, the composite mean for the eight items was obtained. Teachers were asked to indicate the extent of their perception towards integration of indigenous knowledge within mathematical concepts. Their responses were coded as 1= strongly disagree, 2= disagree, 3= neutral , 4= agree and 5= strongly agree. The correlations coefficients are presented in Table 4.10. *Significant at P < 0.05;

**Table 4.10. Correlation Between Teachers’ Perception Towards Integration of IK and Teaching of Mathematics.**

<table>
<thead>
<tr>
<th>Teachers’ Responses</th>
<th>R</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics identified in traditional cultural activities should also be taught in schools.</td>
<td>0.394</td>
<td>0.034</td>
</tr>
<tr>
<td>When teaching Mathematics teachers should take into account students’ prior knowledge learnt out of school.</td>
<td>0.188</td>
<td>0.025</td>
</tr>
<tr>
<td>In schools, teachers should teach only the Mathematics that is prescribed in the syllabus and textbooks</td>
<td>0.37</td>
<td>0.051*</td>
</tr>
<tr>
<td>Traditional practices such as counting, measuring, drawing are also mathematical</td>
<td>0.34</td>
<td>0.05*</td>
</tr>
<tr>
<td>Indigenous knowledge is relevant in teaching Mathematics concepts.</td>
<td>0.247</td>
<td>0.014</td>
</tr>
<tr>
<td>School Mathematics should teach pupils how to apply the concepts in real life situation.</td>
<td>0.21</td>
<td>0.05</td>
</tr>
<tr>
<td>Pupils come to school to learn “school Mathematics”, not cultural Mathematics</td>
<td>0.235</td>
<td>0.027</td>
</tr>
<tr>
<td>Indigenous knowledge consists of experimental knowledge as opposed to theoretical knowledge.</td>
<td>0.343</td>
<td>0.042</td>
</tr>
<tr>
<td>All eight constructs combined</td>
<td>0.182</td>
<td>0.026</td>
</tr>
</tbody>
</table>

The results in Table 4.10 reveal that teachers' perception towards integration of IK has a very positive and significant relationship when teaching mathematical concepts.
Teachers’ attitudes toward and beliefs about the value and potential contribution of indigenous knowledge to sustainable development define how they integrate this form of knowledge into the formal school curriculum (Gachanga, 2007). Educators’ attitudes are pervasively important: positive, enthusiastic attitudes to problem solving are likely to engender enthusiasm and positivity in children’s approaches to learning, but the corollary holds true as well negative attitudes and avoidance of concepts are likely to lead to negativity and avoidance in children (Ramirez, & Levine, 2010; Connor & Neal, 2014).

4.3.2 Testing of Research Hypothesis

HO1: There is no significant relationship between teacher’s perception towards integration of indigenous knowledge and teaching of mathematical concepts.

Pearson’s product moment correlation analysis was used to assess the correlation between the variables (teachers’ perception towards integration of IK and mathematical concepts). The results in table 4.10 indicate that, there is a low positive relationship between teacher’s perception and the level of integrating indigenous knowledge in Mathematics curriculum (r = 0.182, p<0.026). Given the p<0.05, therefore, the researcher rejects the null hypothesis.

4.4 Learners’ Perception on Integration of IK in Mathematics Curriculum

Objective three sought to determine learners’ knowledge of integration of indigenous knowledge in classroom mathematics. Qualitative Analysis of pupils focus group discussion was done to determine learner's understanding on integration of indigenous knowledge in Mathematics curriculum. The FGD contained the following questions items; Q1 (Do you understand the meaning of local knowledge?), Q2 (If yes, What is local knowledge?), Q3 (Does your teacher use local knowledge/artifacts when
teaching Mathematics?), Q4 (If yes, give examples of local knowledge/artifacts used and the topics/sub-topics when it is used?), Q5 (Is local knowledge usefully in understanding Mathematics?), Q6 (Do you think examination should include content on indigenous knowledge?) and Q7 (If yes, Explain why you think examination should include content on indigenous knowledge?)

4.4.1 Q1 (Do You Understand the Meaning of Local Knowledge?)

The responses in the focus group discussion indicate that majority of the learners agreed to have an understanding of local knowledge. This is more reflected in the question item two whereby they were asked to explain what is local knowledge.

4.4.2 Q1 (What is Local Knowledge?)

To determine learners understanding of indigenous knowledge the researcher asked the following question; (What is local knowledge?). The following are some of the common responses from learners concerning their understanding of local knowledge;

"It is the knowledge that is used by the people in the community in their day to day activities"

"It is knowledge that people in a community have developed over time and continue to develop"

"It is knowledge that is acquired from the surrounding trough discovery, imitation, beliefs and superstition"

"This is the knowledge gained through general activities and interaction within the environment"

"Local knowledge is the knowledge you are not taught by a teacher/school"

"Knowledge found in our community"

From the sampled responses from learners is clear that they understand what local knowledge is and can be related to the definitions from various scholars. Most learners agreed that local knowledge is specific forms of knowledge that is local and specific to a particular place. They have perceived indigenous knowledge as historical
and ancient practices of the African peoples, which is a problematic perception. In this context, indigenous knowledge is a multifaceted body of knowledge, practices, and representations that are maintained and developed by peoples with long histories of close interaction with the local natural environment.

The term “indigenous” is loaded with meanings (traditional, local, natural, and primitive), just like the term knowledge connotes different things to different people. A combination of the two words (indigenous knowledge) obviously presents a huge task in constructing a single concept. Hence, some people say, “the meaning of indigenous knowledge is difficult to pin down” (ICSU, 2002, Maurial, 1999).

Indigenous Knowledge, therefore, denotes that the knowledge is typical and belongs to peoples from specific places with common cultural and social ties. Thus, indigenous knowledge is a process of learning and sharing social life, histories, identities, economic, and political practices unique to each cultural group. In this paper, indigenous knowledge is framed as the complex set of activities, values, beliefs and practices that has evolved cumulatively over time and is active among communities and groups who are its practitioners. It remains so as long as the groups and communities who are its practitioners are committed to sustaining, creatively developing, and extending its potential enrichment within a specific setting (Carter, 2006; McKinley, 2005).

4.4.3 Q3 (Does Your Teacher Use Local Knowledge/Artifacts when Teaching Mathematics?)

When asked if teachers use local knowledge/artifacts when teaching Mathematics, Most learners said no to that question.
4.4.4 Q4 (If Yes, Give Examples of Local Knowledge/Artifacts Used and the Topics/Sub-Topics When it is Used?)

In this question item the following are the responses given by few learners who agreed on the use of local knowledge/artifacts by teachers when teaching Mathematics in the classroom and the topics/sub-topics and concepts concerned.

"**Bead work** is used when teaching shapes, sorting and grouping, sequencing and geometry"

"**Constructions** (huts and granaries), -when teaching area, volume, shapes, concept of symmetry but give as examples there is no demonstration of the construction in the classrooms"

**Stories**
"Storytelling when explaining the concept of time for example rising and falling of the sun, measurement, counting of footsteps to indicate certain measurement which traditionally footsteps are used to measure land"

Some of the stories explained by children include;

a) The hare and the tortoise explaining the concept of time and sequence
The two argued about who is the fastest runner. Hare challenged the tortoise to the race, tortoise informed his fellow friends and they aligned themselves along the road. The hare would see tortoise in front of him. Hare reached the end of the race and found that the tortoise had won the race, little did he realize the tortoise trick.

b) The hare and the hippo (weight)
The hare challenged the hippo that he is heavier than the hippo. The agreed and the hare tied the rope across the hippo’s body and tied on a heavy stone. The challenge started and the hippo was unable to pull the hare.

**Games**
a) Bakera
It is played in different ways first by throwing up a stone and simultaneously picking others sequentially i.e. 1,2,3..... secondly by having 6 stones, a hole and moving the stones around with an open-end. 

b) Kati
It involves throwing of a bean ball between two players and the other player is moving around four places/points as she/he counts, the player should move systematically in a certain pattern. Another way of playing kati is when two are throwing bean ball to each other and the player is in the middle and she fills sand in the bottle.
Riddle (to explain the concept of algebra)

The sailor has a cheetah, a goat and grass, he have to sail them across the river, he has to ensure that they are all sailed and safe. Explain how he would do this successfully.

4.4.5: Q5 (Is Local Knowledge Usefully in Understanding Mathematics?)

Concerning the question item on the usefulness of local knowledge, majority of the respondents agreed that local knowledge is useful in understanding some mathematical concepts.

In addition, the learners’ grounding in culturally-relevant Mathematics and Science would help stimulate creativity at an early age, laying the foundations for the development of an innovational, technological potential that would be linked to local needs and realities and which could subsequently be directed to the search for practical, home-made solutions to their country’s development problems (UNESCO, 2010). Mathematical creativity thus stimulated could well spill over into, and influence, other areas of educational and economic activity, acting as a general catalyst and stimulus to the society. An educational approach that is rooted in, and inspired by, indigenous knowledge would be more relevant to the learners' life experiences and thus more capable of arousing their interest.

Far from alienating them from their socio-cultural environment as much modern education in Africa presently does, it would instead reinforce their links with their environment. It is with such methods that the modern school system in Africa could be revitalized and empowered to play the central role any effective educational system should have in the life of the community (Abah, Mashebe & Denuga, 2015).

4.4.6 Q6 (Do You Think Examination Should Include Content on IK?)

Majority of the respondents agreed that content on indigenous knowledge should be examined.
4.4.7 Q7 (If Yes, Explain Why You Think Examination Should Include Content on Indigenous Knowledge?)

The following are some of the common responses from learners on the reasons of examining indigenous knowledge.

"It will help to enrich the cultural knowledge"
"To help stress on content based skills and talent nurturing"
"To enhance better performance in examination and also make learners own exam, makes the exam learner friendly"
"It will help the learner to relate to their environment and solve issues within their surroundings"
"Will make teachers to refer more to local knowledge"
"Will help learners remember and relate the questions with their day to day life"
"Helps learners to be open minded since they can brainstorm from what they know"
"It will reduce fear of examination because pupils can relate to what is being asked in the examination"
"Will make examinations interesting because local knowledge is very interesting to learn"
"Will help understand and interpret concepts that are hard to understand and interpret"
"Will improve pupils problem solving skills in examination"
"Will improve performance because the knowledge is from every day experience"
"Local knowledge is practical therefore easy to remember and apply in the examinations"
"Will make learning real and not theoretical"


Objective four sought to explore the strategies of integrating indigenous knowledge in teaching of mathematical concepts. The on-going global focus on knowledge
commoditization promotes competition, contradictions, and dilemmas for educators and teachers in the implementation of the integration of indigenous knowledge into the curriculum. At the same time the interface between school and indigenous knowledge is rarely a focus for most Kenyan educators and policy makers. Unfortunately the transfer of indigenous knowledge from everyday life to schoolwork is not always valued or recognized by teachers (Dei, 2002; Mwenda, 2003; Semali, 1999), and it is therefore necessary for teacher education programs to rethink ways in which to prepare teachers for effective integration of multiple forms of knowledge when designing and implementing the teacher education curriculum. Therefore this section discusses the strategies of integrating indigenous knowledge in teaching of mathematical concepts. Table 4.12 below shows the responses from teachers.
### Table 4.11: Strategies of Integrating IK In Mathematical Concepts

<table>
<thead>
<tr>
<th>Teachers’ Responses</th>
<th>Freq/%</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Books and materials on various traditional learning activities should be made available at schools.</td>
<td>Freq</td>
<td>13</td>
<td>12</td>
<td>5</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>32.5</td>
<td>30.0</td>
<td>12.5</td>
<td>17.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Traditional objects and activities in which mathematical thinking is embedded such as needlework, house construction, and games should be used during teaching and learning processes.</td>
<td>Freq</td>
<td>12</td>
<td>17</td>
<td>2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>30.0</td>
<td>42.5</td>
<td>5.0</td>
<td>15.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Mathematics is perceived to be very difficult therefore needs to be taught based on learner experiences (known to unknown)</td>
<td>Freq</td>
<td>25</td>
<td>12</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>62.5</td>
<td>30.0</td>
<td>5.0</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Examination of indigenous knowledge should be considered in schools curriculum.</td>
<td>Freq</td>
<td>9</td>
<td>21</td>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>22.5</td>
<td>52.5</td>
<td>17.5</td>
<td>5.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Teachers to adopt teaching methods that are learner centered and activity based approach.</td>
<td>Freq</td>
<td>15</td>
<td>16</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>37.5</td>
<td>40.0</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Invite elderly speakers from the community who still understand indigenous knowledge.</td>
<td>Freq</td>
<td>14</td>
<td>14</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>35.0</td>
<td>35.0</td>
<td>15.0</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Teaching of mathematical concepts should also be done in outdoor environments so as learners can be able to observe theory to practice.</td>
<td>Freq</td>
<td>18</td>
<td>13</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>45.0</td>
<td>32.5</td>
<td>12.5</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>There should be time for cultural activities such as games, dances and songs to convey mathematical concepts.</td>
<td>Freq</td>
<td>20</td>
<td>19</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>50.0</td>
<td>47.5</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: Field Data 2018*

Findings in table 4.11 indicate that 13(32.5%) strongly agreed, 12(30%) agreed, 7(17.5%) disagreed, 3(7.5%) strongly disagreed and 5(12.5%) were neutral on the statement that books and materials on various traditional learning activities should be made available at schools. 12(30.0%) strongly agreed, 17(42.5%) agreed, 6(15.0%)
disagreed, 3(7.5%) strongly disagreed and 2(5.0%) were neutral on the statement that traditional objects and activities in which mathematical thinking is embedded such as needlework, house construction, and games should be used during teaching and learning processes. 25(62.5%) strongly agreed, 12(30%) agreed, 1(2.5%) disagreed and 2(5.0%) were neutral on the statement that Mathematics is perceived to be very difficult therefore needs to be taught based on learner experiences (known to unknown).

On the other hand, 9(22.5%) strongly agreed, 21(52.5%) agreed, 2(5.0%) disagreed, 1(2.5%) strongly disagreed and 7(17.5%) were neutral on the statement that examination of indigenous knowledge should be considered in schools curriculum. 15(37.5%) strongly agreed, 16(40%) agreed, 3(7.5%) disagreed, 3(7.5%) strongly disagreed and 3(7.5%) were neutral on the statement that teachers to adopt teaching methods that are learner centred and activity based approach. 14(35.0%) strongly agreed, 14(35.0%) agreed, 4(10.0%) disagreed, 2(5.0%) strongly disagreed and 6(15.0%) were neutral on the statement of inviting elderly speakers from the community who still understand indigenous knowledge. 18(45.0%) strongly agreed, 13(32.5%) agreed, 2(5.0%) disagreed, 2(5.0%) strongly disagreed and 5(12.5%) were neutral on the statement that teaching of mathematical concepts should also be done in outdoor environments so as learners can be able to observe theory to practice. Finally, 20(50.0%) strongly agreed, 19(47.5%) agreed and 1(2.5%) were neutral on the statement that there should be time for cultural activities such as games, dances and songs to convey mathematical concepts.

The knowledge that can be derived from various forms of the luhya tradition is abundant in traditional decorations, paintings, story-telling and many others. The development of mathematical patterns to form particular sequences in natural and odd
numbers, gives pupils the opportunity to derive knowledge from the local artifacts they are familiar with and relate these to Mathematics content learnt in class. For class six learners, the structures developed to establish patterns and sequences can provide them with prior knowledge before they develop more advanced knowledge of proving the formulas for determination of the sums of natural and odd numbers when they join secondary schools. The process of teaching the concepts in these topics would provide students with long term retention of mathematical knowledge (Kaino, 2013).

From the findings, possible use of Mathematical Knowledge and Concepts used at Cultural Villages in Mathematics Classroom Settings to enable all learners to achieve to their maximum ability can be done through setting outcomes to be achieved at the end of a process. These outcomes will encourage a learner-centred and activity-based approach. One of the developmental outcomes in Mathematics will envisage learners who will be culturally and aesthetically sensitive across a range of social contexts. Exposure to activities that take place at various cultural villages goes a long towards ensuring that this developmental outcome is attained. It is therefore possible that some of the artifacts that are found at the cultural villages may be brought to classroom and analysed by the educators and learners together to reveal related mathematical concepts embedded in such artifacts. As they do so they will also learn more about the communities in which they live. In fact, the use of various artifacts provides an opportunity for the community members knowledgeable in various artifacts and cultural activities to interact with the educators and learners.

According to UNESCO, (2001), In the context of indigenous education, the development of appropriate policies, strategies and programmes, and diverse, responsive and participatory approaches to meet these goals involves, among other factors: reinforcing community-based practices of early childhood care, using local
languages for initial literacy, creating culturally responsive programmes of bilingual or multilingual education for children and adults providing skills specific to indigenous cultures, such as hunting, trapping and weaving, as well as more general skills, knowledge, attitudes, values and beliefs of a wider diffusion, creating the basis and providing equal opportunities for further learning, developing appropriate learning material, using methods such as distance education, radio-broadcasting and e-learning, as well as creating in-situ programmes and training and employing local teachers to meet the needs of remote communities. The Action Plan for the Implementation of the UNESCO Universal Declaration on Cultural Diversity (2001), underline that linking education to other aspects of the learner’s life, such as health, nutrition, safe water and the natural environment, using and integrating formal and non-formal learning styles and teaching methods as a means of recognizing indigenous ways of generating and transmitting knowledge and of giving value to the oral wisdom of indigenous peoples and non-verbal communication in education.

4.6 Challenges Faced by Teachers While Incorporating IK In Mathematics

Objective five sought to document the challenges faced by teachers while incorporating indigenous knowledge in teaching of mathematical concepts. Shizha, (2007) conducted a study using qualitative research methods. Ten teachers were purposively selected and interviewed to gain their insights into problems faced in incorporating indigenous knowledge into teaching. The study found that the problems were attitudinal, institutional, and systemic. Therefore, this study sought to establish responses on challenges faced by teachers while incorporating the concepts of indigenous knowledge into the Mathematics curriculum in Kenya.
Table 4.12: Challenges Faced by Teachers while Incorporating IK in Mathematics

<table>
<thead>
<tr>
<th>Teachers’ Responses</th>
<th>Freq/%</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers undervalue the effectiveness of indigenous knowledge in teaching Mathematics.</td>
<td>Freq 3</td>
<td>20</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>50.0</td>
<td>12.5</td>
<td>20.0</td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td>Teachers don't understand the relevant indigenous knowledge in the community that can be incorporated in Mathematics curriculum.</td>
<td>Freq 3</td>
<td>15</td>
<td>6</td>
<td>14</td>
<td>2</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>37.5</td>
<td>15.0</td>
<td>35.0</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Examinations do not test indigenous knowledge or indigenous ways of knowing, as a result, teachers makes little reference to the local indigenous</td>
<td>Freq 12</td>
<td>14</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>35.0</td>
<td>20.0</td>
<td>10.0</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Teacher preparation in teachers’ colleges do not incorporate indigenous knowledge in Mathematics curriculum.</td>
<td>Freq 5</td>
<td>15</td>
<td>8</td>
<td>9</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>37.5</td>
<td>20.0</td>
<td>22.5</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>The complex nature of indigenous knowledge and practices make it difficult to integrate in the classroom.</td>
<td>Freq 3</td>
<td>14</td>
<td>4</td>
<td>13</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>35.0</td>
<td>10</td>
<td>32.5</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Dependence on foreign assistance to support Kenyan education reforms has led to education policies being influenced by external agents, forcing the government to focus on meeting the goals of globalization above the local needs and interests.</td>
<td>Freq 14</td>
<td>16</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>35.0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>40.0</td>
<td>5.5</td>
<td>12.5</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Mathematics identified in traditional culture is too simple (at the arithmetic level)</td>
<td>Freq 1</td>
<td>11</td>
<td>10</td>
<td>13</td>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>27.5</td>
<td>25.5</td>
<td>32.5</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Some teachers come from different cultural backgrounds and they don't understand the indigenous knowledge from the schools they are teaching</td>
<td>Freq 9</td>
<td>20</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>50.0</td>
<td>12.5</td>
<td>7.5</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Globalization and internationalization of English and Western Mathematics portray indigenous knowledge as retrogressive. Most Kenyan communities have fewer adults who possess the skills that need to be passed on to the youth that would support the capacity for integration of indigenous knowledge in formal education.</td>
<td>Freq 8</td>
<td>17</td>
<td>13</td>
<td>2</td>
<td></td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>42.5</td>
<td>32.5</td>
<td>5.0</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Field Data 2018
Findings in table 4.13 indicate that 3(7.5%) strongly agreed, 20(50.0%) agreed, 8(20.0%) disagreed, 4(10.0%) strongly disagreed and 5(12.5%) were neutral on the statement that teachers undervalue the effectiveness of indigenous knowledge in teaching Mathematics. 3(7.5%) strongly agreed, 15(37.5%) agreed, 14(35.0%) disagreed, 2(5.0%) strongly disagreed and 6(15.0%) were neutral on the statement that teachers don’t understand the relevant indigenous knowledge in the community that can be incorporated in Mathematics. 12(30.0%) strongly agreed, 14(35.0%) agreed, 4(10.0%) disagreed, 2(5.0) strongly disagreed and 8(20.0%) were neutral on the statement that examinations do not test indigenous knowledge or indigenous ways of knowing, as a result, teachers makes little reference to the local indigenous knowledge in their teaching.

Also, 5(12.5%) strongly agreed, 15(37.5%) agreed, 9(22.5%) disagreed, 3(7.5%) strongly disagreed and 8(20.0%) were neutral on the statement that teacher preparation in teachers’ colleges do not incorporate indigenous knowledge in Mathematics curriculum. 3(7.5%) strongly agreed, 14(35.0%) agreed, 13(32.5%) disagreed, 6(15.0%) strongly disagreed and 4(10.0%) were neutral on the statement that the complex nature of indigenous knowledge and practices make it difficult to integrate in the classroom. 14(35.0%) strongly agreed, 16(40.0%) agreed, 5(12.5%) disagreed, 3(7.5%) strongly disagreed and 2(5.0%) were neutral on the statement that dependence on foreign assistance to support Kenyan education reforms has led to education policies being influenced by external agents, forcing the government to focus on meeting the goals of globalization above the local needs and interests.

In addition, 1(2.5%) strongly agreed, 11(27.5%) agreed, 13(32.5%) disagreed, 5(12.5%) strongly disagreed and 10(25.5%) were neutral on the statement that Mathematics identified in traditional culture is too simple (at the arithmetic level).
9(22.5%) strongly agreed, 20(50.0%) agreed 3(7.5%) disagreed, 3(7.5%) strongly disagreed and 5(12.5%) were neutral on the statement that some teachers come from different cultural backgrounds and they don't understand the indigenous knowledge from the schools they are teaching. 8(20.0%) strongly agreed, 17(42.5%) agreed 2(5.0%) disagreed and 13(32.5%) were neutral on the statement that globalization and internationalization of English and Western Mathematics portray indigenous knowledge as retrogressive.

Finally, 5(12.5%) strongly agreed, 19(47.5%) agreed 10(25.0%) disagreed, 1(2.5%) strongly disagreed and 5(12.5%) were neutral on the statement that most Kenyan communities have fewer adults who possess the skills that need to be passed on to the youth that would support the capacity for integration of IK in formal education.

The researcher also observed that some of the challenges in the integration of indigenous knowledge in formal education arise from teachers’ lack of faith that such a curriculum can actually contribute significantly in addressing the socio-economic needs of the country. Teachers’ inability to integrate indigenous knowledge in their practice may also be resulting from limited knowledge on what aspects to integrate. Somjee, (1996) noted that although teachers are entrusted with the responsibility of fostering indigenous knowledge in the learning institutions of Kenya, “there is no guidance on what aspects of culture are to be integrated into the curricula. The syllabus only tells teachers what they must do and should do, but not explain how to do it”, indicating the limitations that Kenyan teachers are bound to phase when implementing such a curriculum.

Efforts to understand indigenous knowledge is thwarted by several reasons ranging from ambiguity of terms, obscure forces that act on conception of ideas and processes
surrounding indigenous peoples, socio-cultural lives (power, politics, and socio-economic factors), and lack of background knowledge (among teachers) to identify relevant or irrelevant bodies of knowledge in the process of planning and teaching Mathematics that embraces indigenous knowledge. For teachers, who largely depend on knowledge that they learned from college, dealing with indigenous knowledge may look like far out of reach. In other words, ordinary minds do not usually worry about processes that shift the position of things in a society (Wane, 2002). Unfortunately many teachers and educators still privilege Western ways of knowing and interpretation of the world over indigenous knowledge especially in the face of globalization (Dei, et al, 2002; Shiva, 2002).

At independence, integrating indigenous knowledge in a British structured model of education created great challenges to Kenyan policymakers and implementation process due to limited capacity of indigenous teachers and curriculum developers. This was because as at that time of Kenya’s independence in 1963, the impact of indigenous teaching force had not evolved sufficiently to create a critical mass of African educators who were equipped with the right skills and knowledge to support the process of curriculum change (Lillis, 1985; Ominde Report, 1964).

As stated by Abdi, (2006) “colonial programs of education were designed and put into place to maximize all possible returns for colonialism”. Thus, lack of capacity of trained indigenous educators became a hindrance to the curriculum implementation. Hence the dominance of foreign teachers in post-colonial education system under the auspices of British aid to education continued to influence the process of curriculum innovations posing great challenges to the indigenization of the Kenyan school curriculum (Lillis, 1985). Lillis asserts that, “as teachers, course writers, project developers, disseminators, and inspectors of schools, expatriate educationists
dominated these areas of curriculum while Africans played a subordinate role”. Thus, the absence of indigenous personnel to take charge of their own curriculum reconstruction process meant continued presence of foreign assumptions about what constituted valid school knowledge and valid means of assessing such knowledge therefore, implementing the stated education objective of integrating African indigenous knowledge within the curriculum is superficial (Mwenda, 2003 and Lillis, 1985).

Today one can argue that in most Kenyan communities, there are fewer adults who possess the skills that need to be passed on to the youth that would support the capacity for integration of indigenous knowledge in formal education. At the same time the move among young people away from hereditary activities has made transmission and impartation of indigenous knowledge impersonal and disembodied from context. Disembodiment of indigenous knowledge is as a consequence of the replacement of traditional local authorities, demographic changes, urbanization, technological changes, modernization, commercialization, commodification of living resources, and the policies of external assistance agencies. These forces continue to pressurize the world to adopt Western perspectives to the detriment of indigenous ways of knowing, practice, and technology (Owuor, 2007).

The national dependency syndrome on external donors to support education reforms also contradicts education policies in the reform process. Dependence on foreign assistance to support Kenyan education reforms has led to education policies being influenced by external agents, forcing the government to focus on meeting the goals of globalization above the local needs and interests. Therefore, attracting donor funding to support research in education that would provide adequate information for implementation of the integration of indigenous knowledge in formal education has
suffered setbacks (Gachanga, 2007; Lillis, 1985; Mwenda, 2003; Republic of Kenya, 1998). In most cases donors are inclined toward the support of research in education that is based on their conception of what constitutes education or what they validate as important topics and approaches to education. Yet findings from such forms of research are not likely to provide relevant information that would appropriately support the integration of indigenous knowledge into the formal school curriculum.

4.7 Summary of the Chapter

This chapter has presented the results of the data analysis and interpretation based on the four research questions and one hypotheses. The chapter also presents the discussion of the primary findings by linking them to the literature review and data has been presented using charts, graphs and tables. The next chapter presents the summary of the findings, conclusion, as well as recommendations based on the researchers conclusions.
CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter is divided into three sections. Section one deals with the summary of the findings, the second section covers the conclusion basing on the study findings and section three gives the recommendation of the study and suggested areas for further study. The main purpose of the study was to explore on the integration of indigenous knowledge in teaching of mathematical concepts in primary schools in Vihiga County, Kenya. The study focused on the following objectives: to identify the extent to which existing indigenous knowledge practices are applied in teaching of mathematical concepts, to find out teachers’ perception towards integration of indigenous knowledge in teaching of mathematical concepts, to determine learners’ knowledge about indigenous knowledge that can be integrated in classroom mathematical concepts, to explore the strategies of integrating indigenous knowledge in teaching of mathematical concepts and to document the challenges faced by teachers while incorporating indigenous knowledge in teaching of mathematical concepts.

5.1 Summary of the Findings

This section will give a brief summary of the findings on every objective in this study

5.1.1 Demographic Information of Teachers.

This section discusses the demographic characteristics of the respondents based on gender, age, duration of teaching Mathematics in Vihiga County and the highest level of their academic qualification of teachers who teach Mathematics in class six.
On gender, majority of the respondents were male which concurred with majority of studies which tend to stereotype Mathematics as a male domain subject. The findings also showed that most of class six Mathematics teachers are in the age bracket of 30-50 years and it’s believed that they have acquired more knowledge and skills on IK through life experiences. Majority of the teachers sampled had taught Mathematics in Vihiga County for 6-10 years and the findings revealed that majority of the teachers had certificate qualification with few diploma, degree and masters holders.

5.1.2 Application of Existing Indigenous Knowledge.

The respondents were asked if there is existing indigenous knowledge in their community that could be incorporated in teaching of mathematical concepts and majority of the respondents agreed that there is existing indigenous knowledge in their community that could be incorporated in teaching of mathematical concepts. A cross tabulation on gender and existing indigenous knowledge indicated that more male teachers as compared to female teachers agreed that indigenous knowledge exists in Vihiga county.

On the extent to which existing indigenous knowledge is incorporated in teaching of mathematical concepts majority of the respondents said that indigenous knowledge is rarely incorporated followed by those who said indigenous knowledge is never incorporated at all and few said indigenous knowledge is always incorporated while the remaining few didn't know.

Concerning the indigenous knowledge/artifacts/tools, majority of the teachers did not incorporated weaving, decorations, constructions and storytelling in the mathematical
concepts when teaching in the classroom. At least 50% and above of the teachers incorporated beadwork and games in the mathematical concepts when teaching.

5.1.3 Teachers' Perception on Integration of IK in Mathematics Curriculum

The researcher also sought to establish teachers' perception on integration of indigenous knowledge in Mathematics curriculum. As evidenced in the table 4.10, most teachers have a positive perception towards integration of indigenous knowledge in Mathematics curriculum.

The response showed that, more than 50.0% agreed on the statement that Mathematics identified in traditional cultural activities should also be taught in schools. 55.0% of the teachers agreed on the statement that when teaching Mathematics teachers should take into account students' prior knowledge learnt out of school. 75.0% of the respondents disagreed on the statement that in schools, teachers should teach only the Mathematics that is prescribed in the syllabus and textbooks. Majority, 80.0% of the respondents agreed on the statement that traditional practices such as counting, measuring, drawing are also mathematical. Also more of the respondents 80.0% agreed on the statement that indigenous knowledge is relevant in teaching Mathematics concepts. More than 50.0% of the respondents agreed on the statement that school Mathematics should teach pupils how to apply the concepts in real life situation. Also, more than 50.0% of the respondents agreed on the statement that indigenous knowledge consists of experimental knowledge as opposed to theoretical knowledge. Finally, majority of the respondents disagreed on the statement that pupils come to school to learn “school Mathematics”, not cultural Mathematics.
5.1.4 Learners' Knowledge about IK that can be Integrated in Classroom Math

Qualitative Analysis of pupils focus group discussion was done to determine learner's understanding on integration of indigenous knowledge in Mathematics curriculum. The responses in the focus group discussion indicate that majority of the learners agreed to have an understanding of local knowledge. To determine learners understanding of indigenous knowledge the researcher asked the following question; (What is local knowledge?). From the sampled responses from learners is clear that they understand what local knowledge is and can be related to the definitions from various scholars. Indigenous Knowledge, therefore, denotes that the knowledge is typical and belongs to peoples from specific places with common cultural and social ties.

When asked if teachers use local knowledge/artifacts when teaching Mathematics, most learners disagreed. The few learners who agreed on the fact that their teachers use local knowledge/artifacts barely gave examples on the use of local knowledge/artifacts by teachers when teaching Mathematics in the classroom and the topics/sub-topics and concepts concerned. However, some mentioned beadwork used when teaching shapes, sorting and grouping, sequencing and geometry, storytelling when explaining the concept of time for example rising and falling of the sun, measurement, counting of footsteps to indicate certain measurement which traditionally footsteps are used to measure land and constructions (huts and granaries), when teaching area, volume, shapes, concept of symmetry.

Concerning the question item on the usefulness of local knowledge, majority of the respondents agreed that local knowledge is useful in understanding some mathematical concepts. Also majority of the respondents agreed that content on
indigenous knowledge should be examined. Some of the common responses from learners on the reasons of examining indigenous knowledge include:

"It will help to enrich the cultural knowledge"

"To help stress on content based skills and talent nurturing"

"To enhance better performance in examination and also make learners own exam, makes the exam learner friendly"

"It will help the learner to relate to their environment and solve issues within their surroundings"

"Will make teachers to refer more to local knowledge"

"Will help learners remember and relate the questions with their day to day life"

"Helps learners to be open minded since they can brainstorm from what they know"

"It will reduce fear of examination because pupils can relate to what is being asked in the examination"

"Will make examinations interesting because local knowledge is very interesting to learn"

"Will help understand and interpret concepts that are hard to understand and interpret"

"Will improve pupils problem solving skills in examination"

"Will improve performance because the knowledge is from every day experience"

"Local knowledge is practical therefore easy to remember and apply in the examinations"

"Will make learning real and not theoretical"

5.1.5 Strategies of Integrating IK in Teaching of Mathematics.

This section discusses the strategies of integrating indigenous knowledge in teaching of mathematical concepts. Findings in table 4.12 indicate that majority of the respondents agreed that following strategies of indigenous knowledge should be integrated in Mathematics;
i. Books and materials on various traditional learning activities should be made available at schools.

ii. Traditional objects and activities in which mathematical thinking is embedded such as needlework, house construction, and games should be used during teaching and learning processes.

iii. Mathematics needs to be taught based on learner experiences (known to unknown).

iv. Examination of indigenous knowledge should be considered in schools curriculum.

v. Teachers to adopt teaching methods that are learner centred and activity based approach.

vi. Elderly speakers from the community who still understand indigenous knowledge should invited.

vii. Teaching of mathematical concepts should also be done in outdoor environments so as learners can be able to observe theory to practice a

viii. There should be time for cultural activities such as games, dances and songs to convey mathematical concepts.

5.1.6 Challenges Faced by Teachers while Incorporating IK In Mathematics.

This study sought to establish responses on challenges faced by teachers while incorporating the concepts of indigenous knowledge into the Mathematics curriculum.

Findings in table 4.13 indicate that majority (more than 50.0%) of the respondents agreed that, teachers undervalue the effectiveness of indigenous knowledge in teaching Mathematics, examinations do not test indigenous knowledge or indigenous ways of knowing, as a result, teachers makes little reference to the local indigenous knowledge in their teaching, teacher preparation in teachers’ colleges do not incorporate indigenous knowledge in Mathematics curriculum, dependence on foreign
assistance to support Kenyan education reforms has led to education policies being influenced by external agents, forcing the government to focus on meeting the goals of globalization above the local needs and interests, some teachers come from different cultural backgrounds and they don't understand the indigenous knowledge from the schools they are teaching, globalization and internationalization of English and Western Mathematics portray indigenous knowledge as retrogressive and finally the respondents agreed that most Kenyan communities have fewer adults who possess the skills that need to be passed on to the youth that would support the capacity for integration of indigenous knowledge in formal education.

However, most respondents disagreed that teachers don't understand the relevant indigenous knowledge in the community that can be incorporated in Mathematics and also they disagreed that the complex nature of indigenous knowledge and practices make it difficult to integrate in the classroom. In addition, the respondents disagreed that Mathematics identified in traditional culture is too simple (at the arithmetic level).

The researcher also observed that some of the challenges in the integration of indigenous knowledge in formal education arise from teachers’ lack of faith that such a curriculum can actually contribute significantly in addressing the socio-economic needs of the country and also teachers’ inability to integrate indigenous knowledge in their practice may also be resulting from limited knowledge on what aspects to integrate. In addition, the syllabus only tells teachers what they must do and should do, but not explain how to do it”, indicating the limitations that Kenyan teachers are bound to phase when implementing such a curriculum.
5.2 Conclusions.

If Mathematics education continues to fail to connect Mathematics to learners’ cultures, it will continue to fail to socially empower learners (and teachers) into ways of examining real-life activities. Therefore, in order to best address these pitfalls and create individuals which most intended Mathematics curricula claim to be producing, teachers need to embrace, implement and share ideas that promote critical pedagogy.

From the findings the researcher conclude that this study was viable since majority of the respondents agreed on the existence of indigenous knowledge that could be applied in teaching mathematical concepts. On the extent to which existing indigenous knowledge is incorporated in teaching of mathematical concepts, It is evident from the findings that indigenous knowledge that exists in society has historically been ignored since very few respondents admitted to incorporated indigenous knowledge in Mathematics curriculum. However, as much as there are plenty of indigenous knowledge/artifacts/tools such as weaving, decorations, constructions beadwork, games and storytelling, majority of the teachers don't incorporated them in the mathematical concepts when teaching.

In this study, the researcher also conclude that most teachers have a positive attitude towards integration of indigenous knowledge in Mathematics curriculum. Teachers are positive about taking into account students’ prior knowledge learnt out of school when teaching and they agreed that indigenous knowledge is relevant in teaching Mathematics concepts. Teachers’ attitudes toward and beliefs about the value and potential contribution of indigenous knowledge to sustainable development define how they integrate this form of knowledge into the formal school curriculum (Gachanga, 2007).
From the sampled responses from learners are clear that pupils have and understand about local knowledge since their explanation related to the definitions from various scholars. Most learners agreed that local knowledge is specific forms of knowledge that is local and specific to a particular place. From pupils response it was clear that most teachers did not use local knowledge/artifacts when teaching Mathematics. However, learners demonstrated more understanding of indigenous knowledge by the examples they provided and also they appreciate that the use of indigenous knowledge would help them understand better the difficult mathematical concepts.

On the objective concerning strategies of integrating indigenous knowledge in teaching of Mathematics, the researcher conclude that following strategies will give pupils the opportunity to derive knowledge from the local artifacts they are familiar with and relate these to Mathematics content learnt in class;

- Books and materials on various traditional learning activities should be made available at schools.
- Traditional objects and activities in which mathematical thinking is embedded such as needlework, house construction, and games should be used during teaching and learning processes.
- Mathematics needs to be taught based on learner experiences (known to unknown).
- Examination of indigenous knowledge should be considered in schools curriculum.
- Teachers to adopt teaching methods that are learner centred and activity based approach
• Elderly speakers from the community who still understand indigenous knowledge should be invited.

• Teaching of mathematical concepts should also be done in outdoor environments so as learners can observe theory to practice.

• Finally, there should be time for cultural activities such as games, dances and songs to convey mathematical concepts.

Finally, the researcher concludes that teachers face the following challenges in integrating indigenous knowledge in formal education:

• Teachers’ lack of faith that such a curriculum can actually contribute significantly in addressing the socio-economic needs of the country.

• Teachers’ inability to integrate indigenous knowledge in their practice may also be resulting from limited knowledge on what aspects to integrate in the mathematics curriculum.

• For teachers, who largely depend on knowledge that they learned from college, dealing with indigenous knowledge may look far out of reach.

• Many teachers and educators still privilege Western ways of knowing and interpretation of the world over indigenous knowledge especially in the face of globalization.

5.3 Recommendations

The study strongly recommended the following:

i. In teacher education, preparation of pre-service and in-service teachers should focus on adoption of 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.
ii. For quality indigenous education, fully and effectively involvement of indigenous peoples in particular their elders, community leaders and parents at all levels and stages of decision-making, planning, design and implementation of education programmes and support for the implementation of indigenous curricula and materials.

iii. Teachers and educators need to examine their practices and develop ways to authentically engage and legitimise indigenous knowledge forms into the formal education system. The purely Western models of education and economy are not capable of addressing the current socio-economic problems at the micro level, especially in the rural regions of Kenya. Hence, there is a need to revitalize the presence of ethnic indigenous ways of knowing, pedagogy and practices in the educational system if Kenyans are to redefine and re-shape their own socio-economic framework within their own terms of development at the micro level.

iv. In order to address both overt and hidden biases against indigenous knowledge in schools, teachers must first address their own personal attitudes. Because they are strong role models for children, they must be particularly aware of their underlying preconceptions of indigenous Mathematics knowledge. To successfully implement a multicultural curriculum, teachers need to recognize their own biases, be free of cultural biases, and be schooled in cultural awareness.

v. The researcher recommends the inclusion of indigenous knowledge in examination and more so adopt competence based curriculum which is being introduced in schools. This is because importance with which examinations are viewed makes teachers stick to what is considered factual information: what is going to be tested at the end of the primary school education level. Examinations do not test
indigenous knowledge or indigenous ways of knowing, as a result, teachers makes little reference to the local indigenous knowledge in their teaching.

vi. Closely related to the question of examinations is the issue of teaching and learning materials, especially textbooks, as the key source of Mathematics knowledge in school. Textbooks validate knowledge and define and determine what is to be learned and how it is to be learned. A teacher feels confident of and comfortable with their teaching when they had textbooks to which they could refer for information. Therefore, the researcher recommends that authors to include indigenous knowledge in the textbook books being produced for the new curriculum.

vii. In the context of indigenous education, the development of appropriate policies, strategies and programmes, and diverse, responsive and participatory approaches.

viii. Training and employing local teachers to meet the needs of remote communities linking education to other aspects of the learner’s life, such as health, nutrition, safe water and the natural environment.

ix. It is recommended that the exploration of the indigenous mathematical knowledge should be part of the curriculum design process.

5.4 Suggestions for Further Research

This study is not fully exhaustive and in order to achieve greater understanding, the researcher strongly recommends the following areas of research:

i. A similar study should be conducted in other counties in Kenya to establish existing indigenous knowledge that can be integrated in Mathematics curriculum.

ii. The study recommends a similar study to be carried out using a larger sample
iii. Further research should be done in order to find ways in which indigenous knowledge can blend with modern technology to solve current problems.

5.5 Summary of the Chapter

This chapter was driven by core objectives in the study with highlights on key findings and how they relate with underpinning literature and these were clearly covered in the study summary. Several conclusions were drawn based on the findings of the study as well as recommendation for action and suggestions for further research.
REFERENCES


Kumar, M. (2011). Teachers’ role pivotal in shaping future generations. www.scoopnew.s.in.india


APPENDICES

Appendix 1: Teachers' Questionnaire

This questionnaire is intended to gather information on a study that aims to explore the integration of indigenous knowledge within Mathematics curriculum in primary schools in Vihiga County, Kenya. Kindly fill the questionnaires to the best of your knowledge. All the information you provide will be kept confidential and will be used for the purpose of this research only. Your cooperation in the survey will be highly appreciated. Do not indicate your name anywhere on this form.

Please tick the correct alternative and fill in the spaces where applicable.

Thank you in advance.

SECTION A: GENERAL INFORMATION OF THE RESPONDENT

1. Give your gender? Male [ ] Female [ ]
2. Age (in years) Below 30 yrs [ ] 30-50 yrs [ ] 51-above [ ]
3. How long have you been teaching Mathematics in Vihiga County? Below 5 years [ ] 6-10 years [ ] Above 10 years [ ]
4. What is the highest level of your academic qualifications? M. Ed [ ] B. Ed [ ] Dip Education [ ] Certificate [ ]

Others Specify........................................................................................................................................
SECTION B: EXISTING INDIGENOUS KNOWLEDGE

5. Can you find existing indigenous knowledge in from you community that could be incorporated in teaching of mathematical concepts?

Yes [   ] No [   ]

6. If yes, to what extent is the existing community indigenous knowledge is incorporated in teaching of mathematical concepts?

Always Incorporated [   ] Rarely Incorporated [   ]

Never Incorporated [   ] Don't know [   ]

7. If you answered yes in 5 above, Which of the following indigenous knowledge/artifacts are incorporated in mathematical concepts in the classroom.

<table>
<thead>
<tr>
<th>Existing Indigenous Knowledge (artifacts)</th>
<th>Yes Incorporated</th>
<th>Not incorporated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beadwork:</strong> Used when pupils have to count the number of layers or turns to make before making a particular design in their beadwork. (counting)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weaving:</strong> Used when pupils have to make repeated patterns of selected designs. (circles, squares, triangles)</td>
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<tr>
<td><strong>Decorations:</strong> Used when pupils have to visit mural decorations which create specific geometric patterns.</td>
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<tr>
<td><strong>Construction:</strong> Used to apply to the concept of Symmetry when constructing traditional house, granaries.</td>
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<tr>
<td><strong>Games:</strong> Used when pupils participate in recreation, competition, sportsmanship and many other similar and related notions.</td>
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<tr>
<td><strong>Story telling:</strong> Used to pass over knowledge onsets (algebra) through stories and riddles.</td>
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</tr>
</tbody>
</table>
8. State any other indigenous knowledge/artifacts incorporated in mathematical concepts in the classroom.

__________________________________________________________________

__________________________________________________________________

__________________________________________________________________

SECTION C: TEACHERS’ PERCEPTION ON INTEGRATION OF INDEGENOUS KNOWLEDGE IN MATHEMATICS CURRICULUM.

9. What is teachers’ perception on the level of integrating indigenous knowledge in mathematical concepts in class six.

<table>
<thead>
<tr>
<th>Mathematics Topics or sub-topics/Concepts</th>
<th>Level of Integrating Indigenous Knowledge/Artifacts/Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
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<tr>
<td>Numbers and numeration</td>
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</tr>
<tr>
<td>Measurement</td>
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<tr>
<td>Geometry</td>
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<tr>
<td>Algebra</td>
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</tbody>
</table>
10. The following are teachers’ perception on integrating indigenous knowledge in teaching of mathematical concepts. Kindly tick appropriately.

1= Strongly Agree  2 = Agree  3=Neutral  4= Disagree  5= Strongly Disagree

<table>
<thead>
<tr>
<th>Teachers’ Responses</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>10a Mathematics identified in traditional cultural activities should also be taught in schools.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>10b When teaching Mathematics teachers should take into account students’ prior knowledge learnt out of school.</td>
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<tr>
<td>10c In schools, teachers should teach only the Mathematics that is prescribed in the syllabus and textbooks</td>
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<td>10d Traditional practices such as counting, measuring, drawing are also mathematical</td>
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<tr>
<td>10e Indigenous knowledge is relevant in teaching Mathematics concepts.</td>
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<td>10f School Mathematics should teach pupils how to apply the concepts in real life situation.</td>
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<td>10g Pupils come to school to learn “school Mathematics”, not cultural Mathematics.</td>
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<tr>
<td>10h Indigenous knowledge consists of experimental knowledge as opposed to theoretical knowledge.</td>
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</table>

11. State any other perception teachers have in regard to indigenous knowledge/artifacts incorporated in mathematical concepts in the classroom.

__________________________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________________________
SECTION D: CHALLENGES FACED BY TEACHERS WHILE INCORPORATING INDIGENOUS KNOWLEDGE IN MATHEMATICAL CONCEPTS

12. The following are challenges faced by teachers while incorporating the concepts of indigenous knowledge into the Mathematics curriculum. Kindly tick appropriately.

1= Strongly Agree  2 = Agree  3=Neutral  4= Disagree  5= Strongly Disagree

<table>
<thead>
<tr>
<th>Teachers’ Responses</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>12a Teachers undervalue the effectiveness of indigenous knowledge in teaching Mathematics.</td>
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<tr>
<td>12b Teachers don't understand the relevant indigenous knowledge in the community that can be incorporated in Mathematics curriculum.</td>
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<td>12c Examinations do not test indigenous knowledge or indigenous ways of knowing, as a result, teachers makes little reference to the local indigenous knowledge in their teaching.</td>
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<tr>
<td>12d Teacher preparation in teachers’ colleges do not incorporate indigenous knowledge in Mathematics curriculum.</td>
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<tr>
<td>12e The complex nature of indigenous knowledge and practices make it difficult to integrate in the classroom.</td>
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<tr>
<td>12f Dependence on foreign assistance to support Kenyan education reforms has led to education policies being influenced by external agents, forcing the government to focus on meeting the goals of globalization above the local needs and interests.</td>
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<td>12g Mathematics identified in traditional culture is too simple (at the arithmetic level)</td>
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<tr>
<td>12h Some teachers come from different cultural backgrounds and they don't understand the indigenous knowledge from the schools they are teaching</td>
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<tr>
<td>12i Globalization and internationalization of English and Western Mathematics portray indigenous knowledge as retrogressive.</td>
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<tr>
<td>12j Most Kenyan communities have fewer adults who possess the skills that need to be passed on to the youth that would support the capacity for integration of indigenous knowledge in formal education.</td>
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</tbody>
</table>
13. State any other challenges faced by teachers while incorporating the concepts of indigenous knowledge into the Mathematics curriculum.

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__________________________________________________________________
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SECTION E: STRATEGIES OF INTEGRATING INDIGENOUS KNOWLEDGE IN TEACHING OF MATHEMATICAL CONCEPTS.

14. The following are strategies of integrating indigenous knowledge in teaching of mathematical concepts. Kindly tick appropriately

1= Strongly Agree  2 = Agree  3=Neutral  4= Disagree  5= Strongly Disagree

<table>
<thead>
<tr>
<th>Teachers’ Responses</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>14a Books and materials on various traditional learning activities should be made available at schools.</td>
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<tr>
<td>14b Traditional objects and activities in which mathematical thinking is embedded such as needlework, house construction, and games should be used during teaching and learning processes.</td>
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<td>14c Mathematics is perceived to be very difficult therefore needs to be taught based on learner experiences (known to unknown)</td>
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<td>14d Examination of indigenous knowledge should be considered in schools curriculum.</td>
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<td>14e Teachers to adopt teaching methods that are learner centered and activity based approach.</td>
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<td>14f Invite elderly speakers from the community who still understand indigenous knowledge.</td>
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<td>14g Teaching of mathematical concepts should also be done in outdoor environments so as learners can be able to observe theory to practice.</td>
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<td>14h There should be time for cultural activities such as games, dances and songs to convey mathematical concepts.</td>
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</table>
15. State any other strategies of integrating indigenous knowledge in teaching of mathematical concepts.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

THANK YOU. GOD BLESSINGS
Appendix II: Focus Group Discussion Guide for Pupils

This guide will be used to solicit information from the pupils in regard to existing indigenous knowledge and their perception on the use of indigenous knowledge in teaching Mathematics concepts.

1. Do you understand the meaning of local knowledge?
   YES [ ]    NO [ ]

2. If yes, What is local knowledge?
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

3. Does your teacher use local knowledge/artifacts when teaching Mathematics?
   YES [ ]    NO [ ]

4. If yes, give examples of local knowledge/artifacts used and the topics/sub-topics/concepts when it is used?
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
5. Is local knowledge usefully in understanding Mathematics?
   YES [ ]   NO [ ]

6. Do you think examination should include content on locals knowledge?
   YES [ ]   NO [ ]

7. If yes, Explain why you think examination should include content on local knowledge?
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________
   _________________________________________________________________

**END**
Appendix III: Observation Schedule

This schedule will be used to solicit information in regard to available indigenous knowledge, strategies used to integrate indigenous knowledge and challenges faced when integrating indigenous knowledge in the classroom.

<table>
<thead>
<tr>
<th>Mathematics Topics or sub-topics</th>
<th>Available Indigenous Knowledge/Artifacts/Tools</th>
<th>Strategies used in integrating Indigenous Knowledge</th>
<th>Challenges experienced when integrating Indigenous Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers and numeration</td>
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<tr>
<td>Measurement</td>
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<td></td>
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<tr>
<td>Geometry</td>
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<tr>
<td>Algebra</td>
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</tbody>
</table>
Appendix IV: Vihiga County Map
Appendix V: Introductory Letter

MOI UNIVERSITY
Office of the Dean School of Education
Tel: (053) 43001-8 P.O. Box 3900
      (053) 43555 Eldoret, Kenya
Fax: (053) 43555

An ISO 9001: 2008 CERTIFIED INSTITUTION

REF: EDU/D.Phil.CM/1014/16 DATE: 3rd October, 2017

The Executive Secretary
National Council for Science and Technology
P.O. Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH PERMIT IN RESPECT OF SYLVIE TSINDOLI
   – (EDU/D.Phil.CM/1014/16)

The above named is a 2nd year Doctor of Philosophy (PhD) student at Moi University, School of Education, Department of Curriculum, Instruction and Educational Media, School of Education.

It is a requirement of her PhD Studies that she conducts research and produce a thesis. Her research is entitled:

"Integration of Indigenous Knowledge within Mathematics Curriculum in Primary Schools in Kenya."

Any assistance given to enable her conduct research successfully will be highly appreciated.

Yours faithfully,

PROF. J. K. CHANG'ACH
DEAN, SCHOOL OF EDUCATION
Appendix VI: Research Permit from NACOSTI

THIS IS TO CERTIFY THAT:
MISS. SILVYVER M TSINDOLI
of MOI UNIVERSITY, 0-50325 MAGO, has
been permitted to conduct research in
Vihiga County

on the topic: INTEGRATION OF
INDIGENOUS KNOWLEDGE WITHIN
MATHEMATICS CURRICULUM IN
PRIMARY SCHOOLS IN KENYA.

for the period ending:
19th January, 2019

Signature

Applicant's

Permit No: NACOSTI/P/18/1728/20959
Date Of Issue: 19th January, 2018
Fee Received: Ksh 2000

Kalesa
Director General
National Commission for Science, Technology & Innovation
Appendix VII: Research Authorization Letter

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Ref. No. NACOSTI/P/18/1728/20959

Date: 19th January, 2018

Silyvier M. Tsindoli
Moi University
P.O. Box 3900-30100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on “Integration of indigenous knowledge within mathematics curriculum in primary schools in Kenya,” I am pleased to inform you that you have been authorized to undertake research in Vihiga County for the period ending 19th January, 2019.

You are advised to report to the County Commissioner and the County Director of Education, Vihiga County before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit a copy of the final research report to the Commission within one year of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:
The County Commissioner
Vihiga County.
The County Director of Education
Vihiga County.
Appendix VIII: Letter of Introduction to Head Teachers

SILYVIER TSINDOLI
PO BOX 3900,
ELDORET.

TO:
THE PRINCIPAL,
..........................SCHOOL,
PO BOX ............
..........................

DEAR SIR/MADAM,

RE: REQUEST TO COLLECT DATA FOR RESEARCH IN YOUR SCHOOL

I am a Doctorate student at Moi University pursuing Doctor of philosophy (PhD) in Education Communication Technology (ECT) in the department of curriculum, Instruction and Educational Media and as part of the program I am required to conduct a research on "INTEGRATION OF INDIGENOUS KNOWLEDGE WITHIN MATHEMATICS CURRICULUM IN PRIMARY SCHOOLS IN KENYA".

I wish to request you to allow me to distribute questionnaires to teachers of Mathematics in class six, administer focus group discussion to class six pupils and conduct class observation in class six during Mathematics lessons as instruments of data collection to the teachers. Your contribution will be highly appreciated

Thank you in advance

Yours faith fully,

SILYVIER TSINDOLI
Appendix IX: Letter of Introduction to Teachers

SILYVIER TSINDOLI
PO BOX 3900,
ELDORET.

TO:
THE TEACHER,
........................SCHOOL,
PO BOX ...........
........................
DEAR SIR/MADAM,
RE: REQUEST TO COLLECT DATA FOR RESEARCH IN YOUR SCHOOL

I am a Doctorate student at Moi University pursuing Doctor of philosophy (PhD) in Education Communication Technology (ECT) in the department of curriculum, Instruction and Educational Media and as part of the program I am required to conduct a research on "INTEGRATION OF INDIGENOUS KNOWLEDGE WITHIN MATHEMATICS CURRICULUM IN PRIMARY SCHOOLS IN KENYA".

I request you to fill the questionnaire and allow the researcher to observe classroom presentation of Mathematics lesson in class six. The information you provide will be treated with utmost confidentiality and will solely be used for academic purposes only.

Your contribution will be highly appreciated

Thank you in advance

Yours faithfully,
SILYVIER TSINDOLI