AN INQUIRY INTO THE INTEGRATION OF INDIGENOUS KNOWLEDGES AND SKILLS IN THE KENYAN SECONDARY SCIENCE CURRICULUM

by

Wanja Kithinji

A thesis submitted in conformity with the requirements for the Degree of Doctor of Philosophy
Department of Curriculum, Teaching and Learning
University of Toronto

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Abstract

A major argument in the promotion of 'science' in the schools is the need to link 'scientific' thinking to everyday problem-solving. It is assumed that such a linkage will help improve existing life conditions. However, in rural Kenya and in many other parts of rural Africa, secondary science education has not had a significant effect on existing life conditions.

This study attempts to explain this failure in terms of two underlying deficiencies: first, secondary science omits and de-emphasizes everyday knowledge and skills; second, it promotes sets of ideas and myths about science that are incompatible with its 'experienced' practices.

Some academic theorizing and empirical research work to address these issues has focused on the context-boundedness of knowledge, a field of study that is known as situated cognition theory. A closely linked focus for academic theorizing is the notion of alternative sources of knowledge production and validation outside the existing 'schooled' frameworks, which are mainly Eurocentric. An alternative framework view holds that all cultures have their ways of understanding and explaining natural phenomena. It follows that promoting just one way of understanding and explaining natural phenomena is limiting the diversity of human experiences and is potentially alienating and disempowering to students and teachers who may choose to explain and understand

1 The term ‘schooled’ refers to knowledge and skills that are designated for instruction in schools.
natural phenomena differently, or at least to consider alternatives.

The study aims to contribute to the body of literature on situated cognition by identifying modes of everyday knowing and suggesting how to establish a dialectic between these modes of knowing and 'schooled' science. To identify modes of knowing, I investigated health and healing in a rural part of Kenya, Kirumi, between April and September 1997. Most participants were women because women are, in their role as caretakers, heavily involved in matters of health and healing and, therefore, are more likely than men to generate a wide variety of data. Their role as caretakers also bestows on them the great responsibility of communicating everyday knowledge to current and future generations.
Acknowledgments

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Finally, all glory and honour be to God.
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Chapter One
Introduction

Preamble

This study is about 'science' education. It is an interpretive inquiry about knowledges and skills transmitted in school and in everyday life. It is a study that analyzes, compares, and contrasts knowledges of health and healing in school and in everyday life. This study is an attempt to explain the lack of use, for everyday problem solving, of knowledges and skills taught and learned in secondary science. In this inquiry, I participated, for eight months in Kirumi, a rural part of Kenya, as a cultural ethnographer. I investigated how the people of Kirumi, mostly women, understand and explain health and healing.

Participants consisted of about 100 women, a few men, three healers, and two schooled doctors. The selection of participants was based on convenient and networking sampling techniques. Data collection used an ethnographic approach. Data analysis, during field work and after, involved linking different levels of meaning and interpretation. From the data, I develop categories of skills and knowledges of health and healing. Then, using specific teaching and learning approaches from the published literature, I develop an interpretive framework. I use this framework to compare and contrast knowledge emphases in Kirumi with knowledge emphases in the Kenyan secondary science curriculum. I also identify imbalances of emphasis and suggest teaching and learning

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1 I will refer to any knowledge that has been designated for teaching and learning at school as "schooled". This term is borrowed from Young (1976). The use of the term schooled is intended as a negation of the view that current scientific scholarship is an exclusive preserve of Western Europe. Use of alternative terms such as "Western doctors", "Western science", or "modern doctors", "modern medicine" designates doctors, medicine and science in the European/Western/modern conclave. In attempting to avoid the use of these misleading terms, I have adopted the notion of "school" as a definitive term for all knowledge that is designated for schooling and for the products of schooling, for example, doctors and medicine. This argument will become clearer in later chapters.
approaches that will facilitate a balance. The entire process is rooted in open-endedness, dialogue, explicitness, and self reflexivity.

The research was prompted by a number of educational questions arising from my experience as a student, teacher and researcher in Kenya, my studies in science education at OISE/UT, and my reflection on current international debates about the purposes of science education. Among those questions are the following: Does science education in Kenya serve the needs of the people, all the people? Is the knowledge promoted by the curriculum useful in everyday life? Does the curriculum acknowledge and build upon the existing knowledge of students, especially those from rural communities? Does it recognize and promote the indigenous knowledge of the Kenyan people? Reflecting on questions such as these leads inevitably to more overarching questions: What is science education in Kenya for? Who is it for? What counts as scientific literacy in the Kenyan context? How can universal scientific literacy be achieved?

Several areas of scholarly writing have informed my thinking on these matters: considerations in the history, philosophy and sociology of science; gender issues in education and feminists' theorizing; cultural studies in science education; anti-colonial critique; ethnographic research; curriculum design and development; constructivist pedagogy; and so on. Some of these have informed the design and conduct of the research; some have assisted with the interpretation of the research findings; all have contributed to setting the context for the study.

In particular, the investigation was conducted in the light of specific research work that has found everyday knowledges, such as indigenous² knowledges, more readily

²The term indigenous refers to the skills, knowledge, practices, customs and so on, that have been developed and shared across and among generations of people residing in a particular locality. In this thesis, indigenous is used interchangeably with tradition(al). Note that indigenous knowledges and skills have been influenced by local situations as well as global ones. Knowledges and skills, therefore, are neither exclusive to a group of people nor are they static. The reason they are indigenous is because a large portion is
applicable than schooled knowledges to everyday problem solving. Another major theoretical thread in this study was provided by literature that explicates schooled science through a cultural framework. The overall framework of the study is critical and is developed around the concept of alternative sources of knowledge production and validation outside schooled frameworks, which are mainly Eurocentric.

Schooled frameworks have dominated education in Kenya and elsewhere in Africa since the time of colonization by Europe. This is because with the advent of colonialism ‘school became the main avenue of education’. Since independence, there has been an attempt to redress the heavy emphasis in the school curriculum, on schooled frameworks. Subsequently, educators have focused on ‘indigenization’. ‘Indigenization’ is inspired, mainly, by the realization that indigenous knowledges and skills are more applicable to everyday problem solving than schooled ones.

Current ‘indigenizing’ often consists of ‘adding on’ some cultural materials to the already existing ‘science’ curriculum. In Chapter Eight and Chapter Nine, I will use the Kenyan secondary science objectives and the “Human Health” topic in a Form Four biology text to explain this ‘adding on’. In the history of ‘indigenizing’, there has been no attempt to question, critique, or replace some of unamenable and unattainable principles. processes and content of schooled science with amenable and attainable aspects of indigenous knowledges. This reluctance to question schooled science is indicative of the status that schooled science enjoys, that is, as pure, universal and objective Truth (see Chapter Three). Schooled science is portrayed as pure, universal and objective Truth by the school science curriculum and by popular media.

part of the culture of people who have had ‘unbroken’ residence in a particular locality (Agrawal 1995; Mshana, 1992; Warren, et al., 1995; Slikkerveer & Slikkerveer, 1995). Also, note that schooled and indigenous knowledges are not mutually exclusive. I explain this in later chapters.
The status of schooled science notwithstanding, ‘science’ education research has made remarkable progress. This research has suggested that the principles and processes of indigenous knowledges be taken cognizance of by the school curriculum. This research has also shown how the integration of such principles and processes can be done. However, the inclusion of principles and processes of indigenous knowledges in the school science curriculum cannot by itself resolve the issues of everyday problem solving. Indeed, there is an absence in the available research of a linkage between the issues surrounding everyday problem solving and the issues surrounding indigenous knowledges and skills. Subsequently, the following considerations will form part of this inquiry.

1. The giving of ‘wrong messages’ (myths) about ‘science’, that is, the uncritical emphasis of some positivistic tenets of classical science, such as that ‘nature is simple’, and the notion that schooled science was developed exclusively by Europeans and, among these mainly white middle-class males. Consequently, ‘science’ has acquired synonymous meaning with ‘the white middle-class European male’ and, as explained later, with schooling. These ‘wrong messages’ to do with nature of ‘science’, and ethnic and gender issues will be addressed in Chapter Three and Chapter Four.

2. ‘Curriculum emphasis’ in secondary curriculum. It is necessary to scrutinize the science curriculum in order to be informed of the knowledges and skills transmitted in school. Such information acts as a reference point in ‘indigenizing’. For an illustration, I will focus on the emphasis in secondary science objectives and in the “Human Health” topic of a Form Four biology text (see Chapter Eight and Chapter Nine). Roberts (1982) has persuasively argued that statements of overall intent in any curriculum influence the “meta-lessons” of the curriculum and, invariably, tell us about the “coherent set of messages” or curriculum emphasis given to the student about ‘science’.

In an attempt to conduct an in-depth analysis of the problem of ‘indigenization’, this study identifies indigenous knowledges and skills in a rural context and analyzes how
they compare with schooled knowledges and skills. In addition, to attain a better understanding of the larger context, the 'meta-lessons' of 'science' education in Kenya, this study attempts, from the perspective of 'curriculum emphases', an appraisal of secondary science objectives and the content of a “Human Health” topic in a Form Four biology text.

This study has, therefore, interwoven four major strands:

1. A research strand that attempts to identify the knowledge and skills of health and healing in a rural part of Kenya, Kirumi.

2. A discursive strand that uses published literature to critique ‘wrong messages’ of schooled science as promoted by schools and the media. The critique of these wrong messages provides a context for strands 3 and 4.

3. An analytical strand that identifies emphases in secondary science objectives, and compares and contrasts health and healing knowledges and skills in a Form Four biology text and in Kirumi. This analysis helps to illustrate the omission and underemphasis of indigenous knowledges and skills in the secondary science curriculum.

4. A practical strand that argues for an effective ‘science’ pedagogy through a critical combination of schooled and indigenous knowledges (that is, a dialectic between indigenous and schooled sciences).

Discussion and Definition of Terms

I use the term 'science' to refer to a set of principles, processes, procedures, rules, beliefs, values, norms and so forth that people use or apply in an attempt to understand and explain natural phenomena and to adapt to the manifestations of these natural phenomena (see Hodson, 1998). Similarly, according to Warren, et al., (1995, p.426), "the practice of science is about principles and procedures people use in order to survive within the given total ecological surroundings". I will use the term schooled science to
refer to 'science' that has been designated for use in school curricula, and indigenous science to refer to the 'science' applied largely in everyday life settings. The term science without quotation marks, as in science classes, will be used only when the context of the 'science' is obvious.

As mentioned earlier, indigenous science and schooled science are not mutually exclusive. Some elements of schooled science may have been, at one point in the history of knowledges, adopted from indigenous knowledges and vice versa. This, in fact, is a consequence of the reality of the meeting of individuals or of cultures. As Agrawal (1995, p. 415) argues, knowledges have been exchanged between cultures and among them for as long as people have existed: "in the face of evidence that suggests contact, variation, transformation, exchange, communication, and learning over the last several centuries, it is difficult to adhere to a view of indigenous and western forms of knowledge being untouched by each other".

**Experiential Location of Study**

The study is a result of my experiences with/in the Kenyan science curriculum as a student, teacher and researcher. My schooling from grade One to undergraduate level was in Kenya. The Kenyan school curriculum provided me with a good academic (schooled) grounding. Consequently, my qualifications are acceptable in Western Europe, North America and by extension, to several other parts of the world, thanks to a curriculum that was tailored on those of Western Europe and North America.

What the curriculum did not do for me is allow me to 'engage' with indigenous knowledges. Rather it enabled me to engage with schooled ones. In fact, most of my curriculum experiences shut out anything indigenous. For instance, use of the mother tongue even for 'extra-curricula conversations' was discouraged, and there was a total
absence of indigenous science in my science classes. In their totality, my schooling experiences were far removed from my rural life experiences.

It was during my postgraduate studies in Ontario, Canada, where, ironically, some of my Kenyan school curricula came from, that I began to question my schooling experiences. It became increasingly clear that, although the Kenyan education system had prepared me well for my postgraduate studies in the Western world, this same education system had ‘silenced’ a part of me. This thesis is a political as well as an academic project to begin the ‘recovery’ process.

**The ‘Science’ Education Issue**

After three years of teaching in Kenya, I enrolled in a Masters programme in Ontario, Canada. As part of the M.A. requirement, I carried out an inquiry about some aspects of the education situation in Kenya. The inquiry was about teachers’ experiences of implementing a recent science curriculum innovation. My findings revealed a context for science education that was replete with overly ambitious curriculum goals, highly centralized curriculum planning, inadequate supplies and equipment, poorly remunerated teachers, inadequately prepared teachers and teacher burn-out. To overcome the problem of inadequate equipment, materials, and supplies, some teachers used locally available materials. However, it was not always easy to adopt local materials to curriculum needs or to teach the syllabus without adequate materials and supplies. For instance, it was very difficult for one particular teacher, who tried to dissect a rabbit with a blunt knife, without flowing tap water, and without the help of a lab technician. It was even more difficult for this teacher to show to the students the fine parts of a mammalian kidney. He could not find a proper way of mounting the kidney tissue on the two microscopes shared among twenty to thirty students. But, in an attempt to complete the syllabus, he found a way of letting the students ‘see’ what they are supposed to see. Teachers are obliged to complete
the syllabus and ensure that students achieve an acceptable level of performance in view of the final standardized exams. The standardized exam is administered throughout Kenya by the Kenya National Examinations Council.

The findings of my Masters thesis opened a new world of inquiry for me. I came to the conclusion that, although the working conditions of teachers need improving, it is equally important to investigate the suitability of the scientific knowledge that we are trying to promote, both in terms of relevance and meaning or practical utility. This realization shifted my focus from implementation of the science curriculum to issues of knowledge. My desire was now to investigate knowledge bases that students interact with in the rural areas, in order to get a clear understanding of the epistemological issues involved.

**The Knowledge Issue**

During my Ph.D. programme, I grappled with issues that pertain to knowledge production and its use. Along the way I encountered concepts that helped me conceptualize my experiences of knowledge. The concepts of alternative knowledge and situated knowledge (also referred to as gendered or contextual knowledge) became in particular, the basis on which to theorize my experiences.

Alternative and situated knowledge movements of thought hold that there is no one way of explaining or understanding the world. Wiredu (1996, p. 27) observes that, “to view the allegedly disparate standards of reasoning as all equally valid within their own cultural habitat”, is a “mark of tolerance and broad-mindedness”. Or, as Toulmin (1976, p.158) argues:

> we have learned to accept the bark paintings of the Australian Aborigines, the raga of the Indian music, the dances of African tribes, and the novels of tenth century Japan, as the expressions and products of alternative human standpoints ...; yet we do still tend to behave in practice, as though the cosmological and scientific ideas of other cultures were intellectually negligible, and as though
modern Western science were the work of men who share a single, uniquely valid and rational ‘point of view’.

These points will be discussed at length later.

The movements of thought that endorse “alternative human standpoints” posit that there is no such thing as a universal knowledge. In fact, any knowledge can be said to be particular or ‘local’ in the sense that it was produced in a certain locality, under certain local conditions. After all, as Harding (1997) observes, knowledge production is closely related to modes of labour production and social organization. Consequently, knowledge is in tune with the context in which it was produced.

In fact, current ‘development’ efforts are focusing on the use of local knowledges. Developmentalists, through experiences with many failed development projects, have learned that local knowledges are far more applicable to local problems than are foreign ones (Battiste, 1997; Dei, 1990; 1993; Harding, 1998; Krom, 1995; Stamp, 1989; Warren, et al., 1995; Worsley, 1997). Note that the emphasis on local knowledges is not to be mistaken as meaning that people cannot ‘borrow’ foreign knowledges. As stated earlier, it is part of human nature to share knowledge concepts within and between localities (cultures). Given this reality, knowledge concepts that are particular to a certain locality and people, through sharing, become part of other people’s lives in different localities. Once knowledge concepts of a ‘particular’ nature become applicable to many contexts and situations, they are said to have ‘universal’ importance. Wiredu (1996) explains ‘conceptual universal’ as a situation where a concept is understood and operationalized within a culture and between and among different cultures.

Knowledge becomes of universal importance because it is applicable away from the milieu in which it was developed. It is noteworthy that not all of schooled science is applicable in all settings, and, therefore, not all of it is of universal importance.
Consequently, use of this knowledge in contexts other than where it was developed should be with “due reflection” (Wiredu, 1996).

In order to provide a context for the main argument of this study, I will now discuss the health coverage situation. I will be arguing that indigenous knowledges and skills are indispensable and, therefore, the principles and processes underlying these practices should be taken cognizance of by the school curriculum. To illustrate this point, I will focus on one aspect of indigenous knowledges and skills, that is, indigenous health and healing practices. It is hard to overstate the importance of indigenous principles and processes, especially in light of the health coverage situation.

The Health Coverage Situation

The World Health Organisation (WHO), in its health coverage programme, has been attempting to integrate some elements of indigenous medical knowledges and skills with schooled medical knowledges and skills (Bibeau, 1979). There has been a trend, since the 1970s, to integrate some elements of indigenous health practices with schooled medicine (Bibeau, 1979; Ebey-Tessendorf & Cunningham, 1997). In particular, the WHO has been developing policies to help governments, especially in agricultural societies, to reconsider their policies with regard to indigenous medicine. Since then, there has been renewed interest in the role of indigenous medicine in health coverage. This interest prompted regional governments, at the World Health Assembly in 1994, to call on the director-general of WHO to help promote “respect for, and maintenance of, indigenous knowledge traditions and remedies, in particular, their pharmacopoeia” (Zhang, 1996, p. 4). As Phillips (1990, p. 74) observes, “the time is ripe in many nations for fuller collaboration of modern with traditional medical sectors, although there are often considerable obstacles to overcome”. Similarly, Ebey-Tessendorf and Cunningham (1997) observe that combining modern and indigenous health care is a viable solution for Africa: schooled
medicine is unlikely to solve all problems. A fuller collaboration would aim to integrate beneficial elements of both indigenous and schooled medicine (Dubey, 1997). Yet the trend has been to make indigenous medicine increasingly schooled and not to facilitate an integration of the guiding principles of indigenous and schooled medicine (Cunningham & Andrews, 1997; Dubey, 1997). This in itself creates an obstacle to integration.

Obstacles to the integration of schooled and indigenous medicine emanate from people's beliefs and attitudes. Indigenous practitioners have been known to resist integration through fear of losing their status within the community. Some of them, because they have not been schooled, have little understanding of the operations of schooled medicine and, therefore, are very suspicious. On the other hand, "from the point of view of its practitioners and supporters, scientific medicine is not one medical system among many: it is the standard to which all other medical systems should aspire and which they inevitably must fail to meet" (Cunningham & Andrews, 1997, p. 12). These attitudes have engendered official policies that are not conducive to integration. Official policies notwithstanding, indigenous medicine is "alive and thriving" (Phillips, 1990).

It is documented, for instance, that over 75% of Nigerians (1980s figures) (Phillips, 1990) rely on traditional medicine, and, in Ghana, every adult knows of herbs or recipes for relief of common ailments (Fosu, 1988). Furthermore, 95% of births in rural areas in agricultural societies are performed by traditional midwives (Zhang, 1996). As well, a survey carried out in 1992, in the United States, indicated that a third of the population rely on herbal medicines, acupuncture, chiropractic and homeopathy at one time or another. Similar observations were made for Europe: 74% of the British public favour complementary medicine being available through the National Health Service, while the Dutch and Belgian public expressed willingness to pay extra health insurance for alternative medicine (Zhang, 1996). In China, rural and economically poor people commonly use traditional medicine to cure and manage mental illnesses (Allman, 1988).
Other popular uses and initiatives for promoting traditional medicine are noted in Burundi, Cameroon, Mali, Peru, Philippines, Sudan, Vietnam, India, Japan, Morocco and Kenya (Zhang, 1996). There is overwhelming evidence that people, in their everyday lives, integrate indigenous and schooled medicine.

There is another important aspect to the health coverage issue. At the beginning of 1980, IMF/World Bank policies aiming to improve the economies of African, Asian and Central and South American countries encouraged governments to make structural adjustments to all levels of the economy by managing the balance of payments, reducing the fiscal deficit, increasing economic ‘efficiency,’ and encouraging private sector investment and export oriented production. Loewenson (1993) observes that, after the introduction of the IMF/World Bank structural adjustment programmes (SAPs), cutbacks in public spending reduced the quality of health and nutrition. There has been a reduction in access to health and an increase in food prices.

Overall, “poor rural households” have not benefitted from these measures, some of which are:

1. Currency devaluations and control of the money supply;
2. Reduction of public borrowing and government expenditure, particularly in the social sectors;
3. Trade liberalization, reduction of tariff rates, and other incentives for foreign investment;
4. Abolition of price controls;
5. Privatization of public enterprises or reduction of subsidies to parastatals;
6. Withdrawal of subsidies on food and other commodities; and
Reduced expenditure in the health sector has meant that fees are charged in the majority of government hospitals and that health clinics (dispensaries) are poorly equipped. Fees have increased by as much as 800 to 1000%. Therefore, only those who can afford it get health care, thereby severely limiting access to health, especially for the rural poor.

In Kirumi, for instance, people are required to provide basic supplies like injection needles and "records books" for the recording of their visits to the local dispensary. Also, because drugs are supplied by the Ministry of Health once a month, they are available at the local dispensary for a short duration: a week or two, at best. On these occasions, people form long line-ups at the dispensary in order to obtain drugs. Some of these people have been ill for weeks but could not obtain treatment. In the meantime, some of them experiment with miti (herbal cures), and those who can afford it try over-the-counter-drugs.

The current situation is really a previously bad situation made worse by SAPs. It has long been documented that provision of health in rural areas of agricultural societies compares poorly with provision of health in the urban areas (Dubey, 1997). According to World Bank findings, for instance, two thirds of the health budget for most agricultural societies is devoted to the development and improvement of urban health care (Perry III, 1988, WHO, 1981). Yet 80% of the population live in rural areas (Dubey, 1997). Another point is that the budgeted money goes towards the provision of in-patient curative rather than preventive health services. The WHO (1981) suggests that, given the poor economies, a focus on environmental and public health (sanitation, water supplies and housing), personal practices (family planning and simple preventive health measures), and nutrition may be a better way of bringing improved health to the rural communities. This advocacy calls for the empowerment of both the individual and the community through local initiatives and responsibility: an approach referred to as primary health care.
In this approach, rural people are encouraged to take matters of health into their own hands.

The declaration of the WHO Alma-Atta conference in 1978 focused on these issues. At this conference, it was pronounced that the goal of the WHO is "health for all by the year 2000". The following measures were proposed:

1. Emphasis on low-cost preventive and curative services of "scientifically proven effectiveness for the most common and serious diseases".
2. Emphasis on community involvement in design and implementation of health programs.
3. Utilization of non-physician middle-level health personnel and village health workers in the provision of primary health care.
4. A back-up system of supervision and support for primary health care workers.
5. Creation of new forms of financing health programs, especially from the private sector.

The PHC strategy makes use of local people, indigenous healers and/or schooled people, who are selected by the community on basis of community acceptance and involvement (Valtonen, 1986). Their duties consist of the promotion of preventive health measures such as vaccination. Primary health care workers also facilitate the identification of malnourished children and provide nutritional education and curative health measures, such as treatment of diarrhoea with oral re-hydration. They also provide first aid and referral of patients to health centres or hospital.

The team of community workers consists of a village health worker, trained for four to six weeks, and a middle-level health personnel, trained for eighteen to twenty four months to give primary care. The latter functions as teacher and supervisor of the village health worker. The middle-level worker is, in turn, supervised by a physician. Finally, a village health committee oversees all health matters in the community.

As already noted, in the PHC programme there is an attempt to import schooled knowledge and skills into indigenous healing practices. Consequently, there has been
resistance from indigenous healers, who interpret this move as a strategy for undermining their practice. On the other hand, most schooled people are not receptive to indigenous healing. They claim it is “unscientific”. One wonders what role schools can play in bridging this gap.

**The Inquiry**

To identify indigenous principles and processes within a rural context and to analyze how schooled knowledges and skills compare with the identified principles and processes, this inquiry focused on knowledges and skills of health and healing. Health and healing are aspects of natural phenomena, and the ways in which people respond to manifestations of health constitute aspects of ‘science’. Notably, only negligible aspects of health science used in the everyday lives of people in the rural settings are included in the school curriculum. Conversely, a large portion of what is taught in school is not applied in rural settings (see discussion in Chapter Six, Chapter Seven, Chapter Eight and Chapter Nine).

I thought health and healing would be a particularly interesting area of inquiry, given what is already happening in the provision of health to rural populations. I chose to participate with local people in a locality where I would be most comfortable, especially with the spoken language. I decided to work with women because they are likely to reveal a wide range of knowledge. Being caretakers, women are more actively involved in health and healing in their everyday lives than are men. Therefore, they are likely to generate more information than men. Of course, the knowledge they generate is a reflection of the role they play in society, their place in the mode of knowledge production, and so this study says something about social roles in rural Kenya. Men participated in this study too. (I explain this occurrence in later chapters). In terms of health practice, the fundamental content of what they said and what women said is the same; only the properties and
dimensions differed. That, too, is a reflection of the place men occupy in the mode of knowledge production.

My intention in carrying out this inquiry was to endeavour, as much as possible, to build my meaning and explanations from the data. For this purpose, I loosely adopted Glaser and Strauss’s (1967) ‘grounded theory’. The notion of grounded theory, along with feminists’ and anti-colonial discursive frameworks, enabled me to ensure that the methods of collecting data were trustworthy and ethical. These frameworks also helped me to grapple with the issues of having to conduct the inquiry with people who have watched me ‘grow away’ from my village. The frameworks helped me to reflect on how best I could negotiate around the issues of field entry, especially the telling to research participants that “I have come back to learn from you”. How could I, ‘Wanja who went abroad for further studies’, ask women and men who never went to school, or who had a few years of schooling, to teach me about health and healing? How was I to bridge the visible socioeconomic gap and the presumed knowledge gap? I was right in anticipating this dilemma because, on occasions, women demanded that I tell them things and not ask them to tell me; they imagined I was more knowledgeable. Other researchers who have re-visited their villages to conduct inquiries like this one have had similar experiences (see for instance, Nathani,1996).

Other anticipated and emerging research difficulties and dilemmas were resolved by modifying available ethnographic data-collecting techniques and being creative with the entire research process. However, there were other occurrences in the field that could not be resolved by innovative research techniques. One such occurrence has actually influenced, to a large extent, the review of literature and theoretical framework of this study. I am referring to Jiakathuku’s remark: “Wanja, mucunku niwe waturutire ntumani”. The meaning conveyed is that the European ‘civilized’ us. I would not be wrong to assume that Jiakuthuku’s feelings are shared by some students. It makes it all
the more vital to understand and clarify where she is ‘coming from’ and why anyone would assume that ‘the Europeans civilized us’. Consequently, I have built a theoretical framework around participant remarks and my interpretation of the implication of their remarks for ‘science’ education. Subsequently, I have attempted to explain the place of schooled science as knowledge and the place of Africans in it, given the context of “the marvels of Western science and technology” (Joseph et al., 1990, p. 3). Joseph et al., have argued that many people in agricultural societies are awed by the achievements of ‘science’ and technology.

**Research Questions**

The following items provide the assumptions on which the research questions were formulated.

1. The content of high school ‘science’ in Kenya may lack a genuine connection with people’s sociocultural and environmental contexts.

2. There is a need in Kenya for the development of a ‘science’ that emanates from people’s sociocultural milieu (indigenous science).

3. It is believed that both indigenous and schooled knowledges underlie the way people currently explain and understand natural phenomena. Both could contribute to an appropriate ‘science’.

4. Indigenous ways of explaining and understanding natural phenomena are learned through apprenticeship and imitation.

5. Women provide most of the learning experiences to growing children and, therefore, the skills and knowledge that women have are easily passed on to future generations.
6. The underachievement of girls in school science is a cause for concern because the development of an appropriate ‘science’ is not likely to be successful if they do not participate fully.

7. School science content that has a genuine connection with people’s sociocultural milieu is likely to interest girls, thereby going a long way towards bridging the gap between school and everyday life.

8. The literature on ‘science’ education lacks systematic research that links the issues outlined in items one to seven.

From these items, I derived the following research questions:

1. How do the people of Kirumi define ‘healthy’?
2. What knowledge and skills do women in rural Kenya use in their daily encounters with health and healing?
3. How is this knowledge acquired?
4. How do these knowledges and skills feature in the objectives of secondary science?

**Thesis Structure**

The remainder of the thesis is contained in nine chapters. Chapter Two provides a context for the location of study. It gives some information on the historical, geographical, economic and cultural background of Kirumi and Kirumi people. Chapter Three and Chapter Four deal with the ‘wrong messages’ about schooled science. These chapters discuss issues to do with the nature of science, ethnicity and gender. In general, these chapters are an attempt to respond to the remark made by Jiakathuku, that ‘Europeans civilized us’, and to the impression of schooled science in Kenya as foreign and alienating. Chapter Five details the methods that were used in data collection and
field data analysis. Also, this chapter provides some discussion on ethnography as a research discipline and a set of research methods.

Out-of-field data analysis, in Chapter Six, identifies the pertinent knowledges and skills shared by the people of Kirumi. These knowledges and skills have to do with how people respond to health and healing. This chapter uses a narrative style of data presentation and reproduces quotes from interviews in order to give vivid accounts of participants' views. I have attempted to keep the original message in participant responses by providing 'almost' a literal translation of the interviews, where this does not interfere with the original message. A second level categorization of data, in Chapter Seven, identifies three modes of knowing in Kirumi: embeddedness and connectedness; visuality; inter-generational networking and censorship. These modes of knowing are later used to argue for an in-depth 'indigenization' of science curriculum. Chapter Eight uses the notion of a 'curriculum emphasis' to compare knowledge emphases in Kirumi with curriculum emphases in the objectives of secondary science and in the "Human Health" topic of a Form Four biology text. In this analysis, I show how the curriculum emphasis in the objectives of Kenyan secondary science compares with the goals of 'science' education. Further, I use the "Human Health" topic to highlight, in view of the findings, the knowledges and skills that are emphasized. Subsequently, I suggest how to integrate modes of knowing in Kirumi into the science curriculum. Chapter Nine provides comments and concluding remarks. The last portion of the thesis consists of indices (a glossary of terms, curriculum materials and maps).

**Summary**

In this chapter I have provided an introduction and overview of the study. I have explained the experiential location of this study as it pertains to my subjective/personal location and to the 'science' education and health coverage situations. I have presented an
argument to show that indigenous knowledges plays a vital role in the domain of health and healing. Further, I have implied that schools may have a role to play in making sure that this indigenous knowledge is developed and promoted. Finally, I have provided a brief overview of what was entailed in this inquiry: the participants, method of study, research questions, and thesis structure. Chapter Two will discuss the context of study.
Chapter Two
Context

Preamble

In this chapter I will provide some information on the historical, geographical,
ecological, educational, and cultural aspects of the study. The chapter is in two sections.
The first section is background information on Kenya (also see Appendix B). The second
section is an overview of the Meru geographical area and the Meru people (also see
appendices C and D). Note, the location of study is within what was formerly Meru
district, now Tharaka-Nithi District.

Kenya

Location and Geography

Kenya is located from 3° to 5° latitude, and 34° to 41° longitude, and covers a total
area of 582,650 km². It is bordered by Ethiopia to the north and Sudan to the northwest:
Somalia to the east; Tanzania and the Indian Ocean to the south; and Uganda to the west.
The highest point is Mount Kenya, 5,199 m high. The lowest point is 0 m, at the Indian

Kenya is entirely within the equatorial zone and has a diversified physical
environment. Because of the diversified physical environment (rift valley, Mount Kenya,
and numerous hills, ranges, lakes Turkana and Victoria, and the Indian Ocean), Kenya
experiences varied climatic conditions: savannah, tropical and equatorial. On average,
there are two wet seasons and two dry seasons: The rains come between March and May
(long rains) and October and December (short rains). The dry spell is between May and
October.
**History and Culture**

The Kenyan population is estimated at 28,803,085 (44% are 0-14 years; 53% are 15-64 years; and 3% are 65 years and over). The annual population growth estimate, in 1997, was 2.13% (Central Intelligence Agency, 1998). There are about forty three ethno-linguistic groups in Kenya, with considerable diversity in terms of socio-cultural characteristics and economic activities. In pre-colonial days, these ethnic groups existed as autonomous societies, although they engaged in barter trade and cultural raids. Most had elaborate governance and education systems. Some of the ethnic groups are matrilineal while others are patrilineal. However, there were common characteristics:

1. The absence of written languages;
2. Homogeneity of population in terms of ethnic composition (within particular societies);
3. A well defined division of labour based primarily on age and gender (sex);
4. A limited range of professional specializations;
5. The household as a basic production and consumption unit;
6. An extension of kinship to embrace living relatives and dead ancestors; and
7. The importance accorded to the social group rather than the individual (Otiende, et al., 1992).

Some of these characteristics still prevail in their original form or have been modified to fit the conventional, contemporary mode of living. For instance, the household is still the main unit of production and consumption in the rural areas, and people pay respect to ancestors through the observance of tribal customs like circumcision, naming ceremonies, land tenure and family lineages. For most ethnic groups, the traditional mode of communion with the ancestral spirits, through sacrifices, was displaced by schooling, Christianity and Islam.
The first recorded contact with foreign traders is was in the eighth century, when the early Arab Muslims settled on the coast of Kenya. By the twelfth and thirteenth centuries, Arab Muslims had founded the towns of Mombasa, Lamu and Pate. They had also established schools for Arabic literacy and education in the Quran. The interaction of the natives and the Arabs gave rise to the present day Afro-Islamic Swahili culture and Kiswahili language (Otiende et al., 1992).

The Portuguese and the British arrived in Kenya by the late fifteenth century. They were mainly interested in the slave trade and later in exploration of the interior. However, it was not until the early nineteenth century that Kenya became a British colony. The construction of the Kenya-Uganda railway facilitated exploration of the interior for settlement by the colonists and missionaries. At the same time, a colonial administration was set up to protect the interests of trading companies like the Imperial British East African Trading Company. Such companies imported cheap, mass produced goods into Kenya, and, as a result, local manufacturing and other economic practices (for example, iron smelting, textile, food preservation and medicine) lost incentive (Blakemore & Cooksey, 1981).

Missionaries aimed at winning over local people to their ways. They castigated most indigenous values, beliefs and practices and encouraged or coerced local people to adopt the Christian doctrine (Bogonko, 1992b). Both the colonists and the missionaries worked very closely to create circumstances that led to the marginalization of indigenous modes of life, especially indigenous education. Notably, too, the colonizing schemes were resisted very strongly by the natives and, at the same time, accommodated, depending on how these schemes were interpreted. One point of strong contestation was the mode of schooled education (see Kenyatta, 1938).

Although the establishment of the European schooling was led by a faction of the missionaries and the colonial administration, the local people also played a key role in
educational development. In 1929, for instance, the Gikuyu of central Kenya took the lead in providing for their own education by setting up their own self-help co-operative schools (harambee schools). They realized that European education was damaging to their way of life, especially their indigenous education (Bogonko, 1992a; 1992b; Kenyatta, 1938; Otiende et al., 1992).

I will first discuss indigenous knowledges in general in order to give a context for a discussion on indigenous African education.

**Indigenous Knowledges (IKs).** Roberts (1998, p. 59) defines IKs as “knowledge[s] accumulated by any group of people, not necessarily indigenous, who by virtue of centuries of unbroken residence develop an in-depth understanding of their particular place in their particular world”. Dei (1999a, p. 2) defines IKs as the “common sense ideas and cultural knowledge of local peoples concerning the everyday realities of living”. It is local knowledge, knowledge that is unique to a given culture or society. Indigenous science will therefore constitute of principles, facts, procedures, and systems that are utilized at the local level when people make decisions pertaining to the physical environment when they interact with it. The practice of science is about the principles and procedures people use in order to survive with the given total ecological surroundings. (Warren, et al., 1995, p. 426)

In a study of the Aboriginals of northern Australia (Groote Eylandt), Worsley found an elaborate classification system based on biological, linguistic, totemic, and food categories. He concluded that, “Aborigines have sophisticated taxonomies, based on empirical observation and careful thought” (Worsley, p. 74). Weatherford (1988) provides extensive detail of the sophisticated agricultural theory and practice of the pre-Columbian peoples of the Americas. Dei (1990, p. 16) also showed that Ayirebi farmers of Ghana have acquired “through experience, practical knowledge on topography, soils, weather, climate, running water, moisture in the ground, plant species and their destructive habits, as well as the technology of farm tools”. Similarly, Nathani (1996)
illustrated that indigenous forms of food processing technologies are a survival strategy for the women of rural Embu.

Although this knowledge is culture specific,³ it is not to say that some of its principles and practices cannot be of use to people from different cultures and environments (Loustaunau & Sobo, 1997; Sitaleki, 1994; Warren et al., 1995), or that this knowledge base is static and has not changed over the years to respond to a changing environment (Brown, 1994; Mshana, 1992). The use of indigenous knowledge in health and healing in cosmopolitan settings is an indication that this knowledge is transferable.

In the practice of indigenous knowledges, facts and knowledge are created through trial and error, and by observing sick animals seeking out various plant materials (Christie, 1991). As time goes on, this information is repeatedly tested and modified through sharing with those who are entrusted with practical functions related to knowledges and skills, as in healing responsibilities.

**African Indigenous Education**

Indigenous education according to Otiende et al. (1992) mainly consisted of:

1. **Language and oral literature:** language learning consisted of the teaching of literature, which included myths, legends, riddles, proverbs and poetry.

2. **Basic numeracy:** Basic numeracy skills consisted of counting, addition, subtraction and multiplication.

3. **Biological, environmental and economic education:** knowledge about topography, flora, fauna, as well as about terrestrial bodies. Hunters and gatherers studied the terrain, climatic patterns, habits of animals, patterns of plant growth, climate, location of water holes, trails, caves and pastures. Farming communities specialized in knowledge of

³ Its principles and practices were developed in response to the needs of a certain people in a specific environment over time.
seasons, crop cycles, types of soils, land usage, planting and weeding techniques and methods of pest prevention.

4. **Social and moral education**: the rights and duties associated with specific social roles formed an important part of social education. Moral education was couched in taboos, proverbs, riddles and games.

5. **Military training**: Young men were prepared for the defense of their territory and for tribal raids. In most ethnic groups, cattle raids on neighboring ethnic groups formed a large part of warrior activities.

Both the specific and the broad aims of indigenous education were closely tied to the socio-cultural and physical environment of the learner: “it was effective, utilitarian, and relevant to everyday life” (Otiende et al., p. 9). It was value-oriented (that is, it deliberately transmitted a well-defined social ethic); it was concerned with survival values and trans-survival values, such as respect, dignity, mutual help, social responsibility, law and order; and it was concerned with knowledge as social and personal power (for instance, people were required to obtain knowledge and skills that would enable them to contribute to the general welfare of society, and not be dependent on that society) (Njoroge & Benaars, 1987).

Indigenous education has been categorized as nonformal, formal and informal (Otiende, et al., (1992; Bogonko, 1992b).

**Nonformal education**. This involved explicit planning and was operationalized on the basis of apprenticeship. To learn special skills, such as boat-making and sailing, woodcarving, smithing, smelting, bee-keeping, healing, drumming, and so on, the youths were attached to a specialist and had to pay for their education. The method of fees payment was by labour and in-kind (Otiende, et al., 1992). Presumably, family members did not pay. It was common for special skills to be reserved for certain families, and youths in such families learned them naturally as part of family life.
**Formal education.** Formal education was common in most ethnic groups, but more pronounced where pubertal initiation was elaborated, such as among the Gikuyu, Maasai, Gusii and Meru. There were definite venues, and duration, and instructors to carry out this formal education. It was in such venues that un-circumcised Meru boys were given knowledge of curative plants, (for headaches, stomach-aches and malaria), as well as plants from which poison could be extracted for killing animals (Otiende et al., 1992, p. 12). In addition, there were organizations to prepare males for social roles: *Kamichu* (seven to nine years old); *Kigumi* (ten to fourteen years old); and *Gatuuri* (fifteen to twenty five years old). There was only one organization for women (Imanyara, 1992).

Both boys and girls were trained to observe norms and duties that ensured consensus and social stability among the members of society (Kenyatta, 1938; Otiende et al., 1992). The teaching and learning of social skills and morality were highly regarded.

Significantly harsh punishments were not meted out for making mistakes in the economic and technical skills. It was recognized that a child should be allowed to learn at his or her own pace, according to his ability. However, more severe types of punishments including food deprivation and whipping, were employed for teaching social skills and morality. (Otiende et al., p. 18)

This echoes Kenyatta’s (p. 106) observation of the Gikuyu: “it is with personal relations, rather than with natural phenomena that the Gikuyu education is concerned right from the beginning”.

Teaching of moral values and norms was also emphasized in informal teaching and learning.

**Informal education.** The more general instruction happened on an informal basis. The content of general education included instruction in language, oral literature, numeracy, environmental and technical knowledge, social and moral education, health education, ethics, sex education, physical education, music and dance, religious education and history (Otiende et al., 1992). Learning was through story telling, myths, legends, fables, songs, poetry, proverbs, games, gestures, riddles, imitation, and participation.
Boys and girls observed parents, older siblings, and other caretakers perform duties, for instance, taking care of young ones; tending livestock; selecting suitable crops for planting and taking care of farm crops and animals; identifying herbs and earth and animal products for certain illnesses; distinguishing animals, insects, trees, grasses, fruits, and flowers; exercising social etiquette; and so on.

During play, children imitated adult roles. This way, children became familiar with the norms and duties of society. Participation involved older children (six to nine years) who could use miniature tools and implements, and perform adult duties while under supervision and instruction. A young girl would take a miniature gourd to draw water from the river. She would use a small hoe and weed the farm along with her mother. Similarly, a boy would participate with his father in the designated male roles like supervising grazing animals, hunting, bush clearing and so on.

In most rural areas, informal indigenous education has resisted the influences that came with European schools. The endurance of informal education is enabled by child rearing practices that make use of indigenous languages and literatures, especially in the inculcation of societal values and norms. However, formal and nonformal education were unable to withstand the onslaught of European schooling, although some aspects like initiation and technologies such as medicine have persisted, albeit in altered forms. In fact, indigenous education in its original form is hard to find, although some groups like the Maasai and the Digo exercise some original form of indigenous education (Otiende et al., 1992). An interesting aspect of the development of schooled education in Kenya is the continuing attempt, by curriculum reformers, to recover some aspects of indigenous education (Bogonko, 1992a, 1992b; Otiende et al.)
Schooled Education

Schooled education came by way of Quranic schools, mainly along the coast of Kenya, and colonial and Christian missionary schools in the interior. Christian missionaries worked closely with the colonial government and, therefore, exerted a greater influence on the growth of schooled education than did Muslims. The first missionary school was built in 1846 at the Kenyan coast. By end of the nineteenth century, with the completion of the Kenya-Ugandan railway, missionaries set up more schools in the interior (Bogonko, 1992b). Until the time of independence, most of the schools in Kenya were run by Christian missionaries, although there was a never-ending competition between government and mission agencies concerning who should provide education for Africans.

Since its introduction in 1846, up to the time of independence in 1963, schooled education operated on a three tier system along racial lines, as sanctioned by the Fraser Commission in 1909 (Otiende et al., 1992). Europeans, Asians, and Africans were provided with different education in quality and quantity. Between 1947 and 1957, for instance, Africans, comprising 97% of the population received, 38% of the education budget. Education for Africans was also geared toward providing technical labourers and, therefore, emphasized industrial education. This was mainly at the primary level, for there were very few secondary schools. Secondary education was carefully regulated in order not to exceed the numbers of “functionaries” required in the available job market. As a result, there was a high level of attrition at standards six and eight (Bogonko, 1992a, 1992b). This was accomplished by means of a rigid exam system that ensured that only a few progressed.

Evangelism and proselytization were the main concerns in missionary schools (Otiende et al., 1992). Consequently, mission schools met with a lot of opposition both from indigenous Africans and the colonial administration. Indigenous people were
repelled by the missionary opposition to their ways of life (Bogonko, 1992a). For instance, missionaries threatened to ban a Gikuyu custom of female circumcision (Kenyatta, 1939). This sparked a controversy resulting in the setting up of *harambee* schools in 1929. That is, people pulled their resources together and set up their "own schools and churches so that they could be fully independent of the missionaries" (Kenyatta, 1938; see also Otiende et al., 1992, p. 50).

The colonial administration was opposed to the kind of education offered by missionaries because in India such education had engendered revolt and slowed industrial growth. Consequently, the Phelps-Stokes commission was set up in 1924 to formulate a desirable education for Africans. Among other things, the commission recommended character training and education designed for the particular socio-cultural environment. As a result of these recommendations, the Jeannes schools were set up in Kenya. These schools aimed at promoting vocational and rural-based education by training supervisors for teachers of village schools. Such village schools were to meet the needs of the people through an education that was fashioned on socio-cultural circumstances. For this reason, local languages were used.

However, the Jeannes schools lasted for only ten years. Missionaries opposed them on the basis of secularity. Also, Kenyans did not appreciate the vocational training aspect and interpreted the rural emphasis as an intention to "keep Africans in their place" (Bogonko, 1992b). Technical and agricultural education were, after all, provided for purposes of training Africans who would work as clerks in colonial offices or in the many commercial farms in the country; their work would largely help to expand colonial projects.

Since independence Kenyans have continued to plan for more indigenization of the curriculum. For instance, between 1963 and 1988, various education commissions, development plans and sessional papers have emphasized the need to give the school
syllabus an "African flavour". All the three education commissions (Republic of Kenya 1964/65: 1976: 1981) have "revisited the practical utilitarian aspect of indigenous education" (Otiende et al., 1992). Presently, most of the primary curriculum has an indigenous emphasis in literature, history, economics, geography and language.

In secondary schools, there is an indigenous emphasis in agriculture. But, as Bogonko (1992b) observes, the teaching of agriculture is beset with many problems.

1. Agriculture is looked upon as an occupation for those who lack formal education, whereas formal education is seen as a means of escape from rural drudgery.

2. The Ministry of Agriculture prefers to train candidates with a 'science' background and not an agricultural background. It is also not easy to get a job or a place in higher education with an agricultural background.

3. Agricultural training requires expensive capital intensive investment in the form of equipment, tools, supplies, seeds, fertilizers, pesticides, and so on.

4. Problems arising from adverse weather.

5. Lack of proper teacher training.

Another important aspect of schooled education has been the expansion of secondary education to provide much needed manpower for the scientific field. This expansion began at independence, when many white settlers fled the country. As a result of expansion at the secondary level, enrollment rose greatly between 1963 and 1981 (Bogonko, 1992b, p. 16). Because of the great need for engineers, doctors, surveyors, agronomists, technicians, scientists and architects, expansion was accompanied by an emphasis on science, mathematics and technology. Subsequently, aggregate points for entry to university for science subjects were lowered relative to the arts. The ratio of science to humanities entrants was increased, and science teachers received better remuneration than arts teachers. Despite these significant reforms, science results in standardized exams were consistently poorer than in the arts. In fact, there were not
enough students with "mathematics and science qualifications to fill all existing and proposed places in the university" (Bogonko, 1992b, p. 69). A current attempt to promote science and technology is via the establishment, in every district, of institutes of technology, which offer craft, commercial and technical education for primary school leavers who fail to get a place in secondary schools.

In view of indigenous contexts, the schooled science (SS) curriculum leaves a lot to be desired. A glaring omission is the attempt to indigenize all other subjects and not SS: this is especially so at the primary level. Indigenization of other subject areas at the primary level is remarkable. Bogonko (1992a) observes that, in the universities, the Faculty of Medicine has incorporated African medicine in the curriculum. At the same time, research institutes have been set up to look into various aspects of African medicine. Two main ones are the Kenya Medical Research Institute and the "Mitishamba" Herbal Research Unit of the University of Nairobi. However, most of the research aims at analyzing the medicinal components of various herbs, rather than incorporating indigenous principles of healing into medical practice. As a result, *Mwarobaini, (Azadirachta indica)* has been adopted by the WHO as a cure for Malaria. This is a very encouraging sign that some attention is being paid to indigenous knowledge.

**Meru**

**Location and Geography**

Meru district is located on the southeastern slopes of Mount Kenya (see Appendix B). Mount Kenya is a snow-capped-extinct volcanic mountain with several other cones around it. Meru district is between 36° and 39° E longitude; and 1° N and 1° S latitude. It is bordered by Isiolo district (predominated by Kenyan Somali) in the north and northeast, Kitui district (predominated by the Kamba people) in the east, and Embu district
(predominated by Embu people) in the south. West of Mount Kenya is occupied by the Gikuyu. The Meru have cultural and linguistic affinity with the Gikuyu, Embu and Kamba.

For administrative purposes, Meru district is divided into four zones, which correspond with different Meru dialects. That is, Meru North (Nyambene and Tigania); Meru Central (Imenti); Meru South (Mwimbi, Muthambi, and Chuka); and Meru East (Tharaka). These are then subdivided into divisions, locations, sub-locations, and then villages. Kirumi locality, where I conducted this study, is within the southern division of Meru District. Mwimbi division, Ganga location and Kirumi sub-location. The various Meru groups share similar socio-cultural characteristics and economic activities. See map for different groups of the Meru.

A large portion of Meru is plateau (southeasterly, northeasterly direction), interrupted by numerous hills. Heavy rainfall and melt water from Mount Kenya have given rise to numerous rivers and streams. These form deep gorges in the upper areas and meanders in the low-lying areas.

The plateau area receives plentiful rainfall, as high as 1500-1800 mm on the slopes of Mount Kenya and Mount Nyambene (another volcanic mountain). The east is dry, with less than 750 mm of rainfall. Rainfall patterns give rise to four seasons: two rainy and two dry seasons. The first rainy season is between March and May (long rains-uthima), and the first dry season between June and August (thano); the second rainy season is between the end of October and the beginning of December (short rains-urugura), and the second dry spell is between end of December and the middle of March (Njiru, 1981).

**Socio-economic Activities**

Favourable climatic and soil conditions permit various agricultural and commercial activities. Coffee, tea, sugar cane, *miraa* and tobacco are grown in small and large scale
crop farming, mainly for commercial purposes. Other activities include trade in various farm products, animal husbandry, poultry, beekeeping, timber processing, quarrying and tourism. Common crops are millet, finger millet, foxtail millet, sorghum, maize, tobacco and sugarcane; *ncabi* (*hyacinth* beans), regular beans, pigeon peas and regular peas; yams, cassava, arrow roots, sweet potatoes, Irish potatoes; bananas, oranges, lemons and mangoes. Other economic activities are in the service industry, for instance, transportation, hotels and restaurants and recreation resorts (Njiru, 1981).

Agriculture forms a large part of the economic activities in Meru. The significance of agriculture is reflected in the importance the Meru attach to land and soil. The family lineage in Meru, for instance, is based on the inheritance of land. A boy inherits a portion of land from his father and bequeaths the same to his sons. Therefore, the land of the so and so's family (*mbari ya ng'ania*) is known. Similarly, great importance is attached to hard work on the farm, such that a lazy person is described as 'a person who puts his hands in the soil and finds it hot' (*muntu uria wiraga njara tiirine akethira urina mwanki*) (Njiru, 1981).

Women and men are engaged for most of the year in clearing, planting, weeding, pruning, harvesting, thrashing, winnowing, storing, and treating the growing or harvested crop against pests. For instance, in August, before the short rains, men and women prepare the farms by clearing, digging, and adding manure to the soil. The seed crops are then planted about a month before the October rains. After the rains, the main activity is weeding. Annual crops like coffee and tea are attended to when weeding, pruning, harvesting and treating with pesticides are required. Both men and women perform these activities.

It should be noted, that up until about twenty years ago, most of the clearing (especially of virgin lands), digging and harvesting of crops such as maize, and the growing and harvesting of crops that required heavy physical labour and skills, such as
bananas, sugarcane, yams, tobacco and *miraa*, were done by men. Women did the planting, weeding, winnowing, carrying, storing and harvesting of beans and other crops, all of which required less physical labour. Nowadays, there are no clear gender roles as far as farm work is concerned. With changing economic and social structures, men have migrated to the towns in search of waged labour, leaving women to take care of the farms. Often, women find some of the essential farm labour physically overwhelming. At such times, they request help from male relatives or friends, or hire men to clear or fix things around the farm.

**History and Culture**

The Meru are part of the African linguistic bloc known as Bantu. Other Bantu groups are found in the rest of East Africa, South Africa and West Africa. Two historical accounts explain the origin of the Meru: One version is the Niger-Congo hypothesis and the other is the *Misiri* (Egyptian) hypothesis.

In the Niger-Congo hypothesis, the proto-Bantu that gave rise to the Meru and other Bantu groups occupied the Niger delta. The Meru are said to have emigrated from the Niger delta to Mbwaa, and later to have moved to the slopes of Mount Kenya. Mbwaa (term related to *pwani*, a kiswahili term for coast) is believed to be “the northwestern edge of the contemporary island of Manda” (Fadiman, 1982, p. 21). The migration was a result of persecution by the Pate of the Lamu archipelago (see Appendix E).

The *Misiri* (Egyptian) hypothesis, which is supported by the oral history of the Meru and other Bantu groups in Kenya (the Gikuyu, Embu, Kuria, Gusii, Suba, Luhyia), suggests that the Meru originally occupied the Nile valley between the Blue Nile and the River Atbara (the present day Gezira region, but known as Meroe in ancient times) (Imanyara, 1992). Because of persecution by *nguu ntune* (red cloth referring either to people who wore red clothes or who appeared red, believed to be Arabs), the Meru, along
with other groups mentioned above, migrated south to the north of Lake Turkana, from where they dispersed. Njiru (1981) suggests that others may have immigrated to the Niger Basin. Thus, this hypothesis claims to explain how the Bantu ended up in the Niger basin, thereby combining the two migration accounts. Njiru (1981, p. 83-84) points out some cultural practices that the Meru may have acquired from Meroe. These are:

1. Iron smithing;
2. Circumcision;
3. Shaving of both sides of the head and leaving a crescent of hair from the forehead to the back of the head (*Muthumbi*). This is said to be an imitation of the Egyptian or Roman soldiers who wore helmets on their heads. This practice was abandoned and is currently seen among the Turkana.
4. System of government (*Njuri Nceke*) and hieroglyphic writing. Apparently only the *Njuri Nceke* had knowledge of hieroglyphic writing.
5. Burying of the dead facing north (north indicates where the Meru came from), with all their possessions. In Meroe only “important” people were buried. Others were thrown in the bush.

No one knows where the truth lies with regard to the historical origin of the Meru. In disputing the *Misiri* hypothesis, Fadiman (1982, p. 16) says it is a case of information distortion and the desire for some elders to glorify their lineages by “claiming descent from ‘exotic’ peoples [e.g. Egyptians] or by extending their family genealogies, recalling individual ancestors older than the tribe itself”. Others accept the Misiri hypothesis because it links with the oral histories of other eastern Bantu groups (Imanyara, 1992).

I will now discuss some organizational elements of the Meru. As already stated, the Meru were organized along family and clan lineages. It is from families and clans that leaders were elected. These leaders, elected on the basis of wisdom and trust, constituted an elaborate governing system. The governing system consisted of:
1. Policy makers and the military (*Kiama*).
2. Political leaders (*Njuri Nceke*).
3. Sacred kings, religious leaders and medicine men (*Aga and Agwe*).

These socio-political institutions were governed by men. Women were members of only one organization, which was *Kagita*.

Elders (both men and women), through social norms, rules and obligations, oversaw the social cohesion and harmony of the family and the clan. Rules of governance were taught during and after initiation. Initiation, marked by circumcision (for both females and males) was a very important educational institution among the Meru. It symbolized maturity and a continuation of social-cultural values and duties to the family, clan and ethnic group. For instance, one could not be elected to a leadership position without undergoing the initiation.

Today, circumcision is still practiced for males (in some areas, women too are circumcised), although not in its original form, except in some parts of Igembe, Tharaka and Tigania. Circumcision of females was banned at independence. Nevertheless, the Meru youth are still instructed about social and moral obligations to family and the larger society. Apart from the instruction given during circumcision, there is also the informal instruction that accompanies child-rearing practices.

I will now provide some information on the actual location of the study. This information will help the reader to situate the findings within a specific socio-cultural setting.
**Kirumi Sub-location**

**Historical Notes**

The first missionary settlement in Kirumi was in 1922, with the setting up of the Chogoria mission hospital, seven to nine kilometers from Kirumi sub-location. The early missionaries paved the way for European administrators at Kirumi in about 1938. As was the case elsewhere in Kenya, missionaries castigated local ways of doing things and attempted to introduce new forms of dress, diet, and so on. Most people reacted strongly to this. They did not want to abandon their way of life for alien ways. However, by use of incentives like salt, sugar, fried food and clothing, a few local people were convinced to attend school and others were converted to Christianity. Further, those who worked in European farms were given wages and could afford to buy merchandise from the few shops in the area. In return for those favours, the converted helped in the establishment of local churches.

People recall how the *mucunku* (white person) gained hold of Kirumi until the Mau-Mau revolt culminated in political freedom. The Mau-Mau revolt was a direct response to some events that took place after the world wars, and is popularly known as Mau-Mau struggle. After the first and second world wars (1914-18 and 1939-45), British soldiers who fought were thanked by the British government by being given land in Kenya. In establishing themselves, they drove away the natives and retained the best land, commonly known as the White Highlands (mostly to the west of Mount Kenya). The issue of land-grabbing became very thorny and the Gikuyu people, who live on the slopes of Mount Kenya, secretly organized and planned for a revolution.

This struggle was spearheaded by Harry Thuku, Dedan Kimathi, Jomo Kenyatta and others. Mau-Mau was declared a threat to the European establishment in 1952, and a state

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*Based on personal communication with Fredrick K. Muchiri*
of emergency was declared with the arrest and detention of Jomo Kenyatta. After his release on October 20 1963, Jomo Kenyatta became the first president of independent Kenya. Despite the threat to Mau-Mau, the struggle spread from the Mount Kenya area to all parts of the country, and organizations were set up to mobilize public action against the Europeans. Both Europeans and Kirumi people who were sympathetic to colonial administration were attacked. To counter these attacks, the colonial government concentrated loyal people in villages. Villages were surrounded by *nyambo*, that is, sharp *miangua* (thorns from a very hardwood tree) spikes put in a trench about four to ten feet wide and four feet deep that was dug around the village. This trench made it impossible to leave the village. One could only leave the village by a narrow bridge. This narrow bridge was put in place during the day to enable people to walk above the *nyambo* and removed by night, exposing the *nyambo*. That way, no one would escape the village.

Within the Kirumi sub-location, there was one such village. In fact, the present day name for the local shopping center, Kanyambo (*Ka-nyambo*: of *nyambo*), is derived from the experience of *nyambo*.

**Additional Notes on Kirumi Sub-location**

Kirumi is about seven kilometers from the main road that joins Meru town to the capital city of Kenya, Nairobi, and sixty kilometers from Meru town. It is bordered by two rivers, the Kamara and the Ganga. Another river in the vicinity is the Mara river. Most homesteads are equipped with running water from the local water project. Those people without piped water draw water for domestic use from nearby rivers. They also take their animals to drink in the nearby rivers.

There are two main shopping centres, one secondary school, several primary schools and churches, and three health centres. The nearest hospital is Chogoria Mission Hospital, between seven and fifteen kilometers away (depending on what part of Kirumi location
one is starting from). The majority of people seek treatment in this hospital if they are not adequately cured at the health centres by local herbalists or by use of home remedies.

**Common beliefs and experiences.** Following are some common beliefs and what they signify. I have included these beliefs here to give the reader an idea of some cultural nuances of the people of Kirumi and, in so doing, to help the reader become acquainted, somewhat, with the world view of the participants in this study. The concept of a world view is explained in the next chapter.

1. Cry of an owl or hyena near a homestead may bring bad luck, such as death, to one of the family members.
2. Noise of a Nduriu (certain bird) suggests that a visitor will come the same day.
3. When a mutuntu (certain tree) stoops, the rains are close.
4. The roaring of a lion signifies great danger, such as invasion by enemies.
5. Windy rains mean that the rains will not be plentiful. Also, if the rains begin as the moon appears at the horizon, the rains will not be plentiful. The rain will be sufficient if they begin when the moon is in the middle of the sky. A bright Venus signifies plentiful rain.
6. If someone scratches the palm of the hand it means that he/she will receive a gift, mostly money.
7. Contractions of the upper muscles of the eyelids signify a bad occurrence, or that someone is talking negatively about you.
8. Hiccups indicate that someone has mentioned your name.
9. Prolonged drought indicates that people have sinned against God and that they need to repent.

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*B5Based on personal communication with Tabitha M. Kithinji*
10. A burning sensation in the upper portion of the stomach or sudden reaction of itching and swelling of the skin signifies a problem with *nyongo*. The literal meaning of *nyongo* is bile, but the term is also used to refer to specific bodily problems.

11. Seven (*mugwanja*) is a significant number (or symbol) for the Meru. For instance, when a father is dividing land for his sons, there is talk of ‘*o muntu anenkerwe mugwanja wae*’ meaning, ‘everyone got their portion’. But, the reference to portion is connoted as *mugwanja*, seven. Also, when a goat is split into two parts, after slaughtering, each part is referred to as *mugwanja wa mburi* (literally, the seven of the goat).

**Months of the Year.** Months of the year are calculated on the basis of agricultural activities (Njiru, 1981).

1. *Maganwe* - January: When crops such as maize (corn), beans, peas, millet are harvested.
2. *Kauo gaceke* - February: When millet is harvested, thrashed and winnowed. Also a time of gusty winds.
4. *Mathono muceke* - June
5. *Ruthandato* - July: When *ncugu* (peas) are ready for eating.

Having provided, in this chapter, some socio-cultural, educational, geographical, economic and historical background of the location of the study and earlier, in Chapter One, having addressed the problem of study and research questions, I will now recast the discussion to specifically address the problem of study. I will proceed, in the next two
chapters, to debunk the erroneous messages of schooled science as promulgated at school and by the popular media.
Chapter Three

Demystifying Schooled Science:
A Necessary Step in the Formulation of an Effective ‘Science’ Pedagogy

Preamble

As already mentioned in Chapter One, some of the wrong messages of schooled science are communicated directly or indirectly to students as they interact with SS curriculum, that is, textbooks, teacher talk, examination questions, tests and so forth. Science is presented as ‘flawless’, a-contextual and ‘the standard means of studying natural phenomena’. The aim of this chapter is to cast some of these assumptions within a broader context of arguments in the philosophy and sociology of science. In the following account, I aim to show that SS is:

1. Subject to critical questioning,
2. Not a-contextual, and
3. Not an end in itself and, therefore, not ‘standard’.

The account is brief and not intended as an extensive treatment of the issues involved; it is intended only as an illumination of the issues central to my research.

The discussion in this chapter uses the notion of schooled science as a subculture (see Chapter One): a subculture with its own values, norms, beliefs and standards. This notion of subculture will later be used, in Chapter Eight, to discuss the means to an effective schooled science (SS) pedagogy.

The chapter is in four parts:

1. A brief story of SS;
2. Popular notions of SS;
3. Institutionalization and the spread of SS;
4. Summary.
A Brief Story of Schooled Science

This brief and very much simplified story will account for the emergence of schooled science and its subsequent development. As well, this brief story is a preview of wrong messages to do with nature of ‘science’, ethnic and gender issues. Wrong messages to do with nature of ‘science’ will be discussed in this chapter, and ethnic and gender issues in the next chapter.

Ogilvie (1986) argues that the development of SS began in ancient Greece and Rome with the careful recording of astronomical events. Accurate predictions in astronomy fuelled speculation about the causes of these events. She notes that speculation about the causes of these events were made possible by writing skills and mathematical skills developed in Mesopotamia and Egypt. It was the discussions around the causes of these events that developed into a discipline, natural philosophy, which later developed into ‘science’. ‘Science’ was gradually incorporated into school curricula and became ‘schooled’ (Young, 1976).

Natural philosophy was based on strict rationalism following the teachings of Aristotle. It remained an occupation of the Greeks until Arabs invaded ancient Greece and took possession of the existing philosophical materials. The Arabs then translated, dissected, augmented, and modified the works of natural philosophy. Ogilvie (p. 7) adds that their commentary tradition “became very important in the subsequent development of European science”. Note that it is only recently that ‘science’ history books have documented the contribution of the Islamic world to ‘science’. In fact, writers of the history of ‘science’ have often portrayed “Islamic science as only a conveyor belt that preserved the Greek heritage and then passed it on to its rightful descendant, the post-Renaissance European civilization” (Sardar, 1989, p. 10).

The period between the Arab invasion and the recovery of classical texts is often referred to as the “Dark Ages”. It was a time when Europe was preoccupied with
salvation as espoused in the new Christian faith (Easlea, 1980). Consequently, not much attention was paid to ‘science’, although important technological innovations such as medicine, the magnetic compass, the wheelbarrow, the improved plough, and others were made. It was not until the late eleventh century that Europeans recovered natural philosophical texts (many of the works of Aristotle, Euclid, Archimedes and Ptolemy) from the Arabs, and translated them from Arabic into Latin (Bruno, 1987).

It is interesting to note that the study and extension of philosophical texts, through the method of speculative analysis, went on for a while. Experimentation as a method of knowledge building was not introduced until the fifteenth century. These are interesting observations, given that most school curricula give the impression that the works of Archimedes and the rest were based on experimental work. I will discuss the view of experimentation as presented in the school curriculum later.

A move from philosophical speculation to experimentation was initiated by Francis Bacon, René Descartes and William Gilbert. They envisioned a ‘science’ based on experimentation and not on scholasticism or the authority of philosophical texts. This new vision was accompanied by a change in the way people responded to nature. Formerly, the earth was seen as the centre of the universe in the project of a divine and all powerful God. The new view, introduced by Copernicus, was radically different (World Book Encyclopaedia, 1993)

Copernicus proposed that the sun was the centre of the universe, with the earth and other planets moving around it. This was a “physical reality” model, unlike the earlier view which was metaphysical. Copernicus’s model was considered a “physical reality” because it could be understood mathematically. This, and Giordano Bruno’s ideas of infinite space and the existence of other worlds, opened a new avenue for questioning the authority of the Christian church. These new discoveries demystified the role played by supernatural forces in shaping and directing physical phenomena. In the new social and
intellectual climate, scientists were willing to be more adventurous in the investigation of natural phenomena. In this new climate, Galileo popularized observational astronomy and fueled further discontent with the authoritarian Aristotelian-Ptolemaic metaphysical world view. Galileo emphasized rational means (a philosophic outlook holding that "reason is superior to experience as a source of knowledge, and that the validity of sense perception must be proved from more certain principles" ) as a way of knowing the world (The World Book Encyclopedia, 1993, p. 387). His new method was given further weight by the discoveries of Isaac Newton, who concluded “in a bold and intuitive stroke that the physical laws of the heavens and those of the earth were one and the same, with both planets and apples being subject to the same natural forces” (Bruno 1987, p. 39).

Following this burst of scientific activity, there was more speculative thinking, logical analysis and experimentation of all sorts, leading to organized scientific societies, which precipitated the phenomenal growth of scientific activities from the seventeenth century onwards (Bruno 1987; Kockelman 1968; Oglivie, 1986). An important point to note is that the members of these societies were, at the time of their formation, grappling with the question of what philosophy 'science' should be based on: whether the hermetic philosophy or mechanical philosophy (Easlea, 1980). It appears that mechanical philosophy prevailed in the battle, which Easlea says

...was a case of scholastic Aristotelianism crumbling and protagonists of very different and rival cosmologies engaging in a bitter and protracted struggle for supremacy, both with each other and against the entrenched proponents of Aristotelian-Thomistic cosmology. ‘Modern science’ emerged, at least in part, out of a three-cornered contest between proponents of the established view and adherents of newly prospering magical cosmologies, both to be opposed in the seventeenth century by advocates of revived mechanical world views. (p. 89)

Hermetic philosophy dealt “essentially with the idea of the complete community of all beings and objects” (Harris & Levey, 1975, p. 1232). It represented the alchemical vision, in which metaphysical forces were included in the explanation of all life’s experiences,
“with merging of spirit and matter” (Keller, 1985, p. 58; see also Keller, 1983; 1989). Keller observes that the hermetic world view was also respectful of women: whereas in mechanical philosophy, the mind (mind was equated to man) was to have dominion over everything; to conquer and subdue nature (nature was equated with woman). Also, “men associated themselves with mind and rational activity, women with matter and carnal instinct” (Easlea, 1980, p. 242), that is, equating knowledge and power (mastery and domination) (Keller, 1989; The World Book Encyclopedia, 1993).

The linkage of power and knowledge is undoubtedly the greatest achievement of SS. In Chapter Four, I will explain how the simile of nature and woman significantly influenced the in-equation of women and SS leading to “success in science being defined in opposition to everything female” and the assumption that “different values such as those expressed in hermetic philosophy could not have been conducive to success” (Keller, 1985 p. 64). This is a significant point for issues of ethnicity and gender in schooled science (Oyewumi, 1997).

Breakthroughs in astronomy, together with new mechanical innovations, enabled explorers to go out and discover other lands. Spearheaded through trips by Christopher Columbus to the Americas and Vasco da Gama to India, this exploration was the beginning of a never-ending project of conquering, subjugating, eliminating native peoples and their traditions, and, finally, colonization of new lands (Adas, 1989; Cesaire, 1972; Rodney, 1982). As a result of colonization, Europe became rich in material as well as intellectual wealth (Emeagwali, 1997; Rodney, 1982). Bacon’s vision of a future world where ‘science’ would enable a “flight of technology” of cars, submarines, airplanes, and much more, had come to pass (Bruno, 1987). Because of these achievements, Europeans who travelled to other lands felt materially and intellectually superior. As Adas (1989, p. 3) observes:
...in the industrial era, scientific and technological measures of human worth and potential dominated European thinking on issues ranging from racism to colonial education. They also provided key components of the civilizing mission ideology that both justified Europe's global hegemony and vitally influenced the ways in which Europe's power was exercised.

In this climate of European achievement, philosophers like Kant, Hume, Nietzsche and renowned philosophers such as Hume speculated on why other people had not achieved as much as Europeans had:

I am apt to suspect the Negroes, and in general all the other species of men ... to be naturally inferior to the whites .... There never was a civilised nature of any other complexion than white, nor even any individual eminent either in action or speculation. No ingenious manufacturers amongst them, no arts, no sciences.

(David Hume, 1748, quoted in Easlea [1980, p. 249])

Most of these philosophers came to the conclusion that, unlike the Europeans, Africans lacked the mental capacity to theorize, exercise logic and utilize reason. This notion of a hierarchy of beings was drawing a lot of support from Darwin's evolutionary theory and the anthropological works of Levy-Bruhl (Mudimbe, 1988). It appears that, in celebrating their achievements, Europeans lost sight of the achievements of others, for example, those of Africans in ancient Egypt, Ethiopia, Nubia, Mali, the Maghreb, the Western Sudan, the Interlacustrine Zone and Zimbabwe, (see Anta Diop, 1974, 1987; DuBois, 1977; Kamalu, 1990; Mudimbe, 1994; Mudimbe & Bates, 1993; Murfin, 1994, 1996; Rodney, 1972; Sertima, 1994).

As already noted, the marvels of the new 'science' were not only used as a measure of human intellect based on cultural background, but also based on sex. This sex bias was aggravated by the fact that women's position in society did not permit them to participate in out-of-the-home activities such as in intellectual pursuits. However, as Alic (1986) and Ogilvie (1986) point out, in cultures where women were accorded respect, for example, in ancient Egypt, they made a significant contribution to the 'science' of antiquity. Hypatia, for instance, "best known woman of antiquity, mathematician, and philosopher, was born
in Egypt 370-415 AD., and educated in Neopolitan school of Alexandria” (Ogilvie 1986, p. 5). Hypatia is not well known as a significant scientist because of the nature of information selection in the history of Western thought. For similar reasons, the contributions of many other women in ‘science’ have not been included in mainstream history of ‘science’ textbooks (Abott & Wallace, 1990; Alic, 1986; Ogilvie, 1986). As Alic (1986, p. 11) put it:

most of recorded history of western societies has been dominated by men. History books reflect this male bias. They have ignored the history of women. As science and technology became increasingly valued by patriarchal societies, the scientific work of women was increasingly devalued. As more people, women and men alike, became interested in science, the assertion that women were incapable of scientific work became vehement.

In a similar view, Murfin (1994, p. 96) observes that “the history of science as it has been taught in schools has been from an almost exclusively white, European, male perspective”.

**Popular Notions of Schooled Science**

In this section, I will discuss some popular attributes of SS, such as that SS is pure, universal and objective Truth. As already stated, these popular attributes are promulgated by school science curricula and the popular media. In large part, these popular attributes are based on past erroneous views, largely held by logical positivism, though other errors have been ‘manufactured’ as SS gets learned and taught.

The discussion highlights some arguments of and about SS, following certain debates in the philosophy and sociology of ‘science’. SS is portrayed as a complex knowledge genre that defies simple definitions such as pure, universal and objective Truth; ‘flawed’, ‘flawless’, and so forth. Indeed, such an understanding guides all the discussions in this thesis.
I do not intend to discuss, in detail, how these errors developed or the mechanisms by which they are or were promoted. It will suffice to mention that most of them are a result of the continued promotion of the so-called the ‘scientific method’, which for purposes of instruction is often presented in a simplified form, especially in school textbooks. Overall, this procedure is seen as a means of helping students have an idea of how scientists do ‘science’ (Hodson 1986). Another source of these errors could be the presentation of SS as fact or as “correct explanation” (Roberts, 1982). “Correct explanation” is a term used by Roberts to refer to one set of seven curricular emphases occurring in school science. An analytical discussion of these emphases is provided in Chapter Eight.

‘The Scientific Method’

Jenkins (1996) observes that “investigative activity” has been part of school science since it was first introduced in the mid-nineteenth century. Although many ‘science’ educators have since questioned the validity of depicting the nature of SS as synonymous with this “investigative activity”, there has been

...no serious challenge to the importance of developing ‘scientific thinking’ as a curriculum objective and, during the so-called curriculum development era of the 1960s, this objective was strongly re-asserted. Supported by references to investigative, open-ended or discovery learning, science curriculum projects in many parts of the world emphasized scientific procedures and attitudes. (Jenkins, p. 4)

It is important to scrutinize some assumptions that underlie school science’s understanding of how scientists do ‘science’. The following discussion, while not an exhaustive treatment of these assumptions, will serve as a useful framework for depicting how scientific method or experimentation is understood. There are five essential elements in this description.

1. Nature is simple.
2. Scientists are distanced, isolated and rigorous.

3. Scientific knowledge is value-free.

4. Scientific method is the only means of building scientific knowledge.

5. Scientific method is a step-wise procedure.

**Nature is simple.** A basic assumption of the scientific method that has persisted in school curricula is that nature is simple and susceptible to accurate and true descriptions (Hodson, 1982; Kneller, 1978; Smolicz & Nunan, 1975; Teich & Young, 1973). This assumption, acquired in the seventeenth and eighteenth centuries, and mainly supported by a mechanistic outlook, regards all “physical phenomena as connected mechanically by laws of cause and effect” (The World Encyclopaedia Brittanica, 1993, p.387).

In seventeenth and eighteenth centuries, the study of natural phenomena concerned itself with simple regularities that were subject to the laws of cause and effect, for instance, the periodically repeated movements of the sun and the moon. Pyrilogine & Stengers (1984, p. xiii) argue that seventeenth and eighteenth century ‘science’ pictured a Newtonian world:

A world in which every event was determined by initial conditions, that were, at least in principle, determinable with precision. It was a world in which chance played no part, in which all the pieces came together like cogs in a cosmic machine... a clockwork, planets timelessly orbiting, all systems operating deterministically in equilibrium, all subject to universal laws that an outside observer could discover.

Two thousand years earlier, Plato is said to have posited that heavenly bodies move “only in perfect, eternal, unchanging motion ...: [in] perfect motion” (The New Encyclopedia Brittanica, 1992, p. 34).

With further progress in the study of natural phenomena, scientists realized that these simple regularities were not readily manifested in all phenomena and, therefore, the notion that ‘nature is simple’ was no longer useful, especially in the study of living things (The New Encyclopaedia Brittanica,1992). The contemporary view of nature is that of a
complex network of interconnections and interrelations that defy any simple readings (Keller, 1985; Maslow, 1966). It is noteworthy that the underlying assumption in indigenous knowledges is that nature is very complex and should be approached as an interrelated and interconnected whole (Christie, 1991; Jegede, 1999; Likers, 1992; Worsley, 1997).

Nevertheless, the notion of ‘nature as simple’ is still useful for the purposes of astronomy and certain areas of physics. Arguably, this axiom is still applicable in the study of simple physical phenomena, especially in cases where the relationship between cause and effect is straightforward. Still, it is wrong to use this principle as a generalization for the study of all phenomena.

The SS view of nature as simple may also have originated from the use of simple mechanical models to explain natural processes. René Descartes, who is recorded as the first person to have proposed the use of such models, did warn that “such models were not the way nature probably worked” (The New Encyclopaedia Britannica, 1992, p. 38). It is likely, however, that some SS teachers may, by use of models to explain natural phenomena, impress upon students that the phenomenon is as ‘simple’ as the model. Students, therefore, receive the unintended message that nature as a whole is ‘simple’.

**The scientist is distanced, isolated and rigorous.** School science commonly says that the scientist has to be ‘distant, isolated and rigorous’ to achieve objectivity in the scientific method (Hodson, 1998). While, on occasions, this may be true, and while, on many occasions, “true regularities must be established by detached examination of data” (The New Encyclopedia Britannica, 1992, p. 32), the portrayal of this as the typical scientist and the universal approach is problematic. Abraham Maslow (1966, p. 114), while commenting on ‘value-free science’, makes a similar point:

It was certainly necessary for astronomers and physicists to assert their freedom to see what was before their eyes rather than having truth determined a priori by the church or the state. This is the kernel of sense in the concept of ‘value-free
science”'. But it is this generalization, uncritically accepted today by many, that has crippled so many human and social scientists.

The implications of such a portrayal are that students, who by nature are not ‘distanced, isolated and rigorous’, will lose interest in ‘science’. They will build an opinion that ‘science’ is not their ‘kind of stuff’. This point is made to great effect by Costa (1995)

Conant (1951, p. 8) reflects on how far and for how long scientists have relied on this popular image of a scientist.

Now there is no question that one of the necessary conditions for scientific investigation is an exact and impartial analysis of the facts. But this attitude was not invented by those who first concerned themselves with scientific inquiries nor was its overriding importance at once recognized ... if I read the history of science in the seventeenth century and eighteenth century rightly, it was only gradually that there evolved the idea that a scientific investigator must impose on himself a rigorous self-discipline the moment he enters his laboratory.

He adds, “would it be too much to say that in the natural sciences today the given sociological environment has made it very easy for even an emotionally unstable person to be exact and impartial in the laboratory?: because of the traditions he inherits, his instruments, high degree of specialization and so on” (Conant, p. 9).

Conant (1951) continues to argue that standards of scientific investigation were set by the characters of a few giants and spiritual ancestors like Galileo, who by nature were self-controlled, and by the incorporation of the Socratic tradition. Other standards, for instance, to do with professionalism, were later added by scientific societies to earlier standards. Of spiritual ancestors, Conant (1951, p. 10) says: “these men passed on to subsequent generations many facts and valuable methods of attaining practical ends but not the spirit of scientific investigation”. In fact, some of the “scientific giants”, like Copernicus, “did not experiment and observed very little” (Lindsay, 1963, p. 11). What Copernicus did was to consider material by early scholars, thereby using his mind on familiar material or devising new ways of regarding ‘old’ phenomena (Toulmin, 1960). A similar observation is made by Nadeau and Desautels (1984, p. 3). What may seem to
be a discovery of personal dedication is really an “accumulation of various endeavours, breakthroughs and/or stalemates, and as such, is the consequence of a collective effort”.

An illustration of this point would be, for instance, when a school text informs students that Charles Darwin discovered the evolution of species, without providing information on how his ideas benefitted from those of earlier naturalists who had been “toying with the notion for sometime” (The New Encyclopaedia Brittanica, 1992, p. 41).

This emphasis on ‘a discovery of personal dedication’ is, to a large extent, a fallacy that may serve to deter students who may have useful scientific ideas but fear to develop such ideas on the grounds that they are not ‘a discovery of personal dedication’. Further, the notion of a “distanced, isolated” scientist, as portrayed by school texts, is weakened in the face of evidence that scientists are very passionate people (Maslow, 1966; Wilson, 1972). For instance, the edited volume by Wolpert and Richards (1997) shows the “human reality of scientific life” as “intellectual, emotional and imaginative vigour” (Richards, 1997, p. 1). Scientists use similar “psychological” apparatus like the rest of us.

It is the human qualities of science which come over most strongly: its energy and imaginative richness; the sensations of frustration, love, despair and enchantment which hold its practitioners in its thrall. (Richards, p. 6)

Therefore, like the rest of us, scientists differ in their temperaments and thereby in the approaches they use in their pursuits. As Richards (1997, p. 1) observes, “among the experimentalists and the theorists, the biologists and the physicists, there as many differences in style and motivation as there are in haircuts and accents”.

**Knowledge is value-free.** The requirement to be “distant, isolated and rigorous” is based on the assumption that knowledge can be ‘value-free’ (Maslow, 1966). However, it has been argued that although scientists use ‘standardized procedures’ to gather knowledge of natural phenomena, they do it within specific psycho-social and historical settings (Kuhn, 1970). Therefore, the use of a standard procedure like experimentation does not preclude the interference of extrinsic factors. Besides, extrinsic factors (cultural,
political, ideological, professional commitment to a paradigm, and so forth) determine, to a large extent, the intentions and outcomes of any scientific activity.

Moreover, most of scientific activity is motivated by ‘puzzle-solving’ and not ‘problem-solving’. Puzzle-solving involves deciphering why the initial expectations of the scientist are not being met by ‘the scientific method’, whereas ‘problem-solving’, as espoused by Popper (1968), refers to a situation where the scientist is working from a purely hypothetical stance (Cawthron & Rowell, 1978; Kneller, 1978). Kneller (p. 56) argues that:

...science also grows by systematically extending a major theory through the solution of the problem it raises. Instead of seeking refutations, scientists uncover more facts by applying the theory to the many different kinds of situations it promises to explain. Popper ignores this part of science.

This is what Kuhn (1970) refers to as ‘normal science’, as distinct from ‘revolutionary science’. Normal science is when practices and procedures of ‘science’ are carried out within an accepted tradition, theoretical framework, or paradigm. Revolutionary ‘science’ involves fundamental theoretical revisions of a paradigm.

The essence of the ‘value-freeness’ of SS and its subsequent legitimacy is well captured in the following description:

Its worth is not dependent upon opinion, but is as fixed as is the relation of man to the surrounding world. Necessary and eternal are its truths, all science concerns all mankind for all time. (Binder, 1970, p. 349)

That it is “not dependent on opinion” implies that SS can provide a true description of reality. Furthermore, the statements “fixed as is the relation of man to the surrounding world” and “concerns all mankind for all time” imply that scientific knowledge should be understood by anyone anywhere, that is, anyone can arrive at a similar empirical observation anywhere in the world.

Mathews (1994, p. 181) observes that the claim that SS should be understood by “anybody, independently of their previous convictions” portrays ‘science’ as an
“intellectual activity that knows no national, class, racial or other differences: science transcends human difference” (see also Stanley & Brickhouse, 1994). However, this view does allow for the fact that “while aspects of culture do influence science, ... cultural considerations do not determine the truth claims of science” (Mathews, p. 182). In fact, if by any chance, cultural considerations form part of an account of the natural world, such an account would be marred, and continuous experimental interrogation and checks with reality (falsification) would subsequently prove it to be ‘unscientific’ (Stanley & Brickhouse). There is also the peer review process through which claims of SS are scrutinized for any distorting influences. The aim of the process is to “ensure[s] that scientific accounts of the natural world are culture proof (Stanley & Brickhouse, 1994, p. 389). Whether scientific accounts that have gone through peer review end up being ‘culture proof’ is no doubt a critical issue. Nevertheless, for lack of time and space this issue will not be discussed.

**Scientific method is the only means of building scientific knowledge.** In most cases, ‘scientific method’ is depicted as the only means of building scientific knowledge. Hodson (1998, p. 30) says that this is a mistaken portrayal of experimentation. He argues that there are instances when, in doing ‘science’, scientists do not make use of experimentally-based observation, especially given logical, theoretical/epistemological constraints, or when space, time and ethical considerations do not allow. At such times, correlational studies and ‘thought experiments’ are used in place of experimentally-based observation as a means of building scientific knowledge. Worsley (1997, p. 161) also observes that “‘the laboratory’ is a short hand for only one kind of scientific research, for meteorologists, palaeontologists and astronomers do not perform controlled experiments, which many assume to be typical of scientific work”. Here is an example of such practical suggestions appearing in a class reader and reference book that was used in Kenyan
secondary schools throughout the 1970s and 1980s. Arguably, most of the current biology teachers used this book when they were in secondary school.

Prepare two petri dishes of sterile, nutrient agar as described ... In one of them sprinkle some particles of soil and in the other, as a control, some particles of clean sand that have been sterilized by heating. If bacteria or fungi are present in the soil, they will appear as colonies in the surface of the agar within two days. The absence of such colonies from the control will prove that the bacteria were in the soil and did not come from the air, the dish, the medium or the instrument used to introduce the soil. (Mackean [Tropical Edition], 1976)

**The scientific method is a step-wise procedure.** In a bid to simplify the account of the way scientists do ‘science’, school science normally depicts ‘the scientific method’ as a procedure consisting of:

(i) Making observations from nature;
(ii) Stating a hypothesis;
(iii) Planning the experiment (including control experiment);
(iv) Obtaining the results, interpreting them and writing them up;
(v) Drawing a conclusion.

Given my schooling background (see Chapter One), when I think of laboratory work I think of this step-wise procedure. Not only did the practical procedure leave me and others with the impression that no theory is necessary in SS investigations, it also suggested that SS investigations are neat and easy to follow. This is an astounding fallacy, says Schwab (1964), because such accounts omit the experiences (cognitive, political, social or otherwise), the frustrations, the “messy” work and the trial and error that scientists go through before they develop the theoretical and substantive bases of their work.

Clearly, not all scientific investigations go through these orderly steps. In fact Schwab (1964, p. 36) sees the isolation of hypothesis-making as a discrete, named step in the biological sciences as “pretentious and over-emphatic”. This is because the procedure of
setting up an hypothesis within the biological sciences is not as rigorous and does not involve the same kind of abstract theoretical speculations as in the physical sciences. Similarly, Hodson (1986) argues that instructions for practical work are a common textbook distortion that gives children a false sense of the significance of results deriving from so-called "experiments". Hodson is arguing from the fact that practical demonstrations in science textbooks are given as steps to follow in order to "find out" what is already suggested by the author.

Having shown that SS has a context (see ‘A Brief Story of Schooled Science’) and that it is subject to critical questioning (see discussion on ‘Scientific Method’), I will now argue that most of the critical questioning of schooled science involves debates that do not necessarily lead to conclusions of what schooled science is or how it proceeds and, therefore, that it is wrong for school science to portray SS as ‘the standard way of studying natural phenomena’.

1. **Induction and logical deduction.**

   In a bid to explain how SS proceeds, some scholars have suggested that it is built through a combination of induction and logical deduction, while others have suggested falsification as the essential process of building SS knowledge. Both processes are firmly rooted in observation and experimental interrogation (Chalmers, 1982; Hodson, 1998; Kuhn, 1970; Nadeau, 1984).

   Inductivists would have it that observation (or experience) is the starting point in deriving *true* scientific statements: repeated observation that can be confirmed, variously, by other observers (see Pepper, 1942). Further, to build *objective* scientific knowledge that can be generalized to other situations (*universalize*), observational statements are subjected to logical deduction (The New Encyclopaedia Britannica, 1992).
But there are problems with these kinds of assumptions (Chalmers, 1982; Hodson, 1986; Nadeau, 1984). A problem would arise, for instance, if the observation statement (derived from experience) happens to be wrong. If the observation statement is wrong, the derived generalizations will also be wrong. The best and most amusing illustration of this point is the popular story of the “inductivist turkey”, originally told by Bertrand Russell. This turkey (assume a pronoun ‘he’) was fed for many weeks, at nine o’clock in the morning, each day. Consequently, he came to expect that each day at nine o’clock in the morning he would be fed. His inductions were right, but for a limited time. The farm owner came in each day, routinely, to feed the turkey. Then on Christmas eve, instead of being fed, he was slaughtered (Chalmers, 1982). As Chalmers (p. 13-14) observes, “valid logical arguments are characterized by the fact that, if the premise of the argument is true, then the conclusion must be true” (Chalmers, 1982, p. 13). In the case of the “inductivist turkey”, a logically deduced statement would be:

(i) I am always fed at nine o’clock in the morning;
(ii) It is nine o’clock in the morning;
(iii) I will be fed now.

I have already mentioned what happens to the turkey, despite his inductions. Instead of being fed at nine o’clock in the morning, he was slaughtered. Here is another example.

(i) All cats have five legs;
(ii) Bugs Pussy is my cat;
(iii) Bugs Pussy has five legs (Chalmers, 1982, p. 7).

As in the case of the turkey, statement (3) is a logical consequence of statement (1). There is logical coherence in statements one to three, but nevertheless the outcome is not sensible. Chalmers (p. 7) points out that, the fact that one and three are false, “does not affect the status of the argument as a valid deduction”.
A move to resolve the problems with induction and logical deduction resulted in the development of falsificationism (Popper, 1968).

2. **Falsification.**

Falsificationists admit that “scientific truth” is that which has not (yet) been proved to be false. As they would argue:

A scientific law or theory should ideally give us information about how the world does in fact behave, thereby ruling out ways in which it could (logically) possibly behave but in fact does not. The law, ‘all planets move in ellipses around the sun’, is scientific because it claims that planets in fact move in ellipses and rules out orbits that are square or oval. Just because the law makes definite claims about planetary orbits, it has informative content and is falsifiable. (Chalmers, 1982, p. 40)

Falsificationists are well aware of the inductivists’ dilemma; that is, the “always problematic possibility that a theory can be shown to be false, since final empirical proofs do not exist” (Popper, 1983, p. xxiii). Thus, falsification can be seen as a process for the elimination of errors through experiments, trial and error, logical analysis and feedback. The process aims to rule out alternative ways in which phenomena could exist or operate (Chalmers, 1982; Popper, 1968, 1983): it aims to test observational statements against reality.

In attempting to “establish the truth of universal statements which are based on experience” (Popper, 1968, p. 28), falsificationists work with falsifiable observation statements. Such statements are required to be logically possible, for instance, “it will rain here tomorrow” is logically possible because it makes a definite claim and, as such, exposes itself to a contradictory proposition, that is, “it will not rain here tomorrow”. Whereas, “It will rain or not rain here tomorrow” is not falsifiable. It is bound to be true and, therefore, is not a scientific statement. “An hypothesis is falsifiable if there exists a logically possible observation statement or set of observation statements that are
inconsistent with it, that is, which, if established as true, would falsify the hypothesis (Popper, 1983, p. 28).

The implications of falsification are that there is no end to the search for a ‘truer’ model of reality. Based on this assumption, Popper (1968) defines ‘science’ as a practice that “aims at truth and the solving of problems, of explanations, that is, at theories of greater explanatory power, greater content, and greater testability” (p. xxvi). The dilemma in falsification lies in its reliance on precise observation.

3. **Observation.**

The role of observation as a first step in the building of SS was very central in my school science. Indeed, a double lesson each week was devoted to enabling students to observe things, make inferences and draw conclusions. As students, we were made to believe that in doing observations we were, in effect, re-enacting an initial step in the building of ‘scientific knowledge’. An observation made by Hodson (1999b) ties in very much with how I viewed SS. He observes that: “the validity of all knowledge claims [in SS] is deemed to be judged solely in terms of consistency with observable and experimental evidence” (p. 3). SS has in effect been defined as “an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observations” (Conant, 1947, p. 25). I have already discussed experimentation or the ‘scientific method’, as it is popularly known.

Philosophers have argued about the role of observation in the building of ‘scientific knowledge’ for some considerable time. For instance, Chalmers (1982) observed that the basis of scientific knowledge is not ‘observation’ per se but ‘problems’, while others suggest ‘puzzle-solving’ as the basis of scientific knowledge. ‘Observation is guided by

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Falsification is different from verification, which aims to *prove* a proposition statement to be true.
and presupposes theory”, says Chalmers (1982, p. 38). By way of illustration, Chalmers (p. 46) imagines that a scientist sets out to find how bats fly. Presumably the scientist has already made an observation that bats are able to fly. He or she is intrigued and plans to carry out an investigation. Subsequently, she or he poses a question such as: “How are bats able to fly so dexterously at night, in spite of the fact that they have very small, weak eyes?” It is notable that such a question is not based solely on the observation made by the scientist, but, takes account of the theory that living organisms ‘see’ with their eyes.

Another claim made for observation in school curricula is that observation can be precise. However, a precise observation or an observation that gives a ‘true reading of reality’ is highly disputable. As Einstein is said to have remarked:

Altogether I do not at all like the now fashionable ...positivistic’ tendency of clinging to what is observable. I regard it as trivial that one cannot, in the ranges of atomic magnitudes make predictions, with any desired degree of precision, and I think ... that theory cannot be fabricated, out of the results of observation, but it can only be invented. (quoted in Popper, 1968, p. 459)

Einstein was referring to the fact that, in subatomic physics, one cannot guarantee that an observer or observation instruments will not interact with the object being measured. In fact, physicists have devised methods of calculating quantities of that take into consideration this interference. One such method involves the Heinsenberg Uncertainty Principle (Maslow, 1966). This principle allows for the measurement of quantities of a particle in motion, “given the problem of permanent localization of particles” (de Broglie, 1990, p. 21). Over the years, such physical realities in subatomic physics have shed more doubts on the attainment of objective reality. As Gierer (1986, p. 36) points out:

...modern atomic physics, ... has shown that predictions in the atomic domain depend on the precision of measurements, the precision being limited in principle because the measuring instruments used must themselves consist of atoms. The interrelation between the measuring process and the object of measurement results in an inevitable status of uncertainty.
Another significant point about ‘precision instruments’ is that, since they were built by human beings with a purpose in mind, the ‘innocence’ of the resulting observations becomes questionable.

**Institutionalization and the Spread of Schooled Science**

Although the African, Islamic and Asian worlds made major contributions to the beginning of SS, its ‘schooling’ and eventual spread was carried out by Europeans. SS was taught at European universities from the early sixteenth century (Conant, 1947). Later, groups of people organized institutions that would serve solely to enhance “scientific adventure and learning” (Bruno 1987). The first of such scientific institutions, The Royal Society of London and the Academie des Sciences of Paris, were set up in the seventeenth and eighteenth centuries (Conant, 1947). Until the mid-nineteenth century, ‘science’ was not studied in secondary school (Jegede, 1997; Young, 1976), although in what is now the United States there was a curriculum that aimed to give SS instruction in academies as early as 1751 (Report of the Committee on the Function of Science in General Education. Commission on Secondary School Curriculum, 1938).

In the light of the many gains that had already been made, such as industrialization and medical and mechanical innovations, SS was now considered the “knowledge of most worth” and superior to earlier knowledge categories such as music, poetry, rhetoric and philosophy that, in the light of SS, “have little bearing upon action” (Adas, 1986; Binder, 1970). Subsequently, in the post-independence United States and elsewhere in the West, SS was seen as a symbol of the forward-looking vision, a sense of progress (Bybee & DeBoer, 1994). Indeed, in the United States, SS (and “democratic orientation to schooling”) was the cornerstone of the “progressives’ faith” (Binder, 1970). This reality continued to engender ‘science’ as the only hope for others who wished to ‘develop’ (Jegede, 1997).
Although there is no agreement as to whether the industrial revolution was an intellectual movement involving scientific techniques as a matter of industrial practice, there is evidence that the revolution was not entirely a product of uneducated empiricism or practical craftsmanship (Cardwell, 1972). Considering its presumed role in the industrial revolutions in Britain and France, it is no wonder that SS came to be regarded with such esteem. It is noteworthy that, because of the importance of schooling in the progressives’ vision, all ‘worthy’ scientific knowledge and skills were, therefore, designated for schooling. Gradually, ‘science’ acquired synonymous meaning with schooling (Adas. 1986).

The West was now armed with what Dart and Pradman (1976, p. 655 quoted in Mathews 1994, p. 183) call a “unique and powerful offering”. Certainly, Europeans felt in a superior position to those they conquered and, therefore, justified in imposing this powerful knowledge. Major colonizers (Britain, USA, Portugal, Spain and France) established schools in which the local people were introduced to new ways of interpreting natural phenomena, without due regard for prevailing cultural, socio-political and socio-educational needs (Fensham, 1988; Peacock, 1995; Reiss, 1993).

**Schooled Science Into Africa**

To say that the introduction of SS into Kenyan education was in disregard of local contexts is not to say that Africans had no control over the introduction of SS (Kenyatta, 1938). In fact, I would like to counter the conventional view that SS was totally imposed on local people. The fact that the local people, to an extent, resisted, contested and negotiated the structures, forms, contents and regularities of the school and of education (see Chapter Two) is indication that they had a role to play in the introduction of SS. I am arguing the following: because they demanded and expressed their desire for schooling, local people ‘were party’ to the imposition of colonial education and, therefore, the
denigration of their own. However, this is in no way meant to downplay the powerful colonial schemes (for instance, enforcing, with physical beating when necessary, the abandonment of local customs and practices; giving material rewards only to those who succeed in schooled education, therefore making schooling more desirable, and so forth) that enabled the colonists to discourage the use of indigenous knowledges.

As Kenyatta (1938, p. 318) admitted, there are some things that the African admires in the European, for instance, the “prosperity given them by their command of science”. Africans were particularly enthusiastic for SS because of the power it wielded. Their image of SS was of an area of study that had enabled Europeans to possess impressive and powerful machines and equipment (notice that there was no distinction between ‘science’ and technology), and to discover impressive and effective cures for common and killer diseases. It was for this same reason, the presumed power and significance of SS as knowledge, that the colonial governments decided to exclude Africans from it. In fact, “science teaching in the primary school at that time consisted mainly of nature study, hygiene, and agriculture” (Ogunniyi, 1986, p. 111). Africans were only to acquire basic skills in literacy, crafts and agriculture in order to facilitate colonial and missionary projects.

Another reason why Africans were excluded from SS is because they were thought to be of inferior intelligence. Consequently, ‘European’ science was considered too difficult for the African, such that even when it was taught in schools, it was presented as a dogma (Jegede, 1997; Ogunniyi, 1986), that is, as facts and information, just the way they appeared in text books. This superiority-inferiority conditioning of the colonial experience made Africans view SS as one means of proving their intellectual capability to the Europeans. Therefore, at independence, “scientific development was embraced ... as a necessity” (Eisemon, 1982, p. v). By this time, the global implications of SS were clear.
Largely, it was portrayed as the only form of knowledge standardized for consumption at global level (Adas, 1989; Emeagwali, 1997; Sardar, 1997; Turnbull, 1997).

Many newly independent countries were eager to train their own scientists and engineers to take the place of colonists who left at independence. Their demand for a SS curriculum was readily met by those countries which had already developed a ‘sound’ SS education. The U.S. and the UK, especially, were at the time (late 1950s and early 1960s) engaged in major SS curriculum reforms “inspired by the Russian Sputnik 1” (Jegede, 1997, p. 7). The “Russian Sputnik 1” had inspired the PSSC, BSCS and CHEMStudy curricula in the U.S. and the Nuffield projects in Britain, and the Nuffield in turn inspired School Science Projects in Kenya (Quraishy, 1980). The Ominde Education report (Republic of Kenya, 1964) is a clear case of African educators basing their visions on education practice and curriculum reforms in the industrialized world. The Ominde committee observed:

...but from now on, we in Kenya must go our own way, accepting from other countries any of the fruits of their experience that may be useful to us, and offering them the fruits of ours. We have already, during our drafting of this report, had in mind some of the educational achievements of other countries-the Union of Soviet Socialist Republics, China, Denmark, France, the United States of America, our African neighbours-and Britain, too (Republic of Kenya, p.25).

The tendency to transfer ‘science’ materials from developed countries to developing countries has continued to this day (Eisemon, 1982; Jegede, 1994; 1997; Krugly-Smolska, 1994; Ogguniyi, 1986; 1988; Swift, 1992; Urevbu, 1984).

Materials for the school populations of Britain, the USA or France were exported, with or without minor adaptation, to the school systems of other countries where quite different sociopolitical and socioeducational needs and demands prevailed. These differences were very apparent in the countries of the Third World that had only recently gained political independence. ...It can now be seen, however, that this period of direct importation of science curricula, even in these countries, distorted the educational scene and inhibited more appropriate local developments. (Fensham, 1988, p. 2)
This transfer is an expediency, located in ignorance and lack of attention to the particulars of local environments. It is, of course, based on the belief that SS is objective and universal knowledge, capable of transforming people's lives through socio-economic intervention. Indeed, many agree that "one of the most powerful instruments for the utilization of nature and for fostering development is science and technology" (Thisen, 1993, p. 5). But after nearly four decades of SS in Africa and no 'desirable socioeconomic development' in sight, educators are beginning to question the plausibility of SS. Also, following Thisen's observation (above), educators are asking: Whose 'science'? Whose technology? (See for instance, Harding, 1991).

**Whose 'science'?**

The ongoing concern in Africa, as in other agriculturally based societies, therefore, is with the role of SS education in the lives of people, collectively and individually. It is becoming increasingly clear, for instance, that the SS education provided for Africans does not bring about desirable socioeconomic changes. For instance, there is no indication that, after nearly four decades of SS education, the life conditions of Africans have improved (Jegede, 1994; UNESCO, 1983).

Moreover, given that the content of education is a powerful avenue for socialization (Young, 1971), it has become necessary to review the content of school science. Not too long ago, the content of SS would not have been questioned. This was because of the pervading belief that SS is pure and neutral (as discussed earlier). With the ground breaking socio-historical analysis of the practice of 'science' by Kuhn (1970) and subsequent integration of his approach into SS studies (for instance, Young's 1976 work titled *The Schooling of Science*), it became imperative to investigate the possibilities that SS was not 'pure and neutral'. Could it be that, instead of facilitating socio-economic...
progress, SS was curtailing it? Could this have something to do with the status of SS vis-a-vis indigenous ways of explaining and understanding natural phenomena?

I will consider, briefly, how the issue of SS has been addressed. Up to the 1980s, in Africa and elsewhere, the primary concerns of SS educators and policy makers had been on textbook availability, use of more realistic, practical and experimental work, and deployment of more appropriate teaching methods (Morris, 1980). Questions regarding the nature of the SS that was taught (including epistemological issues) and the underachievement of girls in 'science' (gender issues) were not addressed. A recent survey of 'science' and technology education in Africa by Ajeyalemi (1990) is also silent on the epistemological and gender issues. These issues, addressed in the next chapter, are central to my study.

**Summary**

I have argued that, contrary to popular images of SS promoted by school science and popular media, SS is not a-contextual, unproblematic and undebatable. Nor is it a 'standard way' of studying natural phenomena. I have shown that the current practice of teaching one set of ideas, knowledges and skills in school and not any other ideas, knowledges and skills, is a consequence of historical factors and events. These historical factors and events also culminated in the teaching and learning of schooled science as a school subject and its elevation as the knowledge of most worth. Consequently, schooled science was promoted as the formal discourse to take place in schools, advancing the popular notion that schooled science is synonymous with 'science', and the hidden message that 'other sciences', for instance, indigenous sciences, that are not taught and learned at school are 'not worthy sciences'. Certainly, because they were not included in formal discourses, indigenous sciences were marginalized and silenced.
In an attempt to demystify science, I showed that the beginnings of schooled science were not without cultural, racial and gender biases. Also, I highlighted sociological and philosophical discussions on 'scientific' concepts such as induction and logical deduction, falsification, observation and objectivity, truth and universality and the 'scientific method'. I argued that, given that there is no consensus with regard to what SS is or how it proceeds, its continued promotion as a "correct explanation" is highly questionable. In the next chapter I will continue to discuss other epistemological concerns. I will focus on such concerns from the viewpoints of African and feminists' epistemologists.
Chapter Four
Ethnic and Gender Concerns

Preamble

I will continue to debunk erroneous notions of schooled science by addressing two other wrong messages:

1. African indigenous scientific knowledge is not 'science' because it does not meet the standards of schooled science.

2. The reason girls and women underachieve in school science and are under-represented in the scientific workforce is that they are not good at schooled science.

The chapter is structured as follows: first is a discussion of anti-colonial critique. This discussion will provide a discursive framework for this chapter and, indeed, for the entire study. Following this is 'A Question of African Philosophy', which discusses the issue of 'the standard' from the point of view of debates on African philosophy. I have recently learned that schooled science is not the only discipline with 'established standards' that function to marginalize 'other sciences'. Philosophy, too, has established standards that function to marginalize 'other philosophies'. But unlike in 'science,' where debates on the 'standard' are very recent, such debates about philosophy have been around for a while. I will note here that the debates in philosophy are extensive and very complex and, therefore, I intend only to highlight issues that are pertinent to my study. For a concise introduction to the debate see Imbo (1998). This discussion will focus on the possibilities and limitations of the use of indigenous materials for formal discourses. Therefore, I will draw lessons from published literature on ethnophilosophy, a term used to refer to a branch of philosophy that attempts to look for philosophy in 'cultural materials' (Imbo, 1998).

Following the section on philosophy, I will discuss why girls underachieve in science and why women are under represented in the 'scientific workforce'. First, I will present a
theoretical framework (‘Feminists’ Frameworks’) for the discussion, then I will use published literature in the feminists’ critique of schooled science to explain why boys and girls have different predispositions for science. Subsequently, I will refer to biological and social factors in a discussion of ‘Gender Issues in Science Education’. I will end with a brief summary.

**Anti-Colonial Critique**

This critique is rooted in “recent movements for social change” which questioned the concept of “normative” or the universal by recognizing it as “being the limited and limiting perspective of a particular gender, class, and race (Barbre et al., 1989, p. 3; also see Amadiume, 1987; Collins, 1990; Dei, 1999a; hooks, 1981; 1984; Miller, 1990; Oyewumi, 1997; Smith, 1997). The overall aim of anti-colonial critique is to provide the critical tools for the deconstruction of representations of neo-colonial structures (Césaire, 1972; Dei, 1993; 1999a; Miller, 1990; Mudimbe, 1988; 1994; Mudimbe & Appiah, 1993; see also Williams & Chrisman, 1994), for instance, academic imperialism that currently controls and shapes the destiny of Africa in general and SS education in Kenya in particular (Eshiwani, 1983; Murfin, 1994), and for theorizing the place of displaced indigenous knowledges, that is, seeking recourse to indigeneity (Dei, 1999a). As Dei (p. 9) observes, “anti-colonial theorists work with alternative/oppositional paradigms based on the use of indigenous concepts and analytical systems and cultural frames of reference”.

These alternative paradigms have been created by the rewriting of history and the negating of images and theories that continue to depict indigenous knowledges and skills as unqualified for formal discourses.

**Alternative Paradigms.** In academic theorizing, alternative paradigms are strongly linked to the classic works of Cheikh Anta Diop’s (1974) *The African Origin of*

Diop, Bernal and DuBois locate the African identity in material formations. They demonstrate the African origins of ancient Egyptian civilization and link this to the early formation of Western civilization in Greece. Diop for instance, argues from the fact that “historians have fully accepted the decisive influence of Egypt upon the early formation of Western civilization in classical Greece” (Irele, 1983, p. 22). Irele (ibid.) adds that, “Diop’s project helps to give the sense of African being a proper historical depth rather than a ‘metaphysical’ being and thus to refute the argument that the black race had produced no great civilization”.

Others have attempted to defy the ‘metaphysical’, a formerly “pejorative connotation” perpetrated in Levy-Bruhl’s primitive mentality project. For instance, it was in reaction to Levy-Bruhl’s project that Senghor stated that ‘Emotion is African, as Reason is Hellenic’ (Irele, 1993). Note that Senghor’s views on emotion must be connected specifically to his conception of ‘negritude’ and the development of African consciousness, that is, the value of being black. I will discuss this in detail later. Despite the obvious inflammatory nature of his assertion, some analysts maintain that Senghor gave emotion a new and positive meaning. Moreover, he provided renewed impetus for the study of African thought systems, in general, and made a substantial contribution to current debates on African philosophy and other disciplines (Imbo, 1998; Irele, 1993; Prah, 1997).

Inroads made by the likes of Diop, Bernal, DuBois and Senghor have undoubtedly provided African scholars with a favourable environment for redefining standards in the
disciplines (for example, philosophy) and, thereby, charting new visions, that is, visions that speak to the contexts of Africans (Asante, 1983).

Redefining standards is about going 'back to the drawing table' to revisit and analyze the cosmological order of African worlds, followed by speculation on, and conceptualization of, a meaningful 'existential/living code' for contemporary Africans. Such a process involves "autonomous self expression, sober reflection and profound and sophisticated assessment of values and goals", leading to a "reflective voluntary adoption of some ideas" (Gyekye, 1997, p. 25). The process of reflection, critical assessment, and informed choice ("cross-cultural conceptual analysis") is explained further by Wiredu (1996, p. 151):

The African concerned should satisfy herself that there are no better or equally good African alternatives to the proposed western idea and whether the categories of thought in terms of which the propositions in question are framed are intelligible with the scheme of categories embedded in her own vernacular. Should this turn out to be the case she should then have to investigate whether the problem lies with her vernacular or with the foreign medium.

Cross-cultural conceptual analysis encompasses a new vision that allows one to acquire a deeper understanding of foreign as well as African concepts. In understanding them, the individual can determine best which are appropriate to a situation. This approach resonates with suggestions by Jegede (1994, 1998) of a "conceptual ecocultural paradigm" for the purposes of integrating African thought into SS (see discussion in Chapter Eight). Like cross-cultural conceptual analysis, Jegede's conceptual ecocultural paradigm and collateral learning enable one to make informed choices (Wiredu, 1996).

An important frame of reference in cross-cultural conceptual analysis and in other indigenous theorizing is the notion of a world view. Furthermore, the import of the concept of world view on matters of pedagogy in 'science' is of great interest to 'science' educators (Cobern, 1996; Hodson, 1998; Jegede, 1998; Kilbourn, 1974: 1980; 1980/81; 1982; Ogunniyi et.al., 1995; Pepper, 1942). As Cobern (1991) observes, since its
introduction in science education research by Brent Kilbourn in the 1980s, the concept of a world view has generated a lot of interest.

**The concept of a world view.** Human beings organize their lives around notions which help shape their view of the nature of reality (Kearney, 1984). Nature of reality "refers to a person's view of the structure of the universe and how it works - how things, events, and people come to be as they are, how they interrelate and fit in the general scheme of things, and how we know all this" (Kilbourn, 1980, p. 35). It is suggested, for instance, that the mechanistic world view as promoted in some\(^7\) aspects of science education is based on the notion that nature is ordered by means of discrete features which are spatially and temporally related within the physical dimension. This, though a simplistic way of describing science, helps us understand why the main function of science is to locate discrete features in natural phenomena through deductive means (Kilbourn, 1980). It also helps us appreciate the fact that SS is largely guided by a distinct world view that differs from that guiding indigenous knowledges (Ogawa, 1986; Sardar, 1989).

World view has been defined in various ways. Cobern (1991, p. 12) defines it as the "culturally dependent, generally subconscious, fundamental organization of the mind." It is the common sense fact by which an individual tries to understand all other areas of life. Wanjoji (1997, p. 38) defines a world view as, "how an individual, a society, a community, a nation, or a historic epoch views, sees, conceives, or understands the world and the reaction which follows therefrom". The visible expressions of a world view are language, symbols, behaviour, presuppositions about self, non-self, nature, time, causality, and so on. Taken together, these expressions constitute a system of thought

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\(^7\) Of course, mechanistic science is not the only brand of science in schooled science. The whole field of ecology is based, primarily, on organic (not mechanistic) assumptions about the nature of reality. However, overall, SS is portrayed through school science and popular media as largely mechanistic.
within a culture, and, subsequently, provide the basis on which learning can take place (Ogunniyi et al., 1995).

An African World view.

Given the diversity and complexity of the numerous ethnic communities making up African peoples, it may appear that to talk about an African world view is overly generalizing. However, throughout generations, Africans have shared implicit assumptions based on cosmological and social values (Dei, 1999b). These are (Dzobo, 1975, p. 77):

1. Life is the greatest thing in the whole world.
2. Man’s humanity has an inalienable worth.
3. The good of the individual is a function of the good of the community.
4. The solidarity of the extended family is supreme.
5. The universe is friendly, and this implies a belief in a benevolent God.

It is likely that these common elements point to the existence of a shared world view. Recently, Jegede (1997, p. 1) pointed out:

...for the developing countries of Africa dominated and governed by non-western socio-cultural factors, western science means an imposition of one culture over another. It means the replacement of the anthropomorphic world-view with a mechanistic one. This situation among others, would further militate against the race to development by African nations.

What Jegede is arguing here is that Africans organize their lives around "values, ethos, practices and perspectives for interpreting nature" that are not necessarily supported by

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8 The notion of a benevolent God makes a thorny issue, especially given its origin and its totalizing connotation. It is clearly a colonial heritage and its implications for a colonial critique are far reaching. In discussing his notion of cross-cultural conceptual analysis, Wiredu (1996) has touched on how the concept of 'a God' may be appropriated among African cultures, which formerly understood there to be many gods and not 'a supreme God'. 
SS (see also Dei, 1999b). For instance, it is said that an African world view is people-centered (anthropomorphic) and has a constant communication with nature (Jegede, 1994; Mbiti, 1997), whereas an SS world view is predominantly mechanistic (see Chapter Three).

Of the Gikuyu of Kenya, Kenyatta (1961) and Wanjohi (1997) say that human relations are at the centre of the reality of the Mu-Gikuyu. Wiredu (1996) also points out that, among the Akan of Ghana, ethics and ethos are founded on human well-being. Oyewumi (1997) has posited that among the Yoruba of Nigeria, for instance, seniority is the foundation of social organization and knowledge production. In Yoruba, therefore, what defines who an individual is and what they are capable of is the authority that person commands in the lineage system. Subsequently, what one can know is not restricted on the basis of whether one is a woman or a man.

Another aspect of an African world view is the value attached to human senses other than sight. Among the Yoruba, for instance, there is no privileging of the eye over other senses, as is the case in school science. Oyewumi (1997, p. 14) has observed that this prioritizing of sight in school science “promotes what can be seen over that which is not apparent to the eye; it misses the other levels and the nuances of existence”. See Chapter Seven for a discussion on other modes of ‘seeing’ as identified in Kirumi, a rural part of Kenya.

Given this background, the relationship between cause and effect in an African world view has physical, social, spiritual and cosmological dimensions (Urevbu, 1984). As a result, it is not always easy to decipher which of the dimensions (physical, social, spiritual or cosmological) is dominating unless one takes time to do a more in-depth study of the particular culture involved. A casual encounter is likely to engender the impression that the supernatural mode is the sole explanation for all natural phenomena and, therefore, is the African world view (Mundangepfupfu, 1986; Wiredu, 1996). That is, Africans
attribute all phenomena to a higher power. Wiredu (1996, p. 193) says that in an African world view, “reality is one comprehensive cosmic order in which everything goes according to law”, but this is not to say that Africans cannot tell the difference between a supernatural occurrence and a natural one. What it means is that the operation of the natural is not conceptually excluded from that of the supernatural. For instance, a misfortune that is clearly understood as natural, say a physical illness that is attributable to a physical causative agent, may be further explained as a consequence of supernatural forces. A person who is blinded as a result of snake poison knows that the cause of the blindness is the snake poison, but the reasons why the snake spat in his eyes at that time may be traced to a curse, a non-physical explanation. With regard to supernatural explanations, some medical anthropologists have observed that supernatural and natural explanations provide a range of evidence from which people explain and understand health and healing, and this is of some psycho-social value (Gbadegeisin, 1991). This issue of medical evidence in health and healing will be considered further in Chapter Eight.

Evans-Pritchard’s (1937) study of the Azande of central Africa found that their witchcraft did not contradict empirical knowledge of cause and effect. On the contrary, the Azande had three alternative approaches to cause and effect: mystical, common sense and scientific. They used different frameworks to explain events, depending on the theoretical appropriateness of the framework. Horton (1971) showed that even supernatural notions have certain important features that, when critically analyzed, can be said to be logical. Other sources indicate that, in indigenous African education, “abstract thought was also evoked through riddles, sayings, folk tales and the analysis, of various problems ranging from the astronomical to the mundane” (Bogonko, 1992b, p. 3; also see Wanjohi, 1997).
I will now redirect the discussion to specific concerns in African philosophy.

Discussion of gender issues follows later in the chapter.

**A Question of African Philosophy: Redefining Standards**

Imbo (1998) observes that debates about a ‘question of African philosophy’ have mostly dealt with the nature, definition, and justification of African philosophy.

Evidently, the following questions have been addressed:

1. How is African philosophy to be defined?
2. Is ethnophihosophy really philosophy?
3. What are the implications of ethnophilosophy?
4. Is African philosophy unique?

My interest in this debate is in the lessons to be drawn from discussions around ethnophilosophy. I will not deal directly with other issues. The term ethnophilosophy is used here to refer to attempts that have been made at ‘doing an African philosophy’. Imbo (1998, p. 53), observes that “it is a term coined by opponents of the group of poets, philosophers and anthropologists who look for African philosophy in the cultures of the different peoples”. The term is meant to refer to some kind of “descriptive anthropology” or “collective values of people”. For a better understanding of ethnophilosophy, a brief historical context is provided.

There was a time when academic discussions on matters of knowledge[s] occurred solely in terms of European and/or North American theorizing and experience. The earlier intellectual climate was influenced by the philosophical speculations of influential Western philosophers, such as Kant, Hume, Nietzsche, Schopenhauer and Hegel, with their postulation that Africans lacked logic and abstract reasoning, and by the work of Levy-Bruhl on the “primitives” (Irele, 1993).

Levy Bruhl was highly insistent on the notion that “primitive” (pre-logic mentality), a label commonly used for non-Europeans before the twentieth century, lacked a special
endowment of reason and logic, and therefore did not have a philosophy, a science, and/or a great civilization. Although Africa was Levy Bruhl’s favourite target for theorizing about the primitive, he never travelled to Africa. Instead, he based his knowledge on romantic accounts of travellers who wrote exciting notes about adventures in a strange and exotic land (Mudimbe & Appiah, 1993; Oruka, 1987, 1990). It is notable that it was in this climate of negating the African that Leopold Senghor proposed an ‘alternative view for the African’: that “Emotion is African as Reason is Hellenic” (Prah, 1997).

Senghor proposed and championed a philosophical movement, *negritude*, that aimed to reassert the value of being black. The reassertion was that “Africans were different from but not inferior to Europeans” (Imbo, 1998, p. 12); that their essence was in “reason of participation” and “intuitive reason”; “while European thought is characterized by its rationality (that is, a heavy emphasis on logic, reason, and ‘science’), Negro life emphasizes emotion” (Imbo, 1998, p. 82).

Imbo (1998) goes on to say that Senghor’s assertions, if taken out of their context, are very misleading. Taken out of context, they would imply that Senghor and his followers were endorsing the racist labels pinned on Africans, such as the primitive (pre-logic) mentality of Levy-Bruhl (Prah, 1992). Arguably, Senghor’s project did not aim to endorse these racist labels. Indeed, Imbo (1998, p. 82) suggests that the best way to understand Senghor’s project is to see it as an “accommodation by which he intends to counteract the preoccupation of Europe with difference”. Similarly, Irele (1983) and Prah (1997) argue that Senghor, in his assertion, was looking for a distinctive African characteristic based on the popular racial discourses of his time; that is, a racial discourse that pointed to the fact that each culture or civilization has something distinctively different from other cultures.

Thanks to the ever-changing world intellectual climate brought about by formulations of newer grand theories and paradigm shifts in the social sciences (Mudimbe, 1988).
Bruhl’s notions of primitive and other racial discourses are becoming discredited, albeit slowly. There was even a notable change from what Levy-Bruhl wrote in the 1910s to what he wrote in the 1940s (Mudimbe & Appiah, 1993). This change is explicable through the “progressive disintegration of evolutionist and reductionist models” and the onset of “Malinowski’s functionalism and Levi-Strauss’s structuralism”, which altered the framework within which anthropologists were writing, bringing notable changes to writings on and intellectual life in Africa. Not surprisingly, when Marcel Griaule (1965) and his followers applied the new theories to central Africa, the outcome was a new reading of African realities, including the recognition of African philosophy.

This undermining was done, unwittingly, by Father Placide Tempels (1959). Tempels, a Belgian missionary practicing in Rwanda, unwittingly opened a radically new possibility for African studies by implying that Africa had a philosophy. Recall that just a few decades earlier, other philosophers had denied this possibility. The title of his book, *Bantu Philosophy*, was more provocative than his ontological analysis of some features of Bantu language. Although Tempels’ (1959) project was motivated by the need to acquire a deeper understanding of the spiritual, intellectual, and emotional dispositions of the Bantu, in order to enable the missionaries easy access and manipulation of the people, it had far reaching significance for Western perceptions of African thought (Imbo, 1998). As Irele (1983, p. 17) observes,

...the concessions which Tempels’ had to make were on such a scale as to imply the total recognition of the African mind in its own individuality. Hence Tempels’ work registers, despite the paternalistic tone of its expression, a decisive break with the ethnocentric emphasis of classical anthropology.

**Ethnophilosophy**

What is common about Tempels’s, Senghor’s and Griaule’s projects is that these works looked for philosophy in *cultural materials*. Tempels’ theory claimed that there is
a unifying factor, among Africans, in the form of a “vital force” (Irele, 1993). Senghor claimed unity in values and intuitive disposition, while Griaule underscored Tempels’s claims by arguing for the existence of a “vital force” in Dogon social and cultural features (Imbo, 1998). Some examples of other frequently cited works that have used cultural materials in the study of African philosophy are Cheikh Anta Diop’s (1974) *The African Origin of Civilization* and W.E.B. DuBois’ (1977) *Africa, Its Geography, People, and Products: and Africa, Its Place in Modern History*. It is notable that these classic works focus on African cultural material. In this respect they may be classified as ethnophilosophy. A particularly controversial ethnographic text is John S. Mbiti’s (1997) *African Religions and Philosophy*. Mbiti uses religion and other cultural features and concepts, such as time, to discuss African philosophy. For an extensive discussion on ethnophilosophical texts, see Imbo (1998).

Imbo (1998) observes that the trouble with ethnophilosophy is in being a “response to Europe”, a response to the ‘otherizing of Europe’. Therefore, doing ethnophilosophy is allowing one to be defined by one’s opponent, by Europe; it is essentializing cultural materials in response to European definition of who Africans are. It is seeking to establish a different, distinct, and unique humanness for the African from the rest of humanity. In other words, it is an exclusionary methodology and practice. Moreover, ethnophilosophy does not address itself to the human condition in Africa. It thrives on the status quo by maintaining silence on the issue of gender and the plight of women, and by using existing symbols, myths, and artifacts even when they denigrate women (Imbo, 1998). It is noteworthy that Mbiti (1997, xiii) has referred to this issue in the preface to the second edition of his classic: *African religions and philosophy*.

Ethnophilosophy has come under severe attack, especially from philosophers who use a universalist (mainly Eurocentric) approach. These philosophers have asserted that philosophy as a discipline originated in ancient Greece and, therefore, is a Western
tradition (see Theron, 1995). In accordance with Western traditions, philosophy should be involved with speculative exercises of the mind, by use of reason and logic (Hountondji, 1983). Hountondji is an ardent critic of ethnophilosophy and, in fact, has advanced the opinion that there is no such thing as "‘African philosophy’, just Africans engaged in the philosophical enterprise" (Imbo, 1998, p. 86). His line of argument is that, since systematization of philosophy to the level of a discipline is a tradition of Europe, any study of philosophy anywhere must be based on the tradition and standards of European philosophy (Bernasconi, 1997; Irele, 1983; Janz, 1997; Makang, 1997), and one such standard is ‘the written’. According to Hountondji (1983), since Africa does not have a writing tradition (he is silent on existing writing systems like the Ethiopian Writing System, see Bekerie, 1994), and the tradition of philosophy is such that it should be based on the written word, there should, therefore, be no claim to an African philosophy (Serequeberhan, 1997; Wanjohi, 1997). Consequently, a philosophical discipline in Africa is expected to align itself with the practice of philosophy in Western traditions, although there is no consensus on what may constitute, for the purposes of an African philosophy, acceptable and amenable elements of Western traditions (Oruka, 1987).

There is consensus, however, that an African philosophy should impact on the current human condition in Africa, while not being assimilated or congruent with it (Oruka, 1990; Prah, 1997). African philosophy should aim to liberate people. But, how can it liberate without altering the ‘standards’ of philosophy? Indeed, we have been made to believe that philosophy is about abstract reasoning and logical speculations and not ‘liberation’ projects. We have been made to believe that philosophy is a purely intellectual exercise of the mind and not a political tool (Serequeberhan, 1997).

African philosophers are divided on this issue. But, most are in favour of redefining ‘standards’ of philosophy in order to provide for an African reality (Imbo, 1998; Irele, 1993; Serequeberhan, 1997). Those who support the view that philosophy should have an
impact on the current human condition in Africa (Hountondji, 1983; Oruka, 1990; Prah, 1991; Serequeberhan, 1994; Wanjohi, 1997; Wiredu, 1996) are, at the same time, concerned with the history of ‘intellectual wars’ that Africa has always had with Europe. They maintain that it is important, at this point in time, to be vigilant about the ‘negative other’ invention of Africa by Europe. Hence, if philosophy in Africa is to evoke a different meaning from its meaning in Europe, we have to be careful what that ‘difference’ is, and take cognizance of its implications. In view of such implications, Hountondji (1983, p. 10) observes that:

...words do indeed change their meaning miraculously as soon as they pass from the Western to the African context, and not only in the vocabulary of European or American writers, but also, through faithful imitation, in that of Africans themselves. That is what happens to the word ‘philosophy’: applied to Africa, it is supposed to designate no longer the specific discipline it evokes in its Western context but merely a collective world-view [emphasis added], an implicit, spontaneous, perhaps even unconscious system of beliefs to which all Africans are supposed to adhere. This is a vulgar usage of the word, justified presumably by the supposed vulgarity of the geographical context to which it is applied.

However, most African philosophers argue that Hountondji’s (1976/1983) definition of philosophy is limiting. Moreover, they find it contradictory that he is, at the same time, supportive of the idea of a philosophy that concerns itself with the real life situations of people, that is, an African philosophy that would serve, in a political sense, to liberate Africans by “integrating individual reflection on African material” (Irele, 1983, p. 22). Also, critics say that his overemphasis on Western standards, especially the aspect requiring philosophy to be written, leaves little room for the project of liberation he advocates (Oruka, 1990; Serequerberhan, 1994).

He also has failed to realize that philosophy, like any other discipline, is a human construction that has been influenced by individual circumstances, historical conditions, and communal aspirations (Mudimbe & Appiah, 1993). He fails to realize that the ‘universalistic’ view of philosophy is basically Eurocentric philosophy and that the
‘traditions’ he refers to are essentially set out by the Europeans. On this point, Mudimbe (1988, p. ix) states that “discourses have not only sociohistorical origins but also epistemological contexts”. It follows that philosophy created by an individual cannot be isolated from the circumstances in which that individual was at the time. This assertion renders problematic the divisions between written and oral philosophy, individual reflection and communal knowledge, and the relegation of some to legitimate knowledge and others to ‘illegitimate’ knowledge (Wiredu, 1996).

Others argue that Hountondji (1983) has not investigated how best to use cultural material in ‘modern’ thought (Prah, 1997; Serequerberhan, 1994; Wiredu, 1996). In addition, he fails to realize that an overall framework of African educational thought that is said to be communal does not negate the expression of individual thoughts, or the existence of individuals who can be said to be more reflective and speculative than the common folk. His lamentations overlook the benefits of ‘positive’ ethnophilosophy (Wanjohi, 1997), a notion that will be discussed later.

Unlike Hountondji (1983), other so-called professional philosophers have used “total cultural experience as a legitimate province of activity for the African philosopher” (Irele, 1983, p. 29). They have attempted to use cultural material differently by being critical of the materials and the socio-historical contexts in which these materials exist. Henry Oruka’s (1990) *Sage Philosophy*; Gerald Wanjohi’s (1997) *The Wisdom and Philosophy of the Gikuyu Proverbs: the Kihooto World-view*; Kwasi Wiredu’s (1996) *Cultural Universals and Particulars: An African Perspective* are some examples of such works.

Wanjohi (1997) advocates the use of *some distinguishing aspects of African life*, particularly those to do with myths, religion, proverbs, and so forth. By so doing, he redefines ethnophilosophy, citing his own attempt to analyze specific Gikuyu proverbs and to show their ontological meaning, as part of this redefinition. Positive ethnophilosophy is “what the philosopher’s searchlight unearths, when beamed on
cultural matters” (Wanjohi, p. 88). It may be written or oral, and is not to be identified with a people’s world view or with each and every belief of the culture. Such gives rise to African philosophy, American philosophy, and so forth. Negative ethnophilosophy is the “collective, spontaneous, non-reflective, and largely implicit world-view to which all traditional Africans are supposed to subscribe” (Wanjohi, p. 88). In negative ethnophilosophy, lack of critical reflection on beliefs, problems or situations is implied. Consequently, a study of philosophy consists of tackling other cultural phenomena, like religion, in the style (perhaps) of John Mbiti’s (1997) African Religions and Philosophy and Tempels’ (1959) Bantu Philosophy.

Also, Wanjohi (1997) refutes the position that individual reflections are more representative of philosophy. Although it is true, he says, that a few individuals may exercise critical faculties better than the average folk, “the subject matter to which they direct their thoughts is known by everyone else in the community or society” (p. 90). In any case, proverbs may have originated with one intelligent individual before they became known to everyone and acquired commonsense status. However, he does not lose sight of standards (1997, p. 79):

If philosophy is about rationality, then let that rationality be unqualified. Exclusiveness and particularity should be left to culture, not philosophy …for me, if a person of whatever race is a rational animal, then the battle of philosophy has to be fought on the field of reason in its unqualified sense.

This view is also held by Serequeberhan (1994).

Note that Wanjohi’s (1997) statement of ‘rationality’ is of similar logical consequence as Hountondji’s (1983) on ‘written’ philosophy (as discussed above). Wanjohi, therefore, brings us back to the issue of whether specific materials may be regarded as philosophy, or as formal knowledge for that matter, if they do not satisfy the criteria of Western standards. Thereby, it raises the issue of whose knowledge is ‘worth knowledge’?. Who decides which is ‘worth knowledge’ and which is not? These concerns parallel those
raised in the ‘feminists’ critique of science’ with regard to binary divisions, such as subjective/objective, and the relegation of illegitimate knowledge to the ‘subjective’ and legitimate knowledge to the ‘objective’. Several related arguments are made by feminists in a critique of science (See Gilligan, 1982; Harding, 1997; 1997; Mohanty, 1991; Spivak, 1997)

Oruka’s (1990) work, *Sage Philosophy*, is based on extensive research with “philosophical sages” who were prompted by him to speculate on various of life’s phenomena. He reports how these sages articulated and critiqued many previously unexamined beliefs and attitudes available to common folk: the kind of unexamined beliefs and attitudes ethnophiologists call philosophy. Sage philosophy, he says (p. 28), consists of the

...expressed thoughts of wise men and women in any given community and is a way of thinking and explaining the world that fluctuates between *popular wisdom* (well known communal maxims, aphorisms and general common sense truths) and *didactic wisdom*, an expanded wisdom and rational thought of some given *individuals* within a community. While the popular wisdom is often conformist, the didactic wisdom is critical of the communal set-up and the popular wisdom. [emphasis added]

Wiredu (1996) has also contributed to this work through his extensive study of Akan concepts. Arguably, Wanjohi, Oruka and Wiredu are in agreement with Prah’s (p. 22) assertion that “African writers should not simply assimilate their past and culture, they should own it, stand in it, and use it as a basis for contributing to the universal human fund”. The way to do this is to make full use of cultural capital, that is, by examining our past and present, written or not, carrying forward what is desirable and discarding what is not. Imbo’s (1998, p. 72) observation is timely here:

The lesson from all this, and the answer to the question of whether ethnophilosophy is really philosophy, seems to be that whether philosophy should be written or unwritten, modern or traditional, depends with the values with which one starts out. Philosophical thought can be measured on one scale by gauging its perceived usefulness. ... A lesson of the ethnophiologists is that the traditional thought may hold important lessons for contemporary society.
This approach sets the framework for my fieldwork. I will now briefly pay attention to pertinent subtleties in the debate about African philosophy.

**Colonial engendered possibilities and limitations.** From the preceding discussion, it is not clear how ‘standards’ may be redefined. If anything, these discussions have served to depict the difficulties therein. What has been clarified, however, is the nature of the tensions, the kind of tensions (mentioned earlier) that inhere in any project that tries to embrace both the schooled and the indigenous.

Let me try to further elaborate on the limitations and tensions by using the notion of “otherness” and “sameness” as exemplified by Mudimbe (1988). The tension between “otherness” and “sameness” is aptly delineated in Mudimbe’s (1988) *The Invention of Africa: Gnosis, Philosophy, and The Order of Knowledge*, where he uses the work of Tempels (1959) to illustrate these contradictions. (Tempels’ ethnophysics work was mentioned earlier.)

Mudimbe notes Tempels’ (1959) interesting contradictions. For instance, Tempels “granted” a philosophy to the Bantu even though his goal was to enable the colonial master to penetrate the psychology of the Bantu for easy colonization. Thus, he treated the Bantu as the “other” while also claiming that they had a philosophy, just like the Europeans. In that respect, he bore witness to some “sameness” with the European. Mudimbe (p. 8) says that “sameness” is “signified by the white norm”. A similar notion underpinned “the justification of biblical same origin for all human beings and the relegation of slave position to the African:...a negative category of the same”.

Mudimbe (1988) also uses sixteenth century and seventeenth century European paintings of Africans to illustrate the concept of “otherness” and “sameness”. In these paintings, he argues, the artists depicted virtues of resemblance. They represented “blackened whites” -- an image with caucasian features, but black skin; Italinized African women; and so on. He goes on to say that “it is double representation when the nativeness
(that is, adornment with or presence of associated cultural artifacts) of the subjects is also captured in the same picture as is the blackened whiteness”. Mudimbe sees the representation contradictions as a result of trying to integrate difference, within the framework of “otherness”.

As the debate on African philosophy rages on, the ghost of “otherness” continues to make it difficult to come to conclusions.

This “Other” has many forms .... The question remains, though: how do we get past the tyranny of the Other constructing African philosophy, and allow African philosophy to construct itself in dialogue with its own Other? (Janz, 1997, p. 236)

Janz (p. 236) has offered a working ‘resolution’: “African philosophy is the repetition of Africa itself, and also the subversion of any simple recollection”. This, too, is an appropriate definition for an African science, and any other schooled knowledge.

In this recovery process, people have turned to interrogate local knowledges, such as indigenous knowledges. Indigenous knowledges provide a fertile ground for construction of ‘African’s own Other’. They could be used to develop alternative frameworks which may be used to interrogate our visions of schooled knowledges.

Attempts to redefine the ‘standard’ within feminists’ theorizing, too, have led to proposals for a ‘revised science’, that is, a feminine science.

**Feminists’ Frameworks**

In the title above, I have used the term “feminists” instead of “feminist”. This is because there are known to be many frameworks within the women’s movement. In fact, the correct reference to the women’s movement is feminisms and not feminism (Larbalestier, 1990; Mohanty, 1991), as I intend to clarify. Although ‘feminism’ may be used and has been used in a generic sense, such usage creates a danger of essentializing women’s experiences (Mikell, 1995). Essentializing would be contrary to the philosophy of most feminists’ theorizing. It would be reverting to the belief that there is such a thing
as true, universal and objective knowledge. In Chapter Three I argued that the belief in a true, objective and universal knowledge is informed by erroneous notions of SS that have persisted, as myths, through school science and popular media.

Central to most feminists’ epistemologies is a consideration of diversities and differences inherent in physical and social phenomena. Feminists’ theorists have learned the lesson of diversity and difference from attempts to use women’s experiences as the basis for knowledge building. Earlier theorizing attempted to use a ‘typical woman’s’ experience (Amadiume, 1987; Mohanty, 1991). These attempts failed and feminists now maintain that there is no such thing as a ‘typical woman’s’ experience (Aida, 1996; Emberley, 1993; hooks, 1981, 1984; Mackenzie, 1990; Mohanty, 1991; Robertson, 1978). In themselves, women’s experiences are as diverse as women. Even when they are grouped as African-American, professional women, Aboriginal women, White women, working class or Asian women, there are all kinds of divisions within these groups in terms of how particular individuals define themselves.

This definition is merely a prioritizing on the basis of one’s context (historical, political, cultural, economic, religious, and so forth). For instance, some women may see gender simply as male/female relations and a basis for equal rights (Mackay, 1994; Mikell, 1995). Others may wish to broaden the liberation struggle to engage race, class and other human rights issues (James, 1994), and at the same time embrace the various demands of culture, such as seniority (Oyewumi, 1997) and motherhood (Haraway, 1991; James, 1991). Further, these feminists have pointed to the fact that gender or the male/female dichotomy is not a universal problem. In fact, it is a characteristic of European thought that is perpetuated by the privileging of the visual over other human senses, such that what is visible to the eye, for example the body, forms the basis of social organization and thereby, knowledge production. Arguably, to overcome the gender problem in SS, indigenous theorists may have to integrate ‘vision’ with other human
senses and refocus knowledge production from the "gaze of the physical" to an 'embrace of the cosmos'. In Chapter Eight I will discuss modes of knowledge production that attempt to 'embrace the cosmos'.

Other lessons on diversity and difference have been drawn from work in the physical sciences, such as Barbara McClintock's attention to diversity among corn cob kernels, and research work in primatology where extensive diversity among primate groups has been documented (Haraway, 1989; Keller, 1985, 1989). Consequently, feminists' epistemologies reject theories that claim to be 'objective' or to know 'the truth' or to be 'universal' (Longino, 1990). Thereby, feminists' epistemologies have freed themselves, gradually, from the legacies of logical positivism (Aída, 1996; Amadiúme, 1987; Emberly, 1993; Harding, 1996, 1997; Mackenzie, 1990; Mohanty, 1991; Oyewumi, 1997; Robertson, 1987).

Given the understanding that there are no 'standard' discourses, feminists have tried to explain, understand, and redress girls' underachievement in SS and women's under-representation in the 'scientific' workforce. The majority of feminists' scholars favour a non-sexist approach within the 'scientific' enterprise. For instance, they aim to correct stereotypical depictions of women in science by providing data on the contributions of women to science, both current and ancient, and by rewriting school textbooks to displace the image of the male as the ideal scientist (Ogilvie, 1986). Their main concern is the low numbers of women in science and the low enrollment of girls in science subjects, together with those teaching methods and teacher behaviours that discourage girls from pursuing science (Kelly & Smail, 1986; Woodhouse & Ndongko, 1993). As argued above, several feminists see the problem of gender as specific to European thought (Oyewumi, 1997). Admittedly, its pervasive influence in science education is a consequence of the dominance of Eurocentric frameworks in formal discourses (see Chapter One).
Many feminists have refused to take the nature of science for granted (Harding, 1997; Oyewumi, 1997; Rose, 1994). For instance, Keller’s (1985) analysis of the basic structures of SS point to the fact that the very basis of SS was inspired by the need to conquer and dominate nature (see Oyewumi, 1997, in another context). The argument is that women are less likely than men to dominate, and therefore may find many elements of science unattractive (Easlea, 1990), as discussed below.

Yet another group of feminists have used poststructuralist and postmodern feminists’ discourses to problematize the way ‘scientific’ knowledge is formulated. Extreme radical revolutionaries propose a complete rejection of ‘science’ and/ or its replacement with a radically different science. This, Keller (1985) says, is an “enemy chorus” that is bent on looking at science as ideology and not as an intellectual pursuit. Moreover, this trend does accommodate difference and diversity, and so is just like the science it is rejecting. Keller proposes, instead, a science that “allows for the productive survival of diverse conceptions of mind and nature, and of correspondingly diverse strategies” (p. 178; see also Oyewumi, 1997).

A popular trend has been to draw “attention to experimental biases, flaws in experimental design, and overinterpretation of data which occur in the 20th century areas of research” (Rosser, 1989, p. 6) and to analyze “ways in which biologically deterministic arguments have been used to limit women and justify our socially inferior position in society” (Rosser, p. 6) Such in-depth analysis has pointed to the need for feminists’ science. Feminists would, in knowledge constructing, take into consideration biologically and socially determined gender traits (Haraway, 1991). It is argued that feminine traits, if legitimated, may make ‘science’ more accessible to women.

Such feminists’ theorizing is supported by studies in history, philosophy, and the sociology of science (Feyerabend, 1975, 1978). These studies show that the theoretical frame of science, which emphasizes generalization, determinism, and rationality, is an
assumption from which, given experiences in quantum physics, SS has had to free itself (Prigogine & Stengers, 1984). School science curriculum and the media have fallen far behind such developments. The school science curriculum, in particular, continues to promulgate stereotypical and erroneous images of science.

Other socio-historical analyses of science have shown that the theoretical assumptions promoted by school science are really the ideal of science, not its reality (Kuhn, 1970). Therefore, the questions asked, the answers considered acceptable, and the methods of achieving these answers are influenced by the socio-cultural environment in which scientists do their work (Feyeraband, 1978; Harding, 1993; Hodson, 1998; Kuhn, 1970; Longino, 1990; Smolicz & Nunan, 1975).

**Gender and the Construction of ‘Scientific’ Knowledge**

As previously discussed, male biases and discrimination against women are intimately linked to the epistemology of scientific thought, both historically and progressively (Keller, 1985, 1989). It is said, for instance, that Aristotle (Plato’s student and a direct influence on the development of SS) had little patience with positive views on women. (Note that Socrates and Plato had previously expounded ideas on equality between men and women and had attacked Athenian beliefs that endorsed the subjugation of women.) At the time, it was believed that “femaleness should be considered a deformity though one which occurs in the ordinary course of nature” (Ogilvie, 1986, p. 4). As Easlea (1980, p. 242) notes, “mind would not triumph over matter if ... lower feminine passions as women represented were allowed to gain the upper hand over the new philosophy”.

Negative views on women were cemented by the early Christian doctrine and the theories of prominent philosophers such as Hume and Jean Jacques Rousseau, among others. Rousseau is on record as having referred to women as “weak, sensuous and accommodating” and recommended that “women’s training should accentuate those
qualities which prepare her to serve her male counterpart" (Ogilvie, p. 16). In current thinking, it is agreed that such attributes are learned, that women are not genetically endowed with them, but instead socialized into them. For instance, the reason why women are more predisposed to loving and feelings than men are has been linked to early childhood socialization.

Using ideas from psychoanalysis and cognitive science, Keller (1985) has suggested possible ways in which women develop an affinity for feelings, and men acquire an affinity for abstract reasoning. She argues that those predispositions are acquired at an early stage of our development. Thus, predispositions are gendered, that is, we are socialized into them. Later, they show up as gender specific knowing: women’s ways of knowing versus men’s ways of knowing. Of course these are broad generalizations, and it does not mean that each and every individual develops an affinity for feeling, loving and abstract reasoning through the means described by Keller. She is only giving a likely explanation of why men and women, girls and boys, end up with different predispositions.

Keller (1985) continues to argue that, as infants, we identify overwhelmingly with our mothers. As we grow older, however, there is a need to detach in order to develop our individual identities. Usually, in a traditional family set-up, the other person we know closely is our father. However, our fathers are emotionally distanced from us, given child-rearing practices that entrust fully the child to the mother. Consequently, we see in our fathers an individual who is objectively distanced from us. Our consuming desire, then, is to attain detached independence like the one we see in our fathers. With time, we begin to associate maleness with detached objectivity. As they grow older, boys increase their zeal for objectivity, while girls fall back to ‘emotional attachment’, because of the need to model their personalities on older women (‘mothers’) who embody attributes of emotions
and feelings. These early inclinations are strongly supported by cultural forces, which encourage boys to engage in abstract reasoning and girls not to.

For all of us, male and female alike, our earliest experiences incline us to associate the affective and cognitive posture of objectification with the masculine, while all processes that involve blurring of the boundary between subject and object tend to be associated with the feminine. [emphasis added] (Keller, 1985, p. 87)

Keller’s (1985) analysis gives an indication of what to look for when formulating feminists’ theory of science. Maybe feminists will have to look for “blurring of the boundary between subject and object” or, as suggested by Oyewumi (1997 in another context), feminists will have to problematize the issue of the “body”. Oyewumi argues that, in current theorizing, much attention is directed to what is seen with the eye, that is, “the gaze of the physical”. Little or no attention is given to other human senses; this encourages and perpetuates an over-valuing of what is seen or of ‘the physical’.

Subsequently, problematic dichotomies are created, such as the male/female and subjective/objective. In fact, as suggested in recent feminists’ theorizing, “the central ideas to a feminist science might be the rejection of dualisms such as subjectivity/objectivity, rational/feeling and nature/culture” (Rosser, 1989, p. 10). In other words, this might be a science that operates with a new notion of objectivity (Haraway, 1991, p. 191):

Objectivity ... [that is not about] dis-engagement, but about mutual and usually unequal structuring, about taking risks in a world where ‘we’ are permanently mortal, that is, not in ‘final’ control. We have, finally, no clear and distinct ideas.

Haraway (1991) further observes that this kind of objectivity is situated and embodied; it is contextualized, just like the knowledge it engenders. That is, there in no such thing as ‘detached’ objectivity. Consequently, there is no possibility of a logical division between subjectivity and objectivity; nor of any other dichotomous pairs, such as feeling/reason, emotion/intellectual, and nature/mind. Traditionally, one member of these
pairs has been relegated to an inferior position, while the other has been considered superior. For instance, objectivity has been considered a better measure of reliable data than subjectivity. Feelings have been relegated to an inferior position, while reason is regarded as a source of admissible facts, and so on.

As sources of data, these dichotomous pairs have resulted in legitimate (facts) and illegitimate (opinion) genres of knowledge. Because, on average, women show their emotions more often than men do, it is concluded that they are less likely to build objective knowledge. Subsequently, men are encouraged to participate in scientific endeavours, while women are discouraged. Note that objectivity and reason are believed to have initiated, built and enabled the progress of SS (Easlea, 1990).

Feminists' critiques of science, therefore, grapple with such questions as: How much of the nature of science is bound up with the idea of masculinity? What would it mean for science if it were otherwise? What is the relationship between gender and science in its historical, political, social [HPS] contexts? (Keller, 1985; see also Jaeger, 1987). The epistemological ramifications of the historical, philosophical and social contexts of science are such that Popper's (1968) description of scientific endeavour as "silent, systematic, and closed within itself" is refutable.

As Kuhn (1970) has shown, there is an internal logic implied by a "silent, systematic, and closed" system, but this logic supports the progression of a "normal science", with its accumulative characteristic. However, most celebrated discoveries or "scientific revolutions" (to use Kuhn's term) cannot be explained exclusively through the power of experimentation, verification or refutation of theoretical conjectures within a "silent, systematic, and closed" system. Keller (1985, p. 5) has denounced the existence of a closed system, stating that "above and beyond empirical evidence and theoretical necessity", there are always extra-scientific factors which influence the process of
science. She concludes that science is not entirely impersonal. Rather, it is a personal and social activity.

A further advance in the feminists’ critique of SS has been facilitated by the notions of “difference” and “multiple subjectivities”. These are postmodern analytical tools that enable theorists to work with nontraditional data sources and standards. Dickens & Fontana (1994, p. 6) say that postmodern methods of analysis ... reject the assumption of stable referents upon which the notion of underlying structure is based”. That is, meanings and standards derived from referents such as patriarchy, gender, women, and men are arbitrary and relative to the particular social structure. Admittedly, these meanings and standards can stand only as working tools for the advancement of knowledge, and not as indisputable yardsticks for categorizing (Haraway, 1991; 1997; Keller, 1985).

In the absence of strict adherence to standards and grand narratives, it is possible to envision a boisterous creativity of knowledge, where each idea or theory is judged according to its particular history and context, in contrast to the traditional practice of judging all knowledge claims against one standard. Thus, feminists’ analysis has enabled the demystification of the positivistic tenets of objectivity and, thereby, the universality of scientific knowledge. The challenge now is to formulate and recapture alternative knowledge genres that do not derive their worth from claiming to be objective and universal (Keller, 1989, Ginzberg, 1989).

**Gender Issues In Science Education**

Rosser (1997, p. 3-4) characterizes the development of research and theorizing on gender issues in science and mathematics in terms of six stages.
Stage 1. Absence of women not noted. This is the traditional approach to science and the curriculum from the perspective of the white, Eurocentric, middle-to-upper-class male. The absence of women is not noted, it is assumed that gender affects neither who becomes a scientist nor the science produced.

Stage 2. Recognition that most scientists are male and that science may reflect a masculine perspective on the physical, natural world. A few exceptional women such as Nobel laureates who have achieved the highest success as defined by the traditional standards of the discipline may be accepted in the scientific community and included in the curriculum.

Stage 3. Identification of barriers that prevent women from entering science. Women are recognized as a problem, anomaly, or absent from science and the curriculum. Women may seem as victims, as protesters, or as deprived or defective variants, who deviate from the white, middle-to-upper-class norm of the male scientists.

Stage 4. Search for women scientists and their unique contributions. The extent to which the role of women has been overlooked, misunderstood, or attributed to male colleagues throughout the history of science is explored to determine women’s scientific achievements.

Stage 5. Science done by feminists/women. In this phase, new perspectives result when women become the focus. Topics chosen for study, methods used, and language in which data and theories are described may shift and become expanded, changing the nature of science.

Stage 6. Science redefined and reconstructed to include us all.

Several factors contribute to gender disparity in science. These will be grouped into two domains, that is, biological and social. The social domain is further divided into formal and informal settings.
**Biological Factors**

There is a long standing belief that girls, unlike boys, have a low aptitude for abstract reasoning, visual-spatial, and analytical abilities that engender an affinity for science, math related disciplines and computers (Bernhard & Nyhof-Young, 1994; Bleir, 1984; Hubbard, et al., 1979; Keller, 1985; Oakley, 1972; Piburn & Baker, 1989; Rosser, 1988; Sayers, 1982). This belief was once backed by "scientific findings", which showed that women have smaller and lighter skulls than men. Even recent cognitive-gender-difference studies claim that female and male brain hemispheres (right and left brains) are qualitatively and quantitatively different. These hemispheres are associated with "complex, conscious, and associative cognitive processing" necessary for science, although there is no consensus with regard to the use of concepts such as "spatial ability", or even suitable experimental designs for studies on cognitive gender differences, and little knowledge on brain functions (Kotte, 1992).

The dominant theory holds that males process visuospatial information predominantly with the right hemisphere while females (i.e., girls and women) are said to use both hemispheres more symmetrically. In the absence of any evidence whatsoever, this dominant theory assumes, for obvious reasons, that right hemispheric lateralization of the processing of visuospatial information is superior to bilateral hemispheric processing of such information. (Bleir, 1988, p. 94)

The belief is reinforced by centuries-old cultural norms and practices (Chodorow, 1976). In some cultures women were always relegated to inferior positions. Women could not own property, or participate in the public domain; wife beating was conducted with impunity; there was "apparent" control of female sexuality through circumcision, dress codes, behaviour codes, and so on (Etta, 1994).

Arguments for biological predisposition and cultural norms have been dispelled by findings that show women have a high achievement in math-related disciplines, science and computers, when properly encouraged (Bernhard & Nyhof-Young, 1994; Harding & Apea, 1990). Kelly and Smail (1986), for instance, found few sex differences in cognitive
tests taken by 2,065 eleven year olds. In the GIST project, a major schools-based action research project in Britain involving 1,700 pupils ages eleven to seventeen, interventions such as minimizing sex stereotyping in instructional strategies and materials, and providing role models, significantly improved girls’ attitudes towards science (Smail & Kelly, 1984; Whyte, 1986).

Where educational policies have aimed at promoting women in science, the achievement and performance of women has improved (Leder, 1990). Also, parental role is crucial. As illustrated by one of the women in Harding and Apea’s (1990, p. 19) study on women scientists and technologists: “he [father] used to tell us that he gave us [5 girls and 3 boys] education because that was all he could give us, he was not a wealthy man, so if we could take that we could use it for our future, ... so long as he could pay for our education he expected us to do what we could - both girls and boys”. Another woman said that her parents treated the girls and boys in the family alike, and this engendered her positive attitude to school subjects: “all those around me took it for granted that whether you were a boy or a girl you were supposed to do the very best you could” (Harding & Apea, p. 95).

**Social Factors**

**Formal settings.** Schools, by omission and commission, reinforce the deeply entrenched beliefs that women lack the capability for science. In Africa, the following factors have been considered among possible impediments to women’s participation in science: sex-stereotyping in textbooks, teaching methods, and the attitudes of teachers (Eshiwani, 1990); inequality in breadth and quality of curricula provided in girl-predominant schools (Kinyanjui, 1988, 1993; Njuema, 1993); and problematic science pedagogy (Woodhouse & Ndongko, 1993; Harding & Apea, 1990).
In co-education situations, boys are often selectively encouraged to participate in science lessons (Whyte, 1986). Instructional formats that feature asking boys to perform tasks that require more abstract reasoning and analytical skills, while girls are encouraged to work on those that require verbal skills or aesthetics, encouragement of boys to try harder while girls are praised just for trying, and the planning of learning tasks based on competition rather than cooperation have a great influence on the way girls perceive science (Byrne, 1993; Baker & Leary, 1995; Kelly & Smail, 1986; Rosser, 1988).

This selective encouragement starts as early as preschool. Rosser (1988) cites a case where preschool boys were required to go out to gather plants, soil and animals, while girls remained behind to “decorate the terrarium”. Not only were the boys in this case encouraged to be more active and aggressive than the girls, they learned more about the environment, animals, and animal habitats. In other words, the foundations of inequality were laid very early.

The content of science education is also crucial. Predictably, girls are interested in topics that speak to their experiences. For instance, girls in Baker and Leary’s (1995, p. 16) study “wanted to learn about topics that had relevance to their lives”, whether they were in physics, chemistry or biology:

Girls often have affective and altruistic reasons for their choices, stating that they want to help people, animals, plants or the earth. Many of the responses were emotionally charged. On the whole, laboratory-based sciences and the physical sciences in general were rejected because the girls could not make these affective links. The few instances in which the girls chose a physical science career were all based on having experienced that science with a loved one.

There is an indication, too, that relationships are central in the girls’ rating of science. “Relationships which include caring, responsibility, and affective needs, provide the standard by which these girls make judgement concerning science” (Baker & Leary, p. 24). Girls are put off by the image of science as “absolute truth ascertained by value-free, disinterested individuals using entirely objective and reliable methods of inquiry”.

paradoxically a myth that has been perpetuated through science education and popular media (Hodson, 1998, p. 17). Gilligan (1982), Byrne (1993), Morgan (1992), Packard and Wong (1997) and Whyte (1986) point out that girls and women tend to avoid science and technology related professions that take too much time away from important family roles and relationships. It is hard to negotiate the role of mother and scientist. One nuclear physicist put it this way:

You have to organize your family situation to be able to do your own work well, but you have to give the family time, also. I will encourage my daughters to go into science and technology but at the end of the day what will impress the child most is your life. If my daughters find that I would rather study than look after them they will obviously be put off science. On the other hand if they find that I try to make time for them in spite of my busy schedule as a science lecturer, then they may be encouraged to take up science. (Harding & Apea, 1990, p. 113)

There is a great deal of literature that argues that the “masculine image of science” that requires one to adopt an emotional distance from the subject of study is in conflict with the feminine qualities of “warmth, emotion, and concern and involvement with people” (Arditi, 1980; Gilligan, 1982; Whyte, 1986). Other studies support the view that a consideration of affect, complexity, interaction, and holism is central to the ways in which women appropriate knowledge (Belenky, et al., 1986; Keller, 1985; Noddings, 1992).

Yet caution is also needed when using so-called “feminine traits” to argue for a “girl-friendly science”. Longino (1989) argues that an uncritical advocacy for the inclusion of feminine traits in science may be mistaken for “soft-misdescribed and non-mathematical” science. Instead, she says, feminists should “focus on science as practice rather than content, as process rather than product; hence, not on feminist science, but on doing science as a feminist” (Longino, p. 47). Similar views are expressed by Haraway (1991) when she argues for a successor science. This is a science that is not based on ‘distanced
objectivity' but on situated, embodied or contextualized objectivity. This kind of science acknowledges its biases.

These points by Longino (1989) and Haraway (1991) make for very interesting observations when linked to Wanjoji's (1997) and Serequerberhan's (1994) views (see earlier in the chapter). Although they favour the redefinition of philosophy, they do not lose sight of 'the standards' in this abstract reasoning. It is interesting to note that these same philosophers strongly dissociate themselves from Hountondji's (1983) call to maintain, in African contexts, standards of Western philosophy. Wanjoji and Serequerberhan wish to maintain 'some standards', but not all standards. Whereas Houndondji leaves no room for negotiation, the other two philosophers posit that only 'some standards' need be maintained. Notably, these arguments and counter-arguments make sense in the light of Mudimbe's (1988) theory of "otherness and sameness" (see earlier in the section, 'Colonial Engendered Possibilities and Limitations".

**Informal settings.** Informal settings are fostered by family, media, peers, and by cultural norms and socio-economic status. A study in which parents were told to describe their newborns, within twenty four hours of birth, showed that parents described girls with feminine characteristics (softer, with fine features, smaller, more attentive) and boys with masculine characteristics (aggressive, inquiring, sturdy, bigger), even when there was no qualitative or quantitative difference between the babies. In this case study, the hospital personnel had matched the babies so that there were no "physical and neurological characteristics such as color, muscle tone, reflex irritability" and no "differences between males and females, even in size" (Rosser, 1988, p. 4). Rosser cites another study where eleven women, who believed that males and females are alike at a tender age, were given a toy train, doll and toy fish to offer to a six month old child dressed in neutral colored clothing. Those who were told the baby was a boy offered the
train more frequently. Those who were told the baby was a girl offered the doll more frequently.

These parental attitudes are reinforced by peer pressure during adolescent years, by the media, and at all levels of schooling (Bleur, 1988; Gero, 1988; Kronfeld, 1988; Vetter, 1988). Girls may also acquire the popular image of science from science shows on television. One of the girls in Baker and Leary's (1995, p. 16) study believed that she could not be *Mr. Wizard* (a male character on a British science show) because "I am a girl".

In most cases TV 'science' characters are men, and, if women, have masculine characteristics: as seen in *Miss Frizzle of the Magic School Bus* [this show is aired on Canadian television]. This can be discouraging to girls. The attitudes girls pick up from television or science comics and magazines are reflected in the expectations they have of their peers. A girl who wants to remain feminine, and therefore attractive to boys, will shy away from sciences (Rosser, 1988). Peer pressure is associated with self-awareness and 'correct' role modelling and is very crucial in early adolescence (grades five to eleven).

Peer support for a career in science varied by grade level. Second-grade girls believed that their peers would support them if they chose to become scientists. By the fifth grade, only half the students thought that their friends would support them. In the eighth grade most thought that their friends would not be supportive. However, by the 11th grade, the girls again believed that their friends would support their choice of a science career. (Baker & Leary, p. 17)

Self-consciousness with regard to science may decline at grade eleven, but resurfaces in later years. Rosser (1988, p. 9-10) observes that "the conflict between perception of lack of femininity and major in science was observed to increase at the graduate level, since many women stated the 'fear of not being feminine' as a primary reason for not pursuing study in a scientific field".

In countries where girls are under-enrolled in school there is even a greater chance that they will be under-represented as women in the scientific work force. For instance, in
most of Africa, due to the lack of material resources, parents faced with a decision of which child, boy or girl, to take to school will prefer boys. Girls stay home to help with domestic chores, take care of ill or elderly members of the family or get married (Etta, 1994; Stromquist, 1989). In other contexts, parents are more likely to provide the means for computer literacy class for their sons than for their daughters (Cole & Griffin, 1987). Girls are also likely to be asked to do domestic chores after school. This reduces the amount of time and energy they have for homework (Stromquist, 1989; UNEC for Africa, 1975). Education of sons is seen as economically rewarding because they are more likely than girls to get employed (Stromquist, 1989).

In other instances, girls may not be allowed to attend school because of structural reasons. For instance, if the school is far from home, if there are many male teachers in the school, or it is a co-educational secondary school, the school may be avoided. Parents are mostly concerned with their daughters’ safety. Some of the issues surrounding safety emanate from cultural and/or religious beliefs, for example, maintaining virginity before marriage (Stromquist, 1989; UNEC for Africa, 1975).

**Summary**

I have highlighted numerous epistemological nuances that make it difficult to integrate indigenous knowledges into formal discourse. Drawing examples from philosophy, the things to consider in such integration would be the discipline’s socio-cultural origin, the historical dimensions of its epistemology in relation to African thought; the defining elements which must be included in its integration; and overall, specific implications for the discipline and for the intellectual image of Africa, upon integration. These parameters bring with them possibilities as well as limitations. This is an unavoidable situation, but it can be overcome by paying critical attention to available cultural materials, such as indigenous knowledges.
Critical attention involves “cross-cultural conceptual analysis”: that is, selecting material that is amenable and effective in the light of the epistemological nuances mentioned above. In effect, ‘African science’ may be defined as a critical recollection and assembling of principles and processes of indigenous and ‘foreign’ understandings and explanations of natural phenomena.

In their project of liberation, feminists too have sought to re-define schooled science. They have proposed a situated science: a science that will accommodate paradoxes and contradictions, and thereby lead to an appreciation of a more encompassing account of the world; a science that will ‘view itself’ as part of the existing local knowledges; a science that will view ‘objectivity’ as a partial, embodied and gendered parameter. Such arguments are based on the understanding that schooled science is based on constructs that equate maleness with mind and femaleness with nature. Further, just as mind dominates nature, male dominates female (Keller, 1985). Subsequently, males are in a better position to understand ‘scientific’ pursuits than females are. Moreover, given its nature, that includes “disembodied scientific objectivity”, women are predisposed to find ‘science’ unattractive and unappealing.

I have also attempted to review the literature for other explanations of why girls and women are under-represented and underachieve in schooled science. In this regard, I have considered biological and societal factors.
Chapter Five

Methodology

Preamble

This chapter describes the methods of data collection. Given that part of the aim of my research was to identify indigenous knowledges and skills in a rural context (see Chapter One), I selected data-collecting methods that would allow me to uncover meaning. These are, of course, data collecting methods in the qualitative research tradition, a tradition that Denzin and Lincoln (1994, p. 4) say is committed to "some version of naturalistic, interpretive approach to its subject matter".

The following research tenets are characteristic of the qualitative tradition. This list, which is not exhaustive, is culled from the writing of Hammersley (1992), Merriam (1988), Simons (1989), Stenhouse (1988) and Strauss & Cobin (1990):

1. Selective description guided by personal or professional experience, technical literature, theoretical orientations and continuous data analysis.
2. Number of participants selected sometimes dependent on how well the research question has been answered, and not on a pre-determined number of participants.
3. Aimed at causal or structural patterns of participants' experiences.
4. Mainly used when the researcher is concerned with theory development or uncovering issues in a field of study.

These research tenets describe a research design or a focus of study referred to as case-study (Stenhouse, 1988). My case study is ethnographic in nature. As Merriam (1991, p.23) observes:

...an ethnographic case study ... is more than intensive holistic description and analysis of a social unit or phenomenon. It is sociocultural analysis of the unit of study. Concern with the cultural context is what sets this type of study apart from other qualitative research.
Further, the theoretical underpinnings against which to identify data-collecting procedures are based on alternative frameworks formulated from anti-colonial critique and feminists' approaches. Anti-colonial critique and feminists' approaches were discussed in the previous chapter. Shortly, I will outline the theoretical framework as it pertains to data collection. This is followed by a discussion of ethnographic methods, the techniques and procedures used for data collection and ethical considerations.

**Research Framework**

In this study, decisions pertaining to the “what” and the “how” of the ethnographic methods, for instance, the choice of interview questions, interview settings and the analysis of participants' responses, were based on anti-colonial critique and feminists' frameworks. A fuller explanation of the theoretical framework is provided in Chapter Four. The implications for research are as outlined by Gross (1986, pp. 198-200), that is rejection of a fixed objective reality; rejection of observer neutrality and context independence as unquestioned theoretical values; and rejection of the separation of subject and object (also see Lather, 1986; Smith, 1981).

Given these circumstances, I have used feminists' frameworks to claim the importance of the 'subjective' in theory construction (Barbre, et al., 1989). What I mean by the subjective is any experience that has traditionally been considered personal and not fit for public discourses. An example of public discourse is, for instance, the building of knowledge or theory construction within academia. In contrast, experiences within the subjective realm are predominated by attributes that cannot be measured, quantified or understood through mathematical symbols or statistical analysis (see Chapter Four). As already discussed in Chapter Four, feminists have reconstructed this long standing view such that now the subjective is said to constitute 'worthy knowledge' (Haraway, 1991). With regard to the subjective as a basis for knowledge construction, Haraway (1991)
posits that, essentially, all experience should be seen as particular or subjective, a point from which to build connections and affinities that eventually lead to partial perspectives.

The notion of "partial perspectives" elaborates on the concept of the context-boundedness of knowledge (Whitt, 1991; see also Denzin & Lincoln, 1994), that is, knowledge is limited by the context in which it was produced (the context of the knowing subject and what is to be known); it is situated (Haraway, 1991; Whitt, 1991). Geertz (1973, p.23) also emphasizes the "complex specificity" and "circumstantiality of anthropological findings".

It is worth noting that the notion of partial perspective does not speak to situations of relativism. In fact relativism, like totalization, normalization and standardization, denies the context-boundedness of knowledge (Haraway, 1991). Both accommodate a situation of competing perspectives, but whereas relativism is indifferent to the plausibility of competing perspectives, partial perspectives is not. That is, partial perspective does not endorse the "anything goes" axiom. What partial perspective does is to scrutiny of knowledges for their context-boundedness. The guiding principle is that any knowledge has particular value because of the particular role it plays, the niche it fills. Schwab (1969) stresses this point. When discussing the role of deliberations in curriculum decision making, Schwab underscores the importance of context. He suggests that curriculum decision makers should take into consideration concrete situations, and that any declarations resulting from such deliberations should be seen not as the 'right' ones, but as the 'best' alternatives. Schwab's point is that there is no such thing as a 'right' decision. Haraway (1991) makes a similar argument. She observes that when a particular perspective is endorsed, the people involved in endorsing it state clearly the context of that perspective and acknowledge its partiality.

The claim that the knowledge we create can only be partial and not the Truth alludes to the role of "subject" in knowledge production. A knowing subject, for instance, in an
interview situation, is an agency actively shaping her or his experiences. In other words, it is a level of experience in which the individuals are actively creating their biographies. At another level, the experiences are being shaped for the knowing subject. This shaping of experience is, therefore, happening in two ways. One, as the interviewer sets the agenda for the interview, s/he controls the construction of the interviewee’s experiences. Two, as discussed earlier, most of the interviewee’s experiences have been determined by social, historical, economic, political and cultural forces. Therefore, we can say that the individuals, apart from being subjects, also experience subjection. No wonder, that subjectivity is central to feminists’ theorizing!

In defining subjectivity within feminists’ research, Oakley (1981) suggests that feminists’ paradigms acknowledge the inter-textual function of the knower’s subjective reality. Being a subject and being subjected is what provides for shifting boundaries, allowing individuals to resist identities and to give primacy to the role of context in knowledge production. The implication of this for the research process is the need to acknowledge the ‘biases’ or epistemological embodiments that we bring to ‘knowledge construction sites’, such as the interview. Haraway (1991) posits that embodiment is configured by acknowledging “where we are and are not”. But most of us have been trained to think that acknowledging our ‘biases’, or our epistemological embodiments, is a bad thing. Yet, a clear presentation of our assumptions may contribute to a better reading of our findings.

In weaving the story of my research, for instance, I have attempted to guide the reader to ‘where I am at and where I have been’. Subsequently, I have showed the participants’ positions, and my position and biases, by detailing my theoretical framework and methodology, participants’ views, the questions I asked participants, other research situations and so forth. Such guidance makes a study more trustworthy; this is an issue to be explored more fully later in the chapter.
At this point, I will consider further the implications of ‘subject’ and ‘being subjected’ for the interviewing process. It is common knowledge that interviewees select the kind of information that they wish to share with the researcher; they will rarely “tell it all”. That is one reason why good rapport gives the researcher a good chance of gaining the trust of the participants and, therefore, being allowed to know more. Similarly, repeated and in-depth interviews increase the chances of a more sincere communication between the participants and the researcher. But even in a satisfactory interview situation, the participant portrays two affinities: as a subject and under subjection.

Chase and Bell (1994) provide a good illustration. When interviewing women on the role of gender in their (women’s) careers, they found that professional women selected the kind of information they would give and how they accounted for it. This selection was dependent on how much control of the gender and ethnicity issues the women believed they had. For instance, one school principal, who had learned to make light of discriminatory remarks about her gender and ethnic origin, initially gave the impression that discrimination is “little stuff”, thereby “suppressing her experience of subjection” (p. 75). She focused on “herself as an active subject in relation to that problem” and not one who is vulnerable (p. 72). In a later interview, however, she claimed that her gender and ethnicity were reasons why she had, on occasions, experienced discrimination.

This illustration from Chase and Bell speaks to the “complexity of subjectivity” and the need to deconstruct narratives in relation to interview contexts and wider societal contexts. In support of context deconstruction in field situations, Oakley (1981) suggests how to conduct an interview that is free from hierarchical representations (see also Glesne & Peshkin, 1992). Similarly, Mudimbe (1988) suggests an approach through which one can avoid representing study subjects as “other”. Representing study subjects as ‘other’ signifies a hierarchical arrangement, where the researcher assumes a superior position in relation to the researched. Of course, the assumption can be unconscious and probably
invisible to both interviewer and interviewee. The important thing is for the interviewer to make an effort to disallow, and, by so doing, minimize such hierarchical arrangements.

The researcher and researched relationship may be enhanced, and power relations between the interviewee and the interviewer balanced, by 'talking-back' (Oakley, 1981; Duran, 1991). Talking back is when the interviewer pays attention to the situated (subjective) needs of the participants and also his or her own. Consequently, the interviewer allows for time during interviewing sessions for participants to ask personal questions or discuss experiences that are not necessarily regarded as relevant data by the researcher. In 'talking-back', therefore, researchers are expected to share their situated experiences as they carefully shift the conversation to the topic for discussion. During my interviews, there were many occasions when women asked me questions about myself. They wanted to know where I had been; why I wanted them to teach me things when I should be teaching them; what it was like in Canada; about my son and husband; and so forth.

In making a similar point, Lather (1986) says that the process of research should be such that the study subjects are allowed space and a voice with which to express themselves within the context of the study. This is a dialectical stance that allows for researcher and researched to construct meanings together without imposition on the part of the researcher. The process entails working towards a common understanding that is satisfactory to both the researcher and the research subject. By so doing, both expand the body of valid propositions (Bereiter, 1991).

This approach requires techniques such as repeating interviews a few times in order to get at deeper meanings, and giving participants a chance to comment on the interpretations. Lather (1986) suggests that researchers should aim at listening to the point of view of the participants and linking it with their (researchers') own points of view within a deliberative mode, thereby bringing their (researchers') and the subjectivities of
the researched to bear on the interpretation of data. Needless to say, in interpreting such data, one has to guard against personal biases by formulating "self-corrective techniques". Further discussion on "self-corrective techniques" is done in the section on data collection.

**Ethnographic Method**

Goetz and LeCompte (1984, p. 2) describe ethnographies as "analytical descriptions or reconstructions of intact cultural scenes and groups ... [they] recreate for the reader the shared beliefs, practices, artifacts, folk-knowledge, and behaviours of some group of people". Although the blurring of methods has made the use of terms such as "ethnography" to describe a research approach redundant (see Hammersley, 1992), I will use the term here to connote an historical development that has sensitized qualitative researchers to discovering constructs from participants and using these constructs to structure the research process (Geertz, 1973; Goetz & LeCompte, 1984).

It should be noted that the need for 'scientific accountability', and its implications for the study of human subject matter, has been the focus of much debate about methodology in ethnography (Denzin & Lincoln, 1994; Lather, 1986; Merriam, 1988; Strauss & Cobin, 1990). In Lincoln and Guba's view, scientific accountability of human subject matter or "standards of trustworthiness" should be based on other criteria. They suggest credibility, transferability, dependability and confirmability as standards of trustworthiness.

Credibility is achieved when the researcher's interpretations of the respondents' views are credible to the respondents and to the readers. To establish credibility, a researcher counterchecks findings with the participants for accuracy and consistency with the participants. S/he also attempts to use multiple sources of data and multiple methods of data collection (Lather, 1986). Transferability means that a study would be found useful in other contexts. To establish this, a researcher articulates the context-bound nature of all
data (Merriam, 1988, p. 167). This helps others to compare the study context with their own, thereby making the study dependable. Plausible credibility, transferability and dependability render study findings logically and contextually linked to the data.

The process of establishing the trustworthiness of the study demonstrates the confirmability of the data (see also Whitt, 1991). Earlier I discussed how feminists' researchers ensure trustworthiness. Non-hierarchical interviewing, "talking-back", and other self-corrective techniques are considered to be important processes in enhancing trustworthiness (Lather, 1986; Oakley, 1991; Duran, 1991).

**Discovery method.** The emphasis in discovery is to allow data to emerge in a manner that leads to the building of a theory. Initially, the researcher goes out in the field with a personal and or professional experience, general interest in a problem, technical literature and a discursive paradigm to provide the descriptive language, selection of what is to be focused on, and analysis and interpretation of data (Glaser & Strauss, 1967; Strauss & Corbin, 1990). No effort is made to test existing hypotheses.

In general, the researcher begins by organizing the data, generating her or his own categories and themes, testing emerging hypotheses against the data, and seeking alternative explanations for data by challenging the themes that seem to emerge (Whitt, 1991, p. 412; see also Merriam, 1988). As the research proceeds, "the focus of the research is narrowed and sharpened, and perhaps even changed substantially" (Glaser & Strauss 1967, p. 8). Glaser and Strauss (p. 149) point out that the discovery method aims to provide a "reasonably accurate statement of the matters studied". Evidently, the emergent theory is dialectically linked to the data, thereby establishing a continuity between theory and research (Stacey, 1991).

The process of generating theory from data in a systematic way involves the techniques of theoretical sampling and constant comparisons (Glaser and Strauss, 1967). Theoretical sampling occurs when as many participants are involved as would
satisfactorily answer the research question. Constant comparison is a continuous process of comparing categories for differences and similarities. This comparison generates further descriptions and explanations of categories: that is, properties are attached to the categories. Any new evidence provides direction for the research in general and, in particular, for the kinds of questions to ask in order to generate more information for existing categories and their properties. In other words, researchers 'hoist themselves up by their bootstraps': they use data to build theory, to collect data, to test and validate theory, to develop more sophisticated theory, and so on. Each step is built on its predecessor; each step informs the one that follows.

Categories and properties are conceptual abstractions and, although derived from data, which could easily change when new information is acquired, they themselves do not change. However, they may be respecified when structural conditions (see Glaser and Strauss, p.23) alter some aspects of the study. Such changes could happen when facts are compared across many cases or across any other units of comparison, for example, informants.

It should also be noted that, during constant comparison, questions pertaining to certain categories may be fully answered. At such times, a researcher may begin to see similar instances over and over again. This is an indication that no new evidence is emerging for that category and, therefore, the category does not require further investigation. As a result, the category is said to have attained theoretical saturation.

Further study of subgroups within the same group provides more categories and properties. Maximizing or minimizing both differences and similarities of data from the categories while comparing many similar groups or diverse groups, that is, a process of comparative analysis, leads to the generation of either substantive or formal theory. Substantive theory compares cases within or among the same substantive area.
Formal theory compares substantive cases for a particular category without relating
them to any one substantive area. Thus, formal theory may be described as a substantive
theory which has been upgraded to a higher level of generalization by increasing and
varying the comparative groups and categories in the group. A substantive theory deals
with institutions (concrete or abstract), for example, race relations and patient care,
whereas formal theory is more conceptual and deals with theoretical abstractions like
stigma, deviant behaviour, socialization, authority and power (Glaser & Strauss, 1967).
Also, comparative analysis establishes the internal consistency of the theory and increases
the generalizing power of the grounded theory (Glaser & Strauss; Strauss & Corbin,
1990).

The purpose of my study was not to generate either substantive or formal theory. My
goal was to obtain theoretical categories that would form a basis for an explanation of
how people understand and explain natural phenomena. Because of time and financial
limitations, I could not engage in comparative analysis. Therefore, I worked with a single
group in order to obtain sufficient theoretical categories and their properties to interpret
and explain some selected health practices.

Data Collecting Procedures

Data came mainly from oral sources and were obtained through preliminary
interviews; semi-structured interviews; in-depth interviews; audio-taping, video-taping
and photographing; individual and group feedback; talks and discussions; field note-
taking and journal-writing.

Oral Sources

Oral sources are commonly used to create and recreate history (Clark, 1994; Evans,
1983; 1987; Fadiman, 1982; 1993; Grele, 1994; Imanyara, 1992; Kenyatta, 1938; Njiru,
Spaull (1984) outlines common uses for oral sources: understanding the contemporary past, capturing the historic dynamics of social structures, studying the collective knowledge of communities, exploring beliefs, and serving as a supplementary source for other research techniques. There is, of course, a great concern for the accuracy of data from oral sources. This is understandable, given the nature of memory. Memory can be elusive. In oral societies, however, people are practiced in remembering stories and have a great desire to communicate, because what is not communicated is sure to be lost.

Consequently,

...memory skills are nourished, repetition having both mnemonic and aesthetic value is commonplace ... there develops a necessity, an economy of stored details, and a greater reliance on cliche, stock phrases, metaphor and symbol. (Pike, 1983. p.15)

Nevertheless, oral historians wrestle with issues such as: How much can people, especially elderly, people recall, and are the recalled facts accurate?. Ordinarily, we recall only part of our experiences, and we sometimes remember differently at different times. Sometimes events that happened many years ago are remembered as recent; they are telescoped. Therefore, long-term memory is both selective and constructive (Sypher, et al., 1994).

In using interviewing techniques to gather data from oral sources, the memory issue is further complicated by the complex subjectivities of an interview situation. In earlier discussion, the interviewee was described as a subject and as under subjection. This situation is further complicated by the fact that both the interviewer and the interviewee are selecting and constructing their narratives. McMahan and Rogers (1994) refer to this complex situation as "interactive construction". Details of everyday life, such as matters of health and healing, tend to distill in the mind because of constant repetition. In this
case, even if accuracy of detail is lost, the general theme is not (Caunces, 1994).

Moreover, ordinary people are likely to be more honest than public figures (Caunces). It is worth noting that my study was looking for the interpretation of everyday experiences (and not accurate facts) from ordinary people.

The process of selection and construction privileges one way of seeing the world at the expense of others (Chase & Bell, 1994). On the other hand, what is selected tells as much as what is not. Therefore, it is the job of the researcher to present ‘as many stories as possible’, thereby revealing ‘the whole story’. The researcher can do this by guessing at what is not selected, and at the reasons it was not selected. As Grele (1994, p. 3) points out, “the act of interpretation must always be concerned not with the intended meaning, but what the intended meaning is about”. Geertz (1973) also emphasizes that interpretation should be concerned with wider social implications. It is also the job of the researcher to foster a successful data collecting process through building rapport, establishing non-hierarchical relationships with the participants, repeating interviews, counterchecking interpretations with participants, detailing the entire process, and so forth.

**Preliminary Interviews.**

Initially, my research assistant (Mumu) and I conducted preliminary interviews with twenty women. These women were selected randomly from the population. The purpose of these interviews was the following:

1. Testing how we presented ourselves to the participants (that is, experience the process of building rapport).
2. Informing ourselves about the topic by discussing it with women and taking the opportunity to experience how much they were willing to talk about.
3. Ascertaining participant interests.
4. Evaluating the effectiveness of interview questions with respect to the research topic. During the preliminary visits, we were able to assess the research situation in terms of:
   1. The kind of reception we would receive.
   2. The time required to travel to people's homes.
   3. The time required to negotiate around women's busy work schedule and family chores.
   4. The time taken to conduct one interview.
   5. The number of women we were likely to interview in a day.
   6. The extent to which weather conditions would influence research activities.

At the same time, I redefined my needs for a research assistant when I realized the important role she was playing during the interviewing. I had anticipated that I would require a research assistant for company and a little guidance. Presumably it would not have been safe to walk unaccompanied in and out of homesteads, especially late in the day, without the guidance of somebody who is a resident of the place. I had assumed that, since Kirumi is my native home, and I speak the local language, I would not require an interpreter. However, during preliminary interviews, it became apparent that Mumu was more than a companion in this venture. She interpreted my questions, making the questions more intelligible for the participants, and she interpreted participants' answers, especially when they included idioms, cliches, or proverbs unfamiliar to me. Sadly, attending boarding schools since grade five, away from the village, has put me out of touch with some elements of village life.

Mumu is a respectable woman within the community, that is, daughter of a former area chief, married for close to thirty years, a mother of four, church elder and a women's leader in her early fifties. She has worked in the Kirumi community for the past twenty years as an extension health worker to promote primary health care (PHC) for the local
mission hospital and the Ministry of Health. In these twenty years she has acquired effective interpersonal skills, especially the "people skill". Because of her expertise, the women we visited for purposes of interviewing responded to us promptly. As we approached the home compounds, Mumu would call women's names (she knows them all by name) and say, "we have come to visit and have a chat with you, would you spare a few minutes for us?" As it turned out, this was a very effective approach because it did not matter what task they were involved in -- busy doing something in the garden, walking to the market, or attending to the children -- they always gave us a chance to tell them what we wanted to chat about. Also, because my topic was concerned with health, women related to us easily, probably because Mumu had talked with them at one time or another about health and healing. Because of Mumu's expertise, we carried out the preliminary interviews fairly quickly. We set out at nine o'clock and interviewed about twenty women in two days.

Although her presence enhanced our interaction with the participants, Mumu's association with schooled medicine meant that some women were unwilling to reveal their traditional knowledge on health until her position or feeling on the topic was clear. A large portion of the primary health care that Mumu promotes concerns the use of modern methods to prevent or cure illnesses. For instance, she encourages people to position an insecticide-soaked-cloth inside the house to keep mosquitos away, or take anti-malaria drugs to cure malaria. Given the effect Mumu's role as a primary health care worker had, we decided that, at the beginning of every interview, she would give an unbiased view of her approaches to health and healing. Subsequently, at the beginning of each interview, she stated: "These days people rely on both indigenous and hospital-based healing methods. We would be interested in hearing the healing methods you adopt when you and/or your family are not well. This is for the purposes of her (pointing at me) school's project". That statement by Mumu made it clear that, although her line of work
promotes schooled medicine, she was not against indigenous medicine. By the time we had completed the preliminary interviews, we were confident with our approach; also word had gone around that we were asking questions and so whenever we approached people they did not have many questions about why we were visiting.

Another thing that came to our attention was the issue of time. We realized that some interview questions needed to be reworded and explained to some participants, especially those who were advanced in age (over sixty five). The implication was that, in estimating the time required to interview a participant, we allowed extra interview time. We also made allowance for participants who were inclined to talk about personal and social issues, and to ask me questions about myself. Similarly, we allowed extra time for participants attending to young children because they were frequently distracted. We also agreed to invite men into conversations when they seemed interested in participating. Earlier, we had gone to four homes where a husband or a male relative of the woman we were interviewing interjected with what he knew about the topic. My initial inclination was to disregard whatever he was saying, since my interest was only on in women’s knowledge. But since what the men said was relevant to the topic, and, moreover, it was mostly an addition to what women were telling me, I decided to write it down and designate the information as ‘men’s’, so I would not confuse it with what women said. Later, I decided to use information from men to check facts and to explain existing categories and properties. Given that my initial intention was to deal with women’s knowledge, integrating information from men into my methodology was problematic. This integration speaks to the nature of health knowledge. Health knowledge is neither women’s nor men’s. As I explained earlier, the basis of what men and women know about health and healing is the same. The difference is in quality. More discussion on this issue is included in Chapter Seven and Chapter Eight.
On completing the preliminary interviews, we realized that the main research objective, that is, to document women's health experiences, needs and expectations, was focused on one issue: knowledge and use of traditional methods of healing. A shift to the topic of traditional ways of healing happened very quickly. Seemingly in no time, we were asking people to tell us what they knew about traditional ways of healing. I made the following journal entry after the preliminary interviews: “seems like women’s experiences, needs, and expectations, are being discussed around one issue: women’s knowledge and use of traditional healing methods. Knowledge of traditional healing methods will be a point of interest as we move on to do semi-structured interviews” (Journal Entry [J.E] April 15/97, p.12).

**Semi-structured Interviews.**

The procedure we used for semi-structured interviews was to ask questions and write down the answers. After interviewing another fifty women, a number of questions were modified because they did not seem to make sense to participants.

Two early questions were: ‘What knowledge and skills are available to science students that you think are useful for the management of common illnesses in our community?’ and ‘What knowledge and skills did you learn at school which you find useful in the management of common illnesses in our community?’ Because these two questions were asking for similar information related to schooling, and because the majority of the participants have not been schooled, I modified the questions to read: ‘What knowledge and skills do you remember learning at school and your children having brought home from school that you find useful in the management of common illnesses in our community?’ Overall, women listed personal, environmental (cleaning the compound, boiling drinking water, and so on), and social hygiene such as not getting
married to relatives, respect and so on. Further discussions on the concept of respect are included below and in the following two chapters.

Another question that people did not find straightforward was: ‘What are your needs with regard to health and healing in our community?’ The wording of this question was unclear and so we tended to explain it and use different versions of it, depending on the participants’ inclination to comprehend it. Often people said they needed to think about it. A number said that they needed a sound financial situation, because with a good income any health matters would be easily taken care of. For instance, money would enable good shelter, nutrition, clothing, and all other necessary amenities for the entire family. Given suitable income, good health is guaranteed.

By the time I had conducted fifty interviews, I decide to omit the question asking for a definition of health: ‘What do we mean when we say an individual is a “healthy person”?’ All participants said that a healthy person is one free of illnesses (personal or familial), quarrels, family deaths and anger. Respect is also a precursor of good health for two reasons: when one respects others, he or she is respectable and will have cordial relationships with everyone. Therefore the individual will be happy, and happiness supports good health. The other reason had to do with the prevalence of AIDS. A respectful person, especially a girl, would not live a promiscuous life. A number of women added that any girl who respects herself, or her parents and community members, would not have sexual relationships before marriage. Consequently, she would not contract sexually transmitted diseases. Therefore, any respectful person is likely to stay healthy. Because answers given for the question about who a healthy person is were the same all through, it was not necessary to keep asking this question just to receive the same answer.

We completed semi-structured interviews with about one hundred women. During the interviewing process, I noted ten women who were knowledgeable about the topic and
were willing to have in-depth interviews with me. Overall, women were willing to direct us to key people who have more knowledge about traditional healing methods. That is how I got to know three men and one woman herbalist. This enthusiasm on their part boosted my confidence in the field as I proceeded with in-depth interviews.

**In-depth Interviews.**

In-depth interviews were audio-taped and consisted of five stages. The conduct of each stage was determined by its predecessor. Sometimes I completed all stages during one visit; other times several visits were required. In the first stage, I gathered background information and explored the issues surrounding the topics from the participant’s point of view. For instance, I would ask a participant to explain health as a concept. This was also a time to build rapport by allowing participants to ask me about myself. During this stage participants mentioned issues of concern, which I compiled into a list. I moved on to the next stage with these issues and the answers to my questions in mind.

In the second stage, I explored a number of issues that had come up during the first stage. Initially, I selected these issues on the basis of women’s interest in them and later on the basis of the need to fill the gaps of emerging theoretical categories. For instance, in the first stage, one of the participants, Mwiki, said that a person in good health is able to meet societal expectations by participating in community activities and performing daily duties. During the second stage, I asked her to tell more about ‘societal expectations’. In her elaboration she mentioned that antisocial people may not be physically ill, but are said not to be healthy. Often, such people did not participate in community activities and also failed to satisfy the needs of their families. For instance, a father may not provide food, shelter or clothing for his wife and children, and schooling for his children. Such a father is said to be unhealthy because of his lack of respect.
I proceeded to the third stage when I had a clear understanding of what participants meant in the first and second stages, unless I had reason to believe (through verbal or non-verbal feedback) that the participant was not willing or ready to proceed with the interview. All the eight who participated in the in-depth interviewing were willing to proceed. Two of the ten women selected for in-depth interviewing were not interviewed because I could not find them at home on any of the occasions when I visited their homes.

In the third stage, I gave the participants, or read to them, a list of the items I wished to understand further. I had compiled this list from earlier interviews. The items in the list reflected the emerging categories of interpretation. I asked participants to add anything they may have thought was omitted during our previous discussions, after which we discussed each item separately. In Mwiki's case, she mentioned something very intriguing that she had forgotten earlier. She said that, nowadays, many women do not know how to take care of their families. They do not work hard enough at providing nutritious foods, especially for their husbands. She went on to say that ground gruel, a form of fermented porridge, is an important part of nutrition. In an ideal situation, every home should have gruel at all times. In the early days, people fed on gruel for 90% of meal requirements. They would take some in the morning, midmorning and at lunch and supper. Gruel would be supplemented with fruits, vegetables, and dishes made from grains, bananas, root crops and vegetables. Mwiki's observation was that new foods like rice and bread would not help build immunity against common illnesses. Moreover, fermented gruel provides immunity against malaria to those who drink it regularly. This was an interesting notion and so I pursued it further.

During the fourth stage, I brought up themes from the structured interviews for discussion. This time, Mwiki and I centered our discussion on immunity. I told her of ways of building immunity that I had learned from the women I had interviewed. She qualified some of their suggestions and gave me further examples of herbs and plant parts
that were used for such purposes. She also described how various herbs and plant parts were prepared and, whenever possible, showed me samples of such herbs and plant parts. During the fifth stage, I summed up my understanding of the health and healing issues from semi-structured interviews and in-depth interviews, and presented summaries to each participant. I also asked participants for any further comments, or if they wished to add or to confirm my interpretations.

The interviewing procedure described above was also used with three herbalists: Irai (man), Mwambia (man) and Kanjiru (woman). However, it took a longer time to build rapport with Irai and Kanjiru. I managed to gain Mwambia’s confidence in one visit, whereas I had to make about five visits before gaining confidence with Irai and Kanjiru. One reason why it took so long before they could trust me is that they are currently practicing with use of the medicine, and would like to keep the details of how they prepare the medicine to themselves. Such secrecy keeps out competition and malpractice. It is believed that, if some secrets on herbs are passed around freely, some people may want to try making the preparations for themselves. In a situation where they fail to mix the ingredients correctly, they could produce ineffective medicine, or even harmful mixtures. The herbalists are aware that people who make such mistakes may claim to have been given the information by the herbalist. The implications are that people will lose confidence in the herbalist or, at worst, the herbalist will be branded as a witch-doctor.

Mwambia is advanced in age and does not sell any of his medicine. His body is frail and cannot endure long walks and expeditions to the bushes and the forests in search of herbs. Whenever he makes medicine, he asks someone to bring the ingredients for him. He uses the medicine for his purposes, and that of his family and friends. He was not very suspicious of me and attempted to answer my questions without probing my intentions. Although he did not give me a hard time, I have reason to believe that he concealed
relevant information from me. This clue came towards the end of our interview. When I asked him to explain how he prepares medicine for malaria, he told me that he would like to show me how to do it, that is, to train me. However, I would have to commit myself to start a health clinic where we could both participate in the selling of the medicine. When I became a member of his team, then he could tell me a lot.

Fortunately, I discovered that I could elicit information from herbalists by asking for remedies for my own illnesses, like allergy or stomach acid. With Kanjiru, I experimented with the cure for my heartburn (hyper-acidity). First, I asked her for a list of the items she had included in the remedy. I took the remedy and used it for two weeks upon her recommendation that, if I did not improve, I should go back for another remedy. Because my stomach acid did not subside after two weeks, she prepared another remedy for me. When she prescribed the second remedy, I inquired about the differences between the two remedies and about what had been substituted for what. By shifting focus from the herbalist to myself, I learned a lot without seeming too to be probing. Also, I had hoped that the herbalists would allow me to videotape activities of healing that they undertook. The structural conditions of their practice did not allow for elaborate healing procedures, where a patient would be under treatment for a period of time in one location. Normally, they dispensed the medicine to people who used it in their homes, as directed. If need be, they would visit critically ill people, but this rarely happened because people prefer to take critically ill patients to the mission hospital or various other government clinics and hospitals in the district. There is a general understanding that critical and serious illnesses are better taken care of by schooled medicine. An interesting observation, too, is that when critical or serious illnesses defy schooled medicine, people then try ‘serious’ traditional medicine, that is, incorporating prayer, herbal remedies and sometimes healing performed by ‘medicine people’.
Audio-Taping, Video-Taping, and Photographing

All in-depth interviews were audio-taped as planned. I had planned to videotape a healing procedure whenever an opportunity presented itself, but as time went on it became apparent that I might not get such an opportunity. Consequently, I devised a way of getting around that problem by videotaping the preparation of medicine. This was possible because, towards the end of my field study, I had earned the trust of the herbalists and one of them, Kanjiru, allowed me to follow her with my video camera to the forest and, thereafter, to her home compound so she could demonstrate the entire procedure of collecting and preparing herbs. Similarly I was able to follow Irai’s son to the bush with my camera. At the time, Irai was weak from an illness and assigned his son, who is knowledgeable about some of the herbs we were looking for, to go with me. The arrangement was that, once we had the necessary ingredients, he (Irai) would instruct me on how to prepare my own allergy remedy. If that remedy did not help alleviate my allergy condition, he would substitute some of the ingredients. (It is important to note that, since some of these expeditions were time consuming and involved digging out roots, scraping tree backs, and so on. I considered it necessary to make small donations to the herbalists for most of my visits.)

Throughout the study, I had many opportunities to take pictures of the plants and plant parts that are used for various curative measures. I also took pictures of the herbalist and groups of women who had gathered for feedback from me.

Feedback and Group Discussions

Because I conducted semi-structured interviews with many women, it was difficult to re-visit each of them for feedback. Therefore, I held a group discussion with two groups of women, about fifty women in each group. These groups were scheduled to meet for their fortnightly women’s development group meeting. The leader of the group allowed
me to read my interpretation of what they had told me during the interviews, discussions
and talks, and to invite them to correct my interpretation or affirm it. On these occasions,
I gathered new facts about traditional healing methods. Busch (1987) suggests that group
interviews or discussion can also be used to collect distinctive information, test constructs
against everyday experience, and stimulate new ideas, as well as to interpret previously
obtained ideas. The group meetings functioned both as a feedback session where I
counterchecked my interpretations of the findings, and as a revelation of new facts that
helped to place the data within its context.

Group dynamics stimulated people to tell of things they had not told me when I met
them as individuals. Also, there were women I had not met before who added some new
facts, or asked questions about traditional healing methods. At this meeting, some women
said interesting things about medical quackery in Kirumi. They described how people
were mis-diagnosed with amoeba and malaria and treated for both when they had neither.
Some of the local health clinics were making wrong diagnoses and bringing heavy
financial and health costs to people. I was unable to pursue this because I was winding up
my field study.

However, the story of one woman, Kawira, was worth pursuing. She described to the
group how she had suffered a debilitating illness and had spent a lot of money and time in
government hospitals without being cured. When she had nearly given up, someone
directed her to a herbalist, who helped to restore her health. Her story was very
interesting, so I requested permission to audiotape it, and I did that the following day.

I also made one specific visit to the herbalists, in which I read to them my
interpretation of what they had told me. This was an opportunity for them to correct my
interpretations or to add anything I had missed. Feedback also consisted of consultations
with medical experts at the Kenya Medical Research Institute (KEMRI) and the African
Medical Research Foundation (AMREF). At KEMRI, I interviewed a researcher, Maua,
at the Centre for Traditional Medicine. At AMREF, I interviewed a medical doctor, Joseph, whose work consists of research on community health.

**Talks and Discussions**

During the preliminary, semi-structured and in-depth interview phase, and throughout my time in the field, I had a chance to talk and discuss the topic with various people I met on my way to the homes of those I was going to interview. People were also open for discussions when I walked with them to church, to the market, or when they visited my home. After we said ‘muga’ (hello), they would customarily inquire what I was doing. When I told them what I was doing, they would contribute, by way of conversation, what they knew about herbs with regard to health and healing. I noted these comments and integrated them in continued data analysis.

**Field Notes and Journal**

The contents of discussions and talks constituted my field notes. I made extensive and detailed field notes on all the discussions and talks I had with people, or comments that I overheard when people were having their own conversations. Also, throughout my field study, there were many incidents and developments that were directly related to my research topic. For instance, a man stopped me after church one day to inquire if I could help him with some medicine for his sick stomach. Such incidents were entered in the journal.

**Legal and Ethical Considerations**

Official permission to conduct research in Kirumi was obtained from the Office of the President and from the Chief of Kirumi sub-location. Consent to participate was obtained verbally from participants.
Simons (1989, after McDonald & Walker, 1975, p. 6) has outlined ethical questions for research where human subjects are involved. I will consider some of these questions: First, whose interests and needs are being served? This study was my initiative, that is, Kirumi people had not requested me to investigate how they conduct their health and healing. My need for a Ph.D. was a motivating factor, but so also was the need to investigate issues in an area that would benefit science education. It is an indisputable fact that people value the education of their children and, from my findings, it appears that Kirumi people would like their indigenous knowledge to be given a place in the school curriculum. In view of this, I would argue that the people of Kirumi and myself were happy to participate in a project that aimed to appraise the science curriculum.

Another concern is: Who owns the data? At one end are the participants and, at the other, the sponsor of the study. I am featured at both ends. Does the research sponsor or myself own the data? One way of looking at it is this: no one owns the data. Participants have the data, and so do I. The question actually should be: Who has the right to interpret the data?. To which I would say, everyone. It so happens that I am in a privileged position to be able to pay scholarly attention to this data, and with the help of the available literature and a very capable thesis committee, to add my interpretations to the data. Ownership also implies that anyone deemed to be the owner can put the data to a use other than what was initially intended. It is hard to predict whether such use would be to the advantage or disadvantage of the participants. In order to protect participants of the study from any unforeseen negative eventualities, I did not use their real names. In any case, the nature of this study did not place demands on personal views or information. I was mainly interested in general information on knowledge that is common to most people in Kirumi. That helps not to pin down any one. A measure taken to further protect participants is to lock away data in a safe place and discard it when the project is completed.
I explained the purpose of the study to the participants. I did not seek information that, in my view, would disadvantage them. But, note that, while a researcher may not fully anticipate all risks, some risks, if there are any, are worth taking on grounds of the need to improve education (Stenhouse, 1988).

What is the status of the researcher’s interpretation of events, vis-a-vis the interpretation made by others? As discussed in this chapter, I have done everything possible to enhance the trustworthiness of my study, particularly through careful deliberation in the choice of methods, theoretical orientation, research techniques and in the way I carried out data collection. However, a research finding is a text and like any other text is subject to as many interpretations as there are readers. Thus, I will expect my audience to draw plurality of meaning from my text. As Foucault (1970) argues, the only determination in such texts is what they represent, given that their truth is not in the presentation but “in some future discourse”, in which case readers of the text determine what experiences to draw from it. In fact, in qualitative research, the facts never speak for themselves (House, 1980; Eisner, 1991). However, the criteria of coherence, insight, and instrumental utility as validity checks will determine if a study is trustworthy to all the stake holders in the research project, even when their principal interests in the study are different (Lather, 1986). A trustworthy presentation requires a high level of persuasion (Eisner, 1991) that can be established by way of spelling out how the study was designed, including the techniques used, the settings studied, and the data presented and interpreted. How far the researcher persuades by reason is what Dewey (1929) calls a science of education. It is also a social responsibility of research.

**Summary**

Ongoing debates about social research methods question how well these methods present a “true” picture of the human world. There are two persuasions in this debate.
One is that, although reality is not fully comprehensible, good science that is free of subjectivity should approximate it (post-positivism). The other results from a dissatisfaction with post-positivism. This view holds that the study of human experiences should be a separate discourse from the study of natural phenomena. This is simply because humans operate in a multi-contextual world and these contexts engender complex subjectivities. Reality in the human world is, therefore, defined by shifting boundaries and cannot be captured through traditional scientific procedures. Therefore, issues of validity, reliability and generalizability, and the research methods and techniques that generalize data, ought to be redefined in terms of the nature of social contexts. Consequently, for this study, the selection of procedures, techniques and research tools was guided by the research context, the research questions, the theoretical orientation of the researcher and available resources. Ethnography was the preferred research method and a deconstructive theoretical orientation provided the ‘how’ and ‘why’ of ethnographic methods. Data was in the form of ‘oral documents’. Oral communication of data (or oral history) presents a peculiar problem to the researcher. However, most of these problems can be minimized by fostering a non-hierarchical interaction and good rapport with the participants, especially during interviewing.

Semi-structured and in-depth interviews were the main tools of data collection. Semi-structured interviews were used to answer the general research question, as well as to generate categories which were built further by use of in-depth interviews. The main emphasis was on ‘discovering’ constructs and building categories from them. During in-depth interviews, I aimed at getting deeper understanding of the categories. When conducting semi-structured interviews, in-depth interviews, and talks and discussion, I attempted to allow time for participants to talk freely about themselves and to ask me questions about myself. Because resource constraints did not allow me to visit all the participants, in order to obtain their feedback, I conducted two group discussions to
facilitate feedback from some of the 100 hundred women who participated in the semi-structured interviews. For trustworthiness purposes, I conducted interviews with two schooled medicine experts. I got other material for triangulation purposes, and for enriching trustworthiness, through other data collecting techniques: for example, informal talks and discussions; field note-taking; videotaping and photographing items that women used for diagnosis, treatment and management of specific illnesses or health conditions.
Chapter Six

Findings

This research was carried out between April and September 1997. The research area is located in the east of Kenya, about 180 kilometres from the city of Nairobi. It is a rural area, Kirumi, within Tharaka-Nithi district, Mwimbi location, and Mugumango sub-location (see map in Appendix D). Participants were randomly selected, within five kilometres of my home in Kirumi sub-location. I used mainly interviews, talks, discussions, observations, and field notes and journal entries to obtain data. Also, I audio-taped, video-taped and took pictures where appropriate. In the thesis, I report interview data with the initial IT (interview transcript), and field notes and journal entries with the initials JE.

At the time of completing the field study, I had interviewed twenty women using preliminary interviews; seventy three women using semi-structured interviews; and eight women and three herbalists using in-depth interviews. I also conducted semi-structured interviews and long discussions with two experts: one, a medical doctor, and the other, a pharmacist. Both were involved in some aspect of traditional medicine. One, Joseph, was carrying out community health research for the African Medical Research Foundation (AMREF) and the other one, Maua, was researching traditional medicine at the Center for Traditional Medicine of the Kenya Medical Research Institute (KEMRI). I had talks and discussions with several other people, mainly women, and also listened to men who volunteered to discuss the study topic.

The following tables provide some descriptions of, and background operation about, the participants in this study. When reading this chapter and the next, readers are requested to refer to these tables, especially table 3, in order to know who is speaking and in what capacity. The tables will be useful as a reference point as one reads participant responses in the ensuing pages. These tables show age, schooling experience or lack of it,
occupation, and religious inclination of the participants. These are all factors which may influence how one approaches health and healing. Table 1 shows the distribution of age among the women who participated in semi-structured interviews. Table 2 shows distribution by schooling, occupation, and religious inclination among the women who participated in semi-structured interviews. Table 3 shows the profile of those who participated in-depth interviews.

The table below shows the distribution by age of those who participated in the semi-structured interviews.

Table 1

**Distribution By Age**

<table>
<thead>
<tr>
<th>Age</th>
<th>Numbers (n=73)</th>
<th>% (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15(^1)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>15-25</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>25-35</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>35-45</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>45-55</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>55-65</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td>&gt;65</td>
<td>8</td>
<td>11</td>
</tr>
</tbody>
</table>

\(^1\)Most of the women below fifteen years were attending school at the time of this field study.
Table 2

Distribution of Schooling, Occupation, and Religious Inclination

(Semi-structured Interviews)

<table>
<thead>
<tr>
<th>Schooling, Occupation, and Religious Inclination</th>
<th>Numbers (n=73)</th>
<th>% (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Schooling</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No schooling</td>
<td>33</td>
<td>45</td>
</tr>
<tr>
<td>Primary (Up to grade seven or eight)</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>Secondary (Up to high school)</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>College</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsistence farmer</td>
<td>57</td>
<td>78</td>
</tr>
<tr>
<td>Shopkeeper</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Teacher</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Student</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other (primary school cook, nurse, agricultural extension worker, etc.)</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td><strong>Religious Inclination</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christian</td>
<td>70</td>
<td>97</td>
</tr>
<tr>
<td>African Religion</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Muslim</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

1 The two women who practiced African religion exclusively used a bio-cultural approach to health and healing; of the other seventy one, five used a bio-medical approach, while the rest used a mixture of bio-cultural and bio-medical approaches.

Among those who used a bio-medical approach, three said that they were not interested
in learning about herbs, while two said that they were interested. Among those who used both bio-cultural and bio-medical approaches, the majority lacked a comprehensive knowledge of herbs and expressed the desire to know more about them.

Table 3

**Participant Profile**

*(In-depth Interviews)*

<table>
<thead>
<tr>
<th>Pseudonyms</th>
<th>Age</th>
<th>Level of Schooling</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anastasia</td>
<td>35-45</td>
<td>Primary level</td>
<td>Subsistence farmer</td>
</tr>
<tr>
<td>Harriet</td>
<td>&gt;65</td>
<td>No formal schooling</td>
<td>Subsistence farmer</td>
</tr>
<tr>
<td>Irai (man)</td>
<td>&gt;65</td>
<td>No formal schooling</td>
<td>Herbalist</td>
</tr>
<tr>
<td>Jiakathuku</td>
<td>55-65</td>
<td>Primary</td>
<td>Subsistence farmer</td>
</tr>
<tr>
<td>Joseph</td>
<td>35-45</td>
<td>University</td>
<td>Medical researcher</td>
</tr>
<tr>
<td>Kago</td>
<td>&gt;65</td>
<td>No formal schooling</td>
<td>Subsistence farmer</td>
</tr>
<tr>
<td>Kanjiru</td>
<td>45-55</td>
<td>Primary</td>
<td>Herbalist</td>
</tr>
<tr>
<td>Makena</td>
<td>35-45</td>
<td>High school</td>
<td>Subsistence farmer</td>
</tr>
<tr>
<td>Mariamu</td>
<td>&gt;65</td>
<td>No formal schooling</td>
<td>Subsistence farmer</td>
</tr>
<tr>
<td>Maua</td>
<td>35-45</td>
<td>University</td>
<td>Medical researcher</td>
</tr>
<tr>
<td>Mbai</td>
<td>55-65</td>
<td>No formal schooling</td>
<td>Subsistence farmer</td>
</tr>
<tr>
<td>Mwambia (man)</td>
<td>&gt;65</td>
<td>No formal schooling</td>
<td>Herbalist</td>
</tr>
<tr>
<td>Mwiki</td>
<td>55-65</td>
<td>Primary level</td>
<td>Subsistence farmer</td>
</tr>
</tbody>
</table>

1 All those who participated in in-depth interviews claimed to be Christians.

In the rest of this chapter, I discuss, in a narrative style, how the women of Kirumi organize their knowledge of health and healing. In this discussion, I use categories that
emerged through in-depth field data analysis (see Chapter Six). Note that further comments on the findings and their educational significance are provided in chapters Seven, Eight and Nine.

Before proceeding with a discussion of emergent categories, it is helpful to provide a brief description of women's view of health, by summarizing their responses to this question: How would you describe a healthy person?

A healthy person is an individual who keeps her/his physical, spiritual, social, and emotional status in good order. The physical body is kept well through observing personal hygiene, for example, by taking a bath regularly and eating well. Eating well comprises taking *miti* soup (herbal soup) regularly, taking ground gruel regularly, using less salt, sugar, frying oils and processed foods. A healthy person also seeks spirituality. Such a person observes customary rules and regulations and does not indulge in wanton pleasures, like marijuana, *miraa* (*catha edulis*), or excessive drinking of alcohol. S/he is supportive of community activities and respectful of other members of the community; s/he maintains a balanced emotional state by keeping good relationships with other members of the community, and by being respectful.

It appears that health is a state of being that is affected by many factors, some of which may be temporary, like family feuds or illnesses. Other triggers of ill health may last a long time, like death in a family and disrespect, which may lead to long term health problems if the behaviour is not corrected. The way to good health is not simple, but is achievable if people are conscious of and critical of their nutritional habits and moral obligations, and cultivate their skills of healing. Below is a discussion of the three categories: moral obligations, nutrition, and skills of healing.
Moral Obligations and Respect

The issue of morals came up many times during my discussions on the topic on health and healing. Some examples of moral obligations are: the obligations that herbalists have in their practice, and the obligation everyone has with regard to respecting each other.

For instance, it is customary for herbalists to taste their medicine before giving it to an individual. This is an old time practice, whereby a host tastes something first before offering it to the guests. Tasting first is a show of good will on the part of the host. By tasting it first, the host or the herbalist gives the message, symbolically, that what s/he is offering is good enough for her, and so it may be good for the guests, or recipients, to have faith in it, be it food or medicine. Another old time practice is to allow recipients of your medicine to recover first before they give a donation, in form of payment. Mwambia told me of how he helped cure his nephew of chronic syphilis and what ensued:

One of our sons had it [chronic syphilis] and would crawl and groan in pain. I went and plucked the flowers, got the roots, and boiled them. I gave the mixture to him and demanded that he drink it. He was so desperate for a cure, he did not hesitate. He drank two cups, one in the morning and the other in the evening. By the third cup, he came and told me to pour out the rest of the mixture because he was now well. He said he had become cured. He later went to look for a job in another town. He brought four hundred shillings for me to thank me for what I had done. (Interview transcript [IT], p.171)

Earlier, Mwambia had told me, in the context of the many hours of hard labour he puts into preparing the medicine, that: "I do not even charge much. The procedure is to give the medication and ask people to come back with payment when they get well. If they do not get well, then they should not come back with any payment" (IT, 174-175).
Similarly, Irai does not ask for payment. As is the case with Mwambia, the onus for reimbursing him is left with the individuals who are being treated. The other herbalist, Kanjiru, is unable to operate with this kind of good will because of the nature of the setting in which she works. She works in an urban environment, whereas Irai and Mwambia are in a rural location. The monetary implications of a rural versus urban setting are obvious.

When doing a diagnosis, herbalists are required to ask for the history or ramifications of an illness in the individual and also in the patients’ family. That way, herbalists get enough information to enable them to provide adequate treatment. If they are well respected, they can influence the course of treatment for other members of the family who may be unwell. Even as a herbalist probes into the medical history of an individual or a family, s/he may not ask too many in-depth questions lest s/he makes the individual uncomfortable. Maua concurred that “traditional healers know how to treat people as personal”, and that is why they succeed where schooled doctors do not (JE, p. 5). Also, the “health of the people seems to be paramount” (JE, p. 5).

Herbalists aim at respecting their patients by not asking too many unnecessary questions and also by not using them for experimentation. Kanjiru told me that the reason they (herbalists) treat all illnesses at once is to avoid subjecting the person to experimentation or trial and error. When I discussed this with Maua, she explained that malaria, flu, pneumonia, amoeba and typhoid have similar symptoms and herbalists cannot tell the difference, so they treat all five at once. Maua was certainly using her schooled framework to understand this practice. As Kanjiru (a herbalist) explained, these diseases are treated all at once because of their common occurrence. This is certainly a case of preventive medicine.

To ‘treat all common illnesses’ requires the use of many potent herbs. There is a common understanding that herbs are generally safe, although mixing a variety of herbs
requires skill and much experience that many women do not have. Therefore, women
tend not to mix varieties of herbs, especially those which may only be used in small
quantities, because it is not easy to tell how much would be toxic. In general, therefore,
women avoid the use of plants that are toxic. However, a herbalist like Kanjiru has
experience and skill and uses these ‘toxic’ plants. She told me that she even uses
*mwerere*, a plant with highly toxic sap, as an ingredient in the treatment of cancer. The
powder from the seed of *mujuthi* is also highly toxic. This, too, is used by herbalists for
the treatment of complicated malaria. Lay people use the leaves of *mujuthi* instead.
Another example is the root of *ndoroko*, which is poisonous, but is used by all three
herbalists. However, the root is used in very small quantities, together with an antidote
(*Kurogora*). Because some plants can be poisonous if not used carefully, the women I
interviewed are just content to experiment with basic remedies known to everyone.

If, in treatment, a herbalist targets one of the diseases, then the s/he gives an
opportunity for the other diseases to manifest themselves. Therefore, it is wise to target
all at once. Kanjiru further explained that treating one disease at a time is ‘playing trial
and error games’ on the sick person. According to Kanjiru, trial and error is mostly used
by the biomedical doctors in a bid to find out which medicine is good for the patient and
which one is not. By contrast, herbalists try their best not to use their patients for
experimenting.

The practice of not using patients for experimenting is an element of respect. Notably,
this practice threads through the moral fabric of the people of Kirumi. It is the general
feeling that society cannot run well when people are not respecting one another. There are
countless incidents of how people became ‘lunatic’ because they did not respect
themselves or someone else. Jiakathuku told me of another woman whose health
deteriorated considerably because she mistreated her mother-in-law by hurling insults at
her and generally making life difficult for her, thereby making it impossible for the
mother-in-law to live within the homestead. This woman’s husband built another house for his mother on a separate piece of land. After a few months, the elderly woman passed away. Within a few weeks of her passing away, the daughter-in-law lost her mind and exhibited bizarre behaviour. Although her mental condition had always been thought to be abnormal, this time she deteriorated fast and ended up committing suicide. Mental instability can often be attributed to situations where people have ignored their moral responsibility. There is a young man in tattered clothes who walks in and out of people’s homes, shouting meaningless words. His mental condition is attributed to cheating. He cheated a business partner out of a lot of money in one of their business transactions. I will discuss this personalistic view of health later, in Chapter Eight.

Clearly, respect is an important element in the keeping of good relationships. When one is not respectful, it means that one does not observe social obligations at the family and/or community level. For instance, a disrespectful man may fail to provide for his family or demonstrate any care for them. Instead of striving, along with his wife, to help raise the children and send them to school, a husband may spend most of his money and time at the local bar. A disrespectful wife may fail to demonstrate care for her family by not providing, or demonstrating the desire to provide, nutritious food for them. What is meant by ‘to demonstrate’ is a show of interest. Arguably, in some cases there is very little in terms of harvest or monetary income, and a woman is not in a position to prepare nutritious meals. However, her early morning walks to look for casual labour in a neighbour’s coffee farm do not pass unnoticed. Similarly, her attempts to grind gruel for her family win her respect among other women. A woman who grinds gruel for her family is well regarded. She is considered a hard working woman. Actually, one indication that an individual is in good health is her/his hard work, or ‘being about with their duties’.
If one is not respectful, people are likely to remark, “guti muntu uri au”, which translates as, “that is not a human being”. This pronouncement implies that the individual under scrutiny has lost her “humanity” and is disconnected from her family and community in a spiritual, emotional, or social sense. The consequences are that she succumbs to self indulgent habits like over-drinking, using drugs, and sex outside marriage or promiscuity. The individual may get all kinds of illnesses as a direct consequence of her behaviour which, in turn, is due to disrespect. The most commonly cited example of ill health resulting from lack of respect is infection with sexually transmitted diseases as a result of having sex outside of marriage. Also people becoming mentally disturbed as a result of habitual use of alcohol, *marijuana*, and *miraa* (*catha edulis*).

It is important to note that a person may be said to be in ill health even when s/he is respectful. This is because whenever the physical, social, spiritual, and emotional aspects are disturbed, one’s health is affected. For example, this may occur when a member of the family is very ill, there is death in the family, family feuds are occurring, or a condition of abject poverty exists.

**Nutrition**

There is a general awareness of what food can do to a person’s health, both in the long term and short term. When discussing nutrition, people cited examples of ill health resulting from the use of chemicals for the growing and the preservation of food, and from drinking water from streams that have been contaminated with chemicals. It is not only the chemicals from pesticides that are considered harmful; chemicals from flowering trees may also cause fevers in some people. The former has long term effects, but the latter has only short term effects. It is noteworthy that when some people, who react to plant chemicals, drink water from a well during the flowering season, they get fevers.
Similarly, if such people drink water from another geographical area, where there are different kinds of trees, which their bodies are not accustomed to, they are likely to become ill. It is believed that sap from the plants gets into the water through plant roots, and because the well water does not flow freely, the chemicals accumulate to a level which cannot be tolerated by some people. When I asked Joseph, the medical doctor with AMREF, about the claim that people get ill from drinking such water, he explained it as a case where people are bitten by mosquitoes and mistake malaria for other illnesses. He said that stagnant water is a breeding ground for mosquitoes. Further, Joseph explained that a recent government policy on afforestation has resulted in the overcrowding of trees near homesteads. This, too, provides suitable habitat for mosquitoes. Another fertile ground for mosquitoes is mangoes and cobs of green maize. Mangoes, when ripe, fall to the ground and, if not removed, decompose into a mash, an ideal breeding ground for mosquitoes. Green cobs of maize can provide similar conditions for mosquitoes. Joseph’s explanation is in keeping with his academic training as a medical researcher. Note that this explanation makes sense as far as the breeding ground for mosquitoes is concerned, but does not fully explain the issue with fevers that are associated with flowering trees. I will refer to Joseph’s explanation again later.

The type of food eaten, and how it is prepared, is also important for the management of health. It is important to note that, at the time of these interviews, there was famine in Kirumi, which may have heightened people’s awareness of the value of nutrition in the management of health. About the time I did my field study, rains had failed during the two previous seasons, and people were not able to make good harvests. People were, therefore, hungry, physically weak, and even emaciated. It was not unusual to go all day without a single meal. School children would come home for the lunch break and go back to school on an empty stomach, or at best having had little to eat. Because of lack of food
and awareness of how that had affected resistance to infections, the importance of nutrition in the maintenance of good health was on everyone’s mind.

The famine notwithstanding, it is clear from my data that nutrition is a key factor in the management of health. The type of food that one prepares for the family is important. It is also important to give different foods to young children, pregnant women, sick people or those who are recovering from serious illnesses, and elderly people. To illustrate the point on the importance of nutrition for health, Kagendo told me of how she helped her daughter-in-law recover from surgery. She told me that her daughter-in-law was very weak when she got home from the hospital. The first thing Kagendo did was to prepare light nutritious food. She made some light porridge from finger millet; this millet was the only food that the daughter-in-law took for three days: in the morning, mid-day, and evening. The grains Kagendo used for preparing the porridge are considered of very high nutritional value and are commonly used to make gruel. As noted earlier, gruel is a highly regarded food among the people of Kirumi and a person who is accustomed to drinking gruel is likely to remain healthy. It is believed that the reason people lived healthier lives a few decades ago is because they drank a lot of gruel. Gruel was their main food.

When fermented, gruel may provide immunity against malaria. To boost the medicinal value of the drink, a root of mukawa is soaked for some days in the gruel. Nowadays people do not drink that much gruel, and very few know of the use of mukawa root. Thus, the prevalence of malaria today is explainable, partly, as a result of weakened resistance because of poor diet. Another way of explaining the prevalence of malaria, according to Joseph, is as a result of the resistance of parasites to drugs. For instance, research reveals that cloroquin (generic name for a popular anti-malaria drug) does not treat malaria as well as it used to. This could be a result of misuse of the drug (although cloroquin may have a place in the cure of malaria; for example, in lowering temperatures
quickly, it is not a cure for malaria - yet doctors still prescribe it for a cure) or of miti. Note that miti have the chemical components of some of the official drugs, and, therefore, the mis-use of miti may have resulted in the resistance of the malaria parasite to official drugs. Joseph continued on to say that, because of global climatic changes that have resulted in warmer climates, *plasmodium* (malaria parasite) cycles are now shorter, and this means more mosquito bites. Admittedly, the linkage of miti to drug resistance needs to be clarified. It is important for people to understand how miti interact with commercial drugs or prescription drugs, and the overall implications for individual and population health.

Not only are people not drinking enough gruel for their immunity, the kinds of food they do eat do not help the body to resist disease. Everyone I interviewed agreed that, with the change in dietary habits, people have weakened resistance to disease. One woman remembers her late mother-in-law as a very healthy person: “Our mother never fried her food. She ate *mutiko* and drank a lot of gruel. She died of old age still a very strong woman” (JE, p. 7, 1997). *Mutiko* is made of beans, maize and green vegetables that are mashed with the powder of sun dried bananas. Women were emphatic about the notion of eating traditional foods for better health.

Another woman compared the elderly women of Tigania, a district more than five hundred kilometres from Kirumi, with the elderly women of Kirumi. She said that the women Tigania live long productive lives because they eat traditional foods, whereas the women of Kirumi become frail and inactive at a younger age because of eating fried foods, using a lot of sugar and salt in their diets, and not drinking enough gruel. Yet another woman compared the children of Kirumi with children who grow up in the city. She observed that ‘our’ children are physically stronger than ‘theirs’. It appears that, although people of Kirumi do not eat a lot of traditional dishes, they eat better than city folk.
What one eats also determines how well one's body can withstand traditional medicines. Like Kanjiru said, over doses or long usage of traditional medicines without proper nutrition can lead to poor health. That is why it is emphasized that individuals who take traditional medicine should eat nutritious foods and avoid over use of salt, sugar and frying oils. Salt, sugar and oil from fried foods are said to cause an imbalance of nyongo ['bile']. A diluted nyongo or a concentrated nyongo makes the body prone to illnesses. Nyongo is believed to be central to human health. It determines the body's ability to overcome disease. When it is healthy, the body maintains a balance of gana and murio: that is, 'a balance of 'bitterness and sweetness'. Imbalance results from an overuse of foods which do not have 'real' nutritional value to the body, such as salt, sugar and frying oils. Because some of the body's waste goes to the nyongo, waste from salt, sugar and frying oil can easily cause an imbalance. The imbalance may be corrected by eating the right foods and herbs. Sometimes a herbal treatment is required in order to correct nyongo. It is interesting to note that a popular phrase that explains healing is "gutaika giko kia nyongo" (Irai, IT, p. 43), that is, 'vomiting the waste from nyongo'. People use this phrase, mostly, to explain how a certain individual responded to treatment, mainly of malaria: 'niataikire nyongo', which translates to, 'the person vomited nyongo'. Maua was of the view that people should be educated about symptoms of illnesses, especially symptoms that are similar to those of malaria, so that people can target particular illnesses and not assume that every illness will respond to treatment, just as malaria does. As I will argue in Chapter Eight, many people are not well informed about herbal cures; their knowledge is fragmented and, therefore, they tend to make many errors with herbal cures. Those who are well informed about these cures, for instance, the herbalists, know the right cure for malaria, flu and other common illnesses. Even when they provide a single treatment for all diseases, like Kanjiru and other herbalists do, it is for purpose of
eliminating the common diseases. Therefore, this strategy is not to be mistaken for the fact that the herbalists cannot tell the difference among the diseases.

To avoid imbalances of nyongo, ideally, one would have to eat mutiko, gruel, and herbal soup. Irai says of herbal soup, “such soup is full of 'n'joya' [essentials]”. He illustrated this point by using his grandson, who was standing beside us as we carried on with our discussion. The boy had a runny nose and a slightly wet cough. Irai pointed at him and asked me if I could tell him what the boy was suffering from:

(I) Like this one, like this one. If you examine him - you see his nose is runny. If you ask his mother or father, they will tell you, ‘I think he [the boy] has a cold’. But myself, I understand, deeply, this one, if some herbs were boiled, and then there was some soup, then he takes that glass of soup in the evening, when you get up by morning, you will be surprised at what happened.

(W) Because, is it the nyongo or what is the real problem in this case?

(I) This one, this is a result of the kinds of food the boy is eating.

(W) The fried food?

(I) That is what I am trying to tell you. Some of the things people do, about convenience: these things do not have long-term benefits, no, there are no long-term benefits. The reason they are doing these things is because there are now ‘convenient things’ that one can do.

(W) Convenience.

(I) So much convenience. You know, if one uses miti in the right way, you see these mosquitoes, these so-called mosquitoes, they would not bite you.

(W) Because your body [Irai interrupts].

(I) Because your body will resist, it [mosquito] will alight on you but will soon fly away. But these other people, if you are in their company going to a coffee
farm, especially, you will hear them say, ‘no, I do not go in there, I would not go in there’. [Other people who do not have nutritious diets are susceptible to mosquitoes [IT, p. 56]

**Healing Skills**

The skills of healing that people posses have either been inherited or developed. ‘Inherited’ means that they were passed down through generations; ‘developed’ means that the individuals have experimented with what they know and modified it by adding to it, or by replacing some of it with what are deemed more useful knowledge and skills; thereby they arrive at a repertoire of useful knowledge and skills.

**Inherited skills.** Our forefathers and mothers, through experience and the processes of observation, and trial and error, came to know of plant, animal and earth products that can be used for the cure of certain illnesses. Through observing how animals, especially birds, interacted with different plants, poisonous plants were avoided. The plants that were not poisonous were then tried for their medicinal powers. Kago told me of how birds led people to the edible plants. She said that anything eaten by birds was safe to try. There are very strong similarities here with other indigenous knowledges, for example, Australian aboriginal knowledge, much of which is obtained through close observation of animals (see Christie, 1991).

One of the men I talked with added that, when looking for a cure, people experimented with thorny plants and plants with an unusual appearance. Such plants were believed to have something special about them and were associated with special powers, for instance, the power to cure illnesses. In the process of searching for a cure, an experimenter would taste a little juice from the thorny or unusual plant and “feel” it. If it ‘felt right’, the experimenter would, within the course of time, take more of its juice to try on various illnesses.
Bitter juices were selected, especially, for serious illnesses. Non bitter tasting juices were mainly used as tonics for calming and relaxing the body and as immuno-stimulants. Maua, the researcher of traditional medicine at KEMRI, referred to this as the “doctrine of signature”, where certain plants are connected with the treatment of disease based on the principle of similarity. Because bitter juices are “harsh”, they are likened to a “harsh” illness. But she also agreed that the cures are effective and there are chemical, physiological and pharmaceutical reasons behind *miti*. For instance, people mix various plant extracts in order to neutralize the different effects of chemicals. Also, soup is used as an ingredient in some of the herbal mixtures because it helps protect the gastric wall from the acids in the plant extracts. She said that most of this knowledge and skills have come through experience, trial and error, and intuition (see further discussion in Chapter Seven).

The majority of the participants knew that any juices to be taken in large quantities for the first time were to be given to domestic animals, like goats, in order to test if they were safe for humans. If the goat survived, then the juices would be given to humans in small quantities initially, until it was established that they were safe. This process of testing was more readily available to men than to women because men wandered into the forest to graze their animals and to hunt. As already mentioned, there were skills and knowledges available to women and not to men. This differentiation of knowledge was, of course, a reflection of the way social life was organized.

Women mainly experimented with plants within the vicinity of their dwellings because they (women) stayed around the home for the most part. Women used plant and earth products for the treatment of simple illnesses like colds, burns, headaches, “diaper rash”, sore nipples, menstrual cramps, after-birth condition, cuts, burns, bruises, eye infections, stomach discomforts, sore gums and so on. Mwiki told me of how diaper rash was cured with the use of very fine soil taken from the sides of an anthill:
Yes, long ago a child, because there was no powder, to prevent your child from rashes [in the diaper area], you take kithwa (anthill) soil and grind it and use it to keep the child dry. Okay, also the mitaumbu (the geko- giant lizard), you know them, there are places they visit on rocks and excrete some white excreta. This white one people ground it and put it on the skin of the child and the skin would heal. Also if the umbilical cord was unable to heal, most of us have done this one: if it is unable to heal, that excreta will do it. That is as good as dettol [dettol is an industrially manufactured antiseptic]. Now, this is the medicine which was used for a child’s umbilical cord. Instead of powder, especially for the chubby kids. Or use the soil from an anthill, the soil that has been purified by the ants with their saliva (IT, p. 185).

Note that dettol is a very expensive item, and many women who cannot afford it and do not know about the efficacy of mitaumbu excreta will wait for the availability of medical supplies in the local health clinic. Sometimes, due to the long wait for these supplies, infections become quite serious and may become a health risk to the individuals, their families and the community at large.

Coughs were treated with finger millet porridge cooked in a special variety of cocoyam leaves and a type of salt called ‘Igati’. Cocoyam leaves were cut into small pieces and boiled in salty water until tender; they were then blended into a solution which was used for cooking the finger millet porridge. A sick person was given this porridge to cure the cough and also strengthen the body.

It was relatively easy to respond to simple illnesses, but things got a little complicated when many and different plant parts, leaves, seeds, barks, flowers, and so on, had to be harvested, sorted out, mixed, boiled and prepared to be taken as a concoction or to be added to soup. Knowing the right varieties of plants to be used, the kinds and proportions of plant parts, the right amount of water to be used, how long to boil the ingredients or
how much soup to add to the end product, required a keen, experienced and hardworking person. To emphasize this point, Kago told me that, although knowledge is passed from older people to younger people, only attentive people acquire the knowledge. She added that it is a mistake to attempt to ‘pass on’ this knowledge to someone who is not interested or attentive. The concern is that such a person, because of lack of interest, could miss the important details and consequently make mistakes.

Mistakes could cost lives. For instance, if an inattentive individual were to prepare medicine using a mixture of roots and barks from various plants, s/he may not have remembered exact details about which plants cannot be used while flowering, what to use as a neutralizer in case male and female kinds are included, and so on. For the same reasons, if a herbalist did not trust a particular family lineage, s/he refused to treat people from that lineage. Irai noted that sometimes such people would come to you with ulterior motives. They would request treatment, although what they really wanted was to gather some information on the types of plants you use and maybe use this information against you. Later they would fabricate information and impress upon people that you had once used these same plants to cause injury to somebody. Irai, therefore, would only treat or share information with people from a background he could trust. Note that other herbalists, too, Kanjiru and Mwambia, claimed to share information with people they can trust.

For the same reason, some knowledge about which plants are used for particular purposes is not to be passed on without much caution. An example is those plants that can be used for family planning purposes. Irai’s son explained that if the knowledge that these plants may be used to procure an abortion or to interfere with pregnancy got out to the general public, people would begin to use them carelessly, thereby endangering lives. He said that it was enough for people to know that such and such a plant was not suitable for women of child bearing age. Subsequently, if any woman had a need that required the
use of these plants, then she consulted with a herbalist. Herbalists had special skills and
knowledge of healing with plant, earth and animal products. To an extent, lay people
required some of these healing skills in order to manage their health on a daily basis, but,
among the general population, not everyone had the special skills that are required in the
selection of herbs or in preparing them.

Apart from the herbalists, only a few experienced people have the skills and
knowledge required to tell which plants and plant parts, and animal and earth products are
safe to mix. For instance, is it safe to mix the bark of mukwego, used to cure rheumatism,
with the root of mukawa, normally used to cure fevers and to keep the body protected
from illnesses? Could one mix the two plant parts to cure rheumatic fever and to keep the
body healthy? It was common practice to soak mukawa root in ground gruel and use the
gruel to keep the body healthy. Would it be safe, then, to combine the plant used to cure
rheumatism with the one used to enhance the body's immunity?

Other skills, like the harvesting of roots and barks, require a lot of experience. As I
observed Irai's son search for the root of mukawa, he explained that it is important for
one to know the different types of roots in the bush or forest, in order to pick the correct
root from a myriad of other roots that may be intertwined and enmeshed below the soil.
Sometimes, even when one starts looking for the root at the point where it is attached to
the stem of the desired plant, there is still a likelihood of picking the root of another plant
in the vicinity. Therefore, considerable skill is required in the picking of roots.

It is equally important to know which plants cannot be used while flowering, which
ones can, and which plants have female and male kinds. Usually male and female kinds
of one plant cannot be mixed in a preparation, and, if they are, then another plant is used
to neutralize the toxins that result from mixing male and female kinds. Similarly, if a
plant is used while flowering, another plant will be used for neutralizing any toxins from
the flowering plant. There is obvious danger if one misidentifies a plant part to be used
for preparing medicine. Misidentification could result to the preparation of poisonous medicine.

A proper mixture is one that is not poisonous and one that can last for a few days without spoiling. However, not all medicine was prepared to last a few days. Sometimes medicine was prepared to overcome the critical stage of an illness. Such medicine was given in only one or two dosages. It was prepared from many potent plants and, therefore, was not expected to remain stable for long. The immediate purpose of this medicine was to overcome the critical stages of an illness prior to the individual being given a regular dosage to cure the illness. Some of the medicine was very strong and it was important to know who could be treated with the medicine and who could not. Elderly people, children, pregnant women, and frail individuals were not given very strong medicine. The course of treatment for them was different.

Illnesses that did not respond to treatment with herbs were treated by the use of physical and/or spiritual forces. An example is pneumonia (giteu) in children: when children had giteu they were dipped, before sunrise, in a very cold river or stream. The child would react with shock because of the icy cold water. The shock “distributed the disease through the body, making it easy to dissipate from the body” (JE p. 10), one woman explained. She went on to say that “the child would cure immediately. It worked then, but if you try it now the child will die. It worked because we had no otherwise”.

When an illness defied all known herbal treatments, a diviner was consulted. The diviner would consult with the spirit world to rid the sick, or the family of the sick, of curses or other forms of evil that were believed to bring illnesses. The reason a diviner would consult with the spirit world was in order to incorporate the psychological aspect of treatment: this personalistic mode of treatment is, sometimes, complemented with the naturalistic mode of treatment. There is more discussion on the personalistic mode of treatment in Chapter Four.
For contagious illnesses, the sick person was to be isolated, or a quarantine was issued for the affected region. For instance, an individual with a communicable eye infection or skin eruption was left inside a hut for the period of infection. Everything was done to try to cure the infections, while healthy people minimized contact with the sick person. Often, such people would subsequently go blind or die from the disease. When an entire village had a communicable disease, like dysentery, a quarantine was issued for that village or geographical region. A select group of elders would place symbolic items (*ntongu* and *nkorombe*) at points where this village bordered other villages in order to warn people from going into the village and the villagers from leaving the village. When the husband of one of the participants was telling us about quarantine, he also remarked that things were very hard in those days and that they are much easier today. He said that people have come a long way and now manage health differently. This man was referring to the convenience that hospitals offer, and especially, the ‘isolation wards’ where people with infectious illnesses are housed.

It is important to think of how people manage health differently or similarly. This will aid in the discussion of the ways in which people currently explain and understand health and healing. This is a central concern of this thesis that will be elaborated in the next chapter. The questions ‘how different or similar?’ and ‘what is different or similar?’ are interesting and revealing. ‘How different or similar?’ is a question I asked myself many times while in the field. I had useful insights from the people I interviewed, and sometimes very problematic remarks like this one made by Jiakathuku:

(J) People have lost faith because they used to die while still being treated with herbs. Now what we value is cleanliness. We were brought cleanliness *Wanja*. We were brought cleanliness by the European. The European came, brought clothing, brought salt. Before that, we used salt from the earth, we would
scoop salt from the ground just like that. The European brought good things for us, we emerged from ignorance. Actually some of the things I only hear about, I did not experience them.

(W) Yes, most of us did not experience some of these things.

(J) Long ago people used to try things because they did not know better.

(W) Some of the things they did were valuable though. Seeing as we still do them, like grinding gruel, for instance. I believe even the herbs people are using are valuable. Only we need to do more work to get them in a ready form.

(J) Yes, even though they [Europeans] discouraged us from using our herbs, they also get their medicine from plants.

(W) Do you think our medicine is effective?

(J) Yes, yes, yes. medicine is derived from plants, from plants. (IT p. 83)

I stated in chapters One, Three and Four that Jiakathuku’s views could be explained in the context of a ‘schooled science’ that has managed to denigrate all indigenous forms of knowledges and skills. Also, conventional technology has provided a lot of convenience, and, unless one takes the time to do some critical reflection on the value of such convenience, then she/he easily falls into the trap of thinking that current conditions of living are progressive, and previous conditions of living were retrogressive. Of course, overall, Jiakathuku has been made to believe that her own knowledges and skills are ‘unworthy’. I mentioned in Chapter One that this remark was a great influence in the shaping of my thesis. Also this remark influenced, to a large extent, the literature review and theoretical framework of my study.

Having read the previous chapters, one can see where Jiakathuku is based. She has the notion that because mucunku’s (European) knowledge (read schooled science and technology) is ‘pure, universal and objective Truth’, then mucunku should be credited
with 'our current [good] conditions of living'. As I argued earlier, the high school science curriculum and popular media have promulgated erroneous views of and about schooled science that have served to distort the reality of what schooled science is and what its place is in everyday life. It is no wonder that Jiakathuku holds such a view. I will discuss later the implications of views such as Jiakathuku's for everyday problem solving.

**Experiential skills.** Earlier, it was stated that inherited knowledge was passed on to keen, interested and hardworking individuals. This is largely a consequence of the pedagogy used when passing on knowledge through oral means. The learner is required to be attentive, to ask questions, to be around the teacher in order to get all the necessary details by observing, trial and error, and to ask questions whenever in doubt. Kago told me about this mode of learning (IT, p. 154-155).

(W) Also, how did you know which plants to use for certain illnesses?
(G) You were told by older women. Just like I am telling you now and you are writing to go and tell others. That is the way we learned as young women. [An inaudible section - she is telling me something about the cure of a toothache].
For malaria you use *mucugucugu, mwangua* leaves, *mutuntu* leaves, *mua* leaves, *makandu* and *mucegene* and cook them. When the water is red, the medicine is ready. ...
(W) About these plants, you have told me that you learned from older women.
(G) Just like I am telling you now.
(W) Since the number and types of plants that are used have increased with time, who decides what to add and so on? Take, for example, the *kiua* you have just told me about; it is not an indigenous of this place.
(K) Yes, *kiua* was brought to this place.
(W) Therefore, who determined that *kiua* could be used as a cure for malaria?
There are some people who were doing that kind of work for God [inaudible section].

How did they know they could use *kiua*?

But you know.

Oh no, I do not know.

I have just told you and then you will go and teach others. These others will be asking you where you got that knowledge from.

My question is: how does the initiator of all the telling get to know the information? How do they go about knowing what is the right plant for this disease or for that?

This knowledge was passed along from older people. And we have many people, most of them going to Nairobi [the capital of Kenya] [inaudible section].

Maybe the initiators of this just tried.

Yes, they tried. They did not just know. They ventured. It is like when a teacher teaches and only the ones with good brains become wise....

That is because there are, and were, teachers to teach. Now I understand.

Kago’s conversation with me is a good example of situations where women felt that I should have the knowledge and, therefore, my asking was seen as being too probing or even pretentious. For instance, Kago’s answer to my question, “who determined that *kiua* could be used as a cure for malaria?” was followed by a ‘coded’ answer, that is, “there are some people who were doing that kind of work for God”. Her answer was not clear to me so. I inquired some more. She impatiently remarked in reply, “but you know”. Also, as I mentioned earlier, the language used by older women and men was sometimes unclear to me. My research assistant, Mumu, decoded the language whenever possible. When this
was not possible, maybe because the flow of conversation did not allow her to intervene, as was the case in the incident with Kago. I tried to exert myself.

Kago continued to explain how knowledge is accumulated. Sometimes, when people travel to other geographical regions, they take with them and bring back information on plants or animal products that may be used for the cure of illnesses. They bring this information back with them, even bringing some of the plants for the purpose of growing them in their village. An example is Mwambia, who acquired his skills for treating chronic syphilis from Thika, a town which is about 150 kilometers from Kirumi. In the next chapter, I will discuss more about how knowledge is acquired.

Learning may also occur in the ways described by Irai and Kanjiru. By collaborating with Dr. Jevi, a missionary whom Irai (IT, p. 64) described as, "ni muntu waiji mila", that is, "he respected our traditions", Irai discovered that one can use oil from the queen ant in place of cod liver oil, which had become popular as a cure for coughs but was not readily available. So, when Irai's child had a persistent cough, Irai prepared some oil from the queen ant for him. Irai was experimenting with what was available and made sense to him. Kanjiru's story concerns her child, who was experiencing fits and seizures. Desperate because she had no medicine to give to her daughter, she meditated, and, through a vision, she was shown three ingredients which she could use to treat the seizures: majuthi leaves, pig oil, and sheep oil. (Pig oil is obtained from any part of pig's meat. Sheep oil is obtained from sheep's tail, kanyanya.)

When she gave this mixture to her daughter, her daughter recovered almost immediately. Her daughter had been cold, stiff and lifeless, and Kanjiru feared she would soon be dead if something was not done. She had been unable to obtain treatment for her at the mission hospital because she had no money to pay for the treatment. The hospital staff had turned her away. In desperation, Kanjiru prayed for a cure and, through a vision,
God showed the three ingredients to her. She had no knowledge of herbal medicine prior to this. Kanjiru's intuition will be discussed further in Chapter Seven.

Like Kanjiru, other women experiment variously with these herbs, often by modifying basic remedies. An example of a modified basic remedy is the one used by Anastasia and several other women for treating whooping cough. Anastasia related how a number of women from the village where she grew up (this village is in a neighbouring district) came up with this cure:

We took the basic ingredients for a cough, which are lemon, egg yolk and honey. Because an egg is very nutritious, we decided to use a whole raw egg, with the shell. We let it stand in half a glass of lemon juice for seven days, after which the egg had dissolved and all one could see was a little deposition at the bottom of the glass. We stirred the egg-lemon juice mixture to make it uniform and sieved it to get rid of any particles. Then we added a spoonful of honey to the solution. The children who drank the mixture got cured of the whooping cough very fast. You could also add sheep oil if you want. That will make the medicine even more effective. (IT, p. 45)

This is yet another example where ideas are borrowed and integrated with the existing ones. I will allude to this mode of integration in Chapter Eight and Chapter Nine, when suggesting how school science may be integrated with the local knowledges and skills.

In this example, Anastasia and others put their ideas together at a seminar, to come up with the whooping cough medicine. This seminar, in particular, was organized by the local hospital as part of its health education mandate. Many other seminars are organized by the Ministry of Health in order to promote primary health care (PHC - see Chapter One for an explanation of PHC). These seminars are led by knowledgeable people from the local areas, the ministry or local hospitals and dispensaries.
Other ideas which have been learned at seminars include the use of pawpaw seeds for treating stomach 'worms' like amoeba. For 'stomach worms', people formerly used menywa seeds, when the menywa plant was still available. The women I interviewed attested to the power of menywa seeds for the removal of stomach worms. Long ago, it was very common to give a sick child a spoonful of ground menywa seeds mixed with a little water, first thing in the morning. Almost immediately the child would have a bowel movement of feces full of worms. Unfortunately, because riverine ecology has changed considerably in the last four decades, this invaluable plant, which grows on swampy riversides, is now found only in a few forest areas around Mount Kenya. However, pawpaw seeds provide a suitable, if less effective, alternative to menywa seeds.

Women have found that pawpaw seeds, although not as effective as menywa seeds, are far more effective than pills given at the dispensary or the mission hospital. I heard many accounts of how individuals suffered from amoeba for years before they learned that pawpaw seeds could completely eliminate amoeba. Another way of keeping stomach worms out is to make regular dietary use of the bitter vegetable, mariaria. Sadly, this once very common vegetable is now very hard to find.

Overall, women use their inner senses to guide them in trying out medication they have never heard of before, as in the following example. As I was interviewing one woman, and we were surrounded by several young children, she reached out for a tendril from the shoot of a yam plant, broke it, and began to apply the juice from it on patches on the head of one of the children. There was spontaneity and ease in her action. When I asked her if the juice from the tendril of a yam shoot was medicine for the skin problem she was treating, she said that she was just trying it. The one time she had used it before it worked, and so she thought that she should "try again" (JE, p. 27).

Similarly, Mwiki has been experimenting with plant extracts which, she says, help her to keep healthy. She remembers growing up in a family where no one used bio-medicine.
Her father made medicine for her and for the rest of the family. Now she can remember some of the plants which her father used, but not all. Therefore, in managing her health, she mixes the plants depending on 'how it feels'. If it feels right, she will try it. For instance, she uses a mixture that is normally used for the treatment of malaria as a tonic whenever her body feels 'kumata' or 'dense'. She drinks the mixture and bathes in the rest. Bathing in the solution gives her a sense of well being. Mwiki told me that, when she treats her body this way, she feels better by the following morning. Because of this practice, she has never suffered from malaria. When I asked her where she got the idea that she can bathe in the medicine, she said that it is based on an old time practice of steaming the body with leaves of *meno* and *makuri*. In other words, Mwiki has modified some of the knowledge she learned from her parents to suit her present health and healing needs.

As already mentioned, not all women are conversant with inherited knowledge and skills. Kawira, for instance, did not know many of the inherited skills. However, when her illness of three years threatened to cripple her body, and various diagnoses and treatments through bio-medicine had failed to cure her, she turned to herbs. As she told me:

(M)  Somebody told me that since I was suffering too much, I should seek help from various sources. The person suggested that, 'since you have already been to the best hospitals and not gotten cured, and they cannot diagnose your illness, you should go out and gather roots from plants'.

(W)  Did you know about these roots then?

(M)  No. I did not know about plants as cure for illness. I asked the person, 'which ones I should look for, in particular?' The person suggested I should get any plant that I know is used for cure. He said I should use everything and also try
some that are used for cows. I should try them all in an attempt to get my health back. (IT, p. 1)

Kawira is like many women in Kirumi, who spent most of their time in formal schooling, and did not get a chance to acquire adequate knowledge and skills about indigenous health and healing. The person who was recommending herbs to her was aware of this fact and the advice to “use everything and also try some that are used for cows” was meant to direct her attention to the notion of trial and error. Trial and error is a useful means for finding a cure when one has no diagnosis, as in the case of Kawira (see full story in Appendix G). As already mentioned, cures that are safe for domestic animals are, in most cases, safe for humans.

Following this advice, Kawira tried various herbs and noticed some improvement. Subsequently, she consulted a herbalist and was given several dosages of medicine that cured her completely. While ill, she did not do anything around the house; she just lay all day on a mat. After the initial herbal treatment, however, she was well enough to go about the house. With more treatment she could go to the farm to work. The people who saw her working in the farm were amazed at her recovery and were curious to know how she got cured.

At the time, 1993, Kawira was afraid to tell people that it was a herbalist who had treated her:

(M) I was afraid I would be excommunicated from the church. Other believers would say that I had been bewitched and I was seeing a witch doctor who had prescribed those herbs for me. I did not want anyone of them to know. I confided this dilemma to a friend who, very concerned about my situation, suggested that I should go to hospital like I used to than take this other
treatment which I was not comfortable with. I quickly cautioned the friend not to tell anyone lest I be excommunicated from the church.

(W) Now, since you did not know those plants, did you always have to ask someone?

(M) I was using the ones which were used by cows. Whenever I was told it was safe for cows, I would use it. The herbalist then told me to use majuthi and the root of mugucwa. The person suggested that I wash with the solution from majuthi. That is how the miracle happened .... (IT, p. 4)

Kawira’s fear of getting excommunicated from the church was based on the views held by many people at the time, that herbal treatment was ‘unholy’ and ‘witch crafty’. Kawira knew that if members of her church came to learn that she had visited a herbalist, they would excommunicate her from the church, and others would think she was being ‘backward’. Interestingly, although her friend did encourage her to seek help from herbs, her real inspiration came from a programme aired on the national radio station. In this programme, information about herbs and where to find qualified herbalists was given. This is an indication that indigenous health and healing is acquiring some recognition in the schooled domains (also see Chapter One, section on health situation). When Kawira heard the announcement, she thought to herself, “if they can say this on radio, then it means it is okay to take herbs. I am going to tell my husband to take me to one of those qualified herbalists” (see Appendix G).

Like Kawira, many women do not have enough knowledges and skills to prepare their own medicine to cure serious illnesses, with the exception of mild malaria, which the majority know is cured with a mixture of majuthi and murubaine leaves. For other serious illnesses, like rheumatism, syphilis and stomach ulcer, it is not easy to select, sort and mix herbs. When Mwambia, a herbalist, was educating me on some aspects of selecting
herbs, he said that there are four plants that are used as basic ingredients in all medicines. What varies is the way they are mixed and what else is added to them. He used our common experience of cooking food and preparing gruel to give me an idea of the amounts of plant parts and water to use when preparing medicine. Mwambia certainly knew the right analogy to use with me, since I have very little experience with herbal preparations. At least he knows that I have had experience with cooking and with preparing gruel. Maybe he would have used a different analogy for someone with more experience with indigenous health and healing.

(W) And how about measurements? How much water and what is the size of the bark?
(M) You have experience with cooking food, what you do is add water so it does not dry up before they (plant parts) are cooked. You measure so that by the time they are cooked, there is enough water. And you can tell when there is the right concentration.
(W) So then is it about feeling? Like when I measure salt for the pot of food? I do this by feeling that it is right. Your senses tell you that you put enough.
(M) No, no.
(W) Because there seems to be no measurement.
(M) Do not worry about measurement, use enough water, if any of it remains, you can save it. If it is too much, like when you grind gruel and it becomes diluted with water, what do you do with it? Do you not just save it in the gourd and use it?
(W) I would like to understand this better so I can instruct others when the occasion arises. And nowadays people want to hear about measurements. They want you to tell them, for instance, take this amount to boil and so on.
To boil, just size a pot with the plant parts that you have got. In putting water, you could put two cupfuls of water, for instance, knowing that one cup will boil away as the plants cook and you will have the other cup left. That is measurement.

Measurement by the mind. (IT, p. 165)

The issue of measurement is discussed further in the next chapter.

Mwambia had mentioned earlier that experimentation and experience were necessary in order to perfect the measurements. The other two herbalists that I interviewed, and women who know about herbs, agree that both experimentation and experience are essential elements in the development of expertise in this form of healing. The experienced know the right proportions of the roots, barks and leaves. They know how much water to use for boiling or for diluting the powder made from these plant parts. Also, because these people know a variety of plants and their properties, it is easy to decide which plants to use for experimentation.

With regard to experimentation, Mbai told me that people search their memories for a priori knowledge of curative measures. This knowledge may have been inherited, heard on the radio, acquired from a friend who had travelled to another geographical region and heard of it there, learned at a seminar, or overheard as other people related their experiences of healing. Clearly, there is not one way of acquiring knowledge and, as stated in Chapter One, indigenous knowledges and skills have at one time or another benefitted from knowledges and skills from other local areas. Therefore, none of these knowledges is static. After searching their memory, they try to ‘see’ if the herb will cure them.
Somebody may think of their illness, and say, I am ailing either from malaria or pneumonia or measles, or whatever other disease may afflict the body. Then I think, now what would help me? Maybe I should go pluck banana leaves, cook them, and see if it will help, you know: these are your own thoughts. So you try on your own. Now, if it helps, the next time, you do the same thing, because this is now your medicine. You try, yes, you try. (Mbai, IT, p. 144)

Again, Mbai stresses the importance of experimentation.

To underscore this point, in answer to my question on how one comes to the conclusion that a banana stem is the one to try and not one from any other tree, like the mango tree. Mbai said that some of the remedies, like pig oil or sheep oil, are "usual" and anyone would begin with them. That reminded me of Kanjiru. When her daughter got seizures, she resorted to using pig and sheep oil and one of the plants, mujuthi, that Mwambia said was among the basic ones for healing. Mwambia said that people normally begin with these basic remedies before they move on to more complicated ones.

Through the same process of trying, a herbalist may seek to cure a patient of an unusual illness like a stomach ulcer. Kanjiru, a herbalist, told me how she cured another woman of her ulcer by 'just trying'. She said:

Now, we (herbalists) do not easily know which one (referring to plant, earth, or animal products) to use when we are not familiar with the illness. What I do is I search for the ingredients and prepare medicine for the patient. After the person has taken the first dosage, I observe if he is improving. If he is not, I substitute some ingredients as I deem necessary. (IT, p. 129)

This is another example of experimentation.
Kanjiru used this procedure to treat my stomach acid. When the first dosage did not work for me, she eliminated one of the ingredients when preparing the next dosage. She said that she eliminated that ingredient because it did not have medicinal value; she had included it, initially, in order to stabilize the mixture. Because I got a reaction from the mixture, she thought that the ingredient may have interfered with the effectiveness of the medicine, largely because one of the properties of the ingredient she eliminated is to cause stomach upset in some people. Kanjiru also told me that she may use this method of elimination to determine the plant parts, and animal or earth products with active ingredients when she has to administer medicine to someone.

Normally her medicine consists of a variety of plant parts, and animals or earth products, and it is difficult to tell which of these is the active ingredient. However, she can determine the ingredients or ingredient that may cause the prepared medicine to spoil by leaving the medicine to stand in a clear bottle, undisturbed, overnight, to determine if it is a stable mixture and therefore safe to use for a number of days. A stable mixture of potent herbs does not change colour or appearance after sufficient boiling, sieving, and bottling. Sometimes many potent herbs are boiled together when treating a very serious undiagnosed illness, so it is important to let every solution stand for a few hours after preparation before taking it or giving it to anyone. Any undesirable reactions happening in the solution can be detected at this point.

When an illness has not been diagnosed, a herbalist may prepare strong medicine of all known and compatible herbs, and give it to an individual. The herbalist then monitors the progress of the illness by observing any symptoms that emerge. Symptoms such as a cough, cold, headache, or diarrhoea are then treated with specific medicines. I also learned of this concept of 'removing' the disease (*kuruta murimo*) from a number of women. These women have used the approach on their children mainly for the treatment of measles. Whenever they suspect that their child is ailing from measles, they give the
child herbs that 'remove' the disease, that is, the herbs let the disease show itself. It appears that, once the disease has been 'removed', it responds to treatment faster than if it is treated while inside the body. The way they know that the disease has been 'removed' is when the child develops a cough and rashes all over the body. At this stage they take the child to the hospital for an injection. The child heals faster from the injection than if the measles had been 'found in the body by the injection'.

**Summary**

The practice of health and healing varies greatly from individual to individual. From this study, I learned that most women combine bio-medical and bio-cultural approaches in health and healing. Others, like Anastasia, Harriet, Kago, Makena, Mariamu, Mbai and Mwiki, lean more toward bi-cultural than bio-medical, that is to say, they will rely on biocultural healing methods until they are convinced that these methods cannot cure the illness. The same goes for the herbalists, Kanjiru, Irai and Mwambia. The herbalists, however, stretch their trust in bio-cultural healing further than anyone else. They were fully convinced about the benefits of the bio-cultural approach and were indignant about people who had little faith in it. None of them confessed to having been to a hospital, but also they did not say that they would never go to a hospital. Maybe 'if the worst came to the worst' they would. Kanjiru did say that she stopped going to hospital after the ordeal with her daughter. The ordeal was also instrumental in her discoveries of *miti*. Also, at one point of my field study, Irai was down with a persistent phlegmatic cough, a cough that most other people would have considered a serious candidate for hospital treatment, but he treated it with *miti*. On the other hand, when Mwambia succumbed to serious joint pains, his family insisted that he had to go to the hospital. However, he declined the offer and members of the family, afraid he might die, called in a nurse to give him an injection. With much misgiving, Mwambia recounted how they forced him into accepting an
injection. In fact, after the pain subsided, he prepared some *miti* to nourish and strengthen his body. Mwambia regrets the fact that his frail body cannot endure the process of *miti* preparation. When he was still strong he would never have succumbed to such an illness. That is because he was able to monitor the needs of his health and target any weaknesses using *miti*.

Interestingly, other participants will rely on bio-medicine until they are convinced that bio-medicine will not provide a cure; then they turn to the bio-cultural approach. On the other hand, Jiakathuku claimed to use bio-medical methods exclusively. Only four other women within the population claimed to use bio-medicine exclusively. Two claimed to use an exclusively bio-cultural approach.

I also learned that the knowledge women have of herbal medicine varies from individual to individual. Some know a lot, while others know very little. Some desire to know about herbal healing, while others do not desire to know.

Overall, men have a broader knowledge of *miti* preparation. This is because men have more opportunities to venture into forests and bushes than women do. They also have more time to reflect on cures than women, who are constantly interrupted by domestic demands. However, given their role as care givers, women use their skills and knowledges more widely than men. In summary, women's and men's knowledge of health and healing is based on their nutritional skills, moral obligations and healing skills.
Chapter Seven
Bases of Knowing in Kirumi

Preamble

In Chapter Four I mentioned that ‘seeing with the eye’, or what Oyewumi (1997) refers to as the “gaze of the physical”, has been privileged over other ways of ‘seeing’. This privileging has consequently “promoted what can be seen over that which is not apparent to the eye”, thereby it “misses the other levels and the nuances of existence” (Oyewumi, p. 14). Subsequently, other human constructs such as ‘respect’ and ‘community’ have been de-emphasized in ‘science’ education (J.P. Miller, 1993; R. Miller, 1993). In this discussion I will attempt to appraise other human senses (besides the eye) and constructs. In the next chapter, I will show the possibilities of integrating ‘other’ human senses and constructs into the practice of school science.

Throughout this chapter, I will make reference to past and discontinued indigenous practices in order to provide a context for discussing contemporary indigenous practices. For instance, I recount how the kinship system, in its original form, operated. This will set the context for explaining the value placed on respect in contemporary living.

Based on my analysis of the data, I have formulated three broad categories that explain how people come to know what they know. Where possible, I explain these categories by reference to the published research. The discussion will touch on many thorny issues in epistemology. Among them, is the question: ‘How can people be certain of what they claim to know?’ In my response to this question, I include reference to norms and customs, feelings, prayers, meditation and reflection as means of gaining knowledge. Of course, such epistemological premises do not count as sources of acceptable knowledge in schooled science.

Schooled science is largely based on the theoretical foundations of rational empiricism, whose naive emphasis has given SS a wrong image, that is, as pure, objective
and universal knowledge acquired only through observable and measurable means (see Chapter Three). The emphasis on observation and measurement, attributes that can be ‘seen with the eye’, has greatly restricted the creative use of other human senses and constructs that cannot be ‘seen’ or measured. An important feature of observing and measuring, in this regard, is the controlled experiment. The controlled experiment enables variables to be singled out for investigation. The data so obtained are quantified through mathematical or statistical symbols. Therefore, anything that is not quantifiable, such as feeling, does not count as legitimate knowledge.

However, for a long time now, philosophical and social studies of SS point to the fact that feelings or, in the field of epistemology, what is known as intuition played, and still plays, a significant role in scientific achievements. However, knowledge acquired through intuition is hard to test. Such knowledge, though its products may be similar to those arrived at through the ‘scientific method’ is therefore not ‘science’. It may be characterized as “revealed science” (Miller, 1985, p. 373). Consequently, data from intuition are said not to yield conclusive evidence and, therefore, are not acknowledged in ‘science’ education. Moreover, there is a concerted effort within the scientific community to deny such data. As Polanyi (1962, p. 9) observes:

Accordingly, scientific theory is denied all persuasive power that is intrinsic to itself, as theory. It must not go beyond experience by affirming anything that cannot be tested by experience; and above all, scientists must be prepared immediately to drop a theory the moment an observation turns up which conflicts with it.

There is reason to believe, too, that intuition is integral to the practice of school science. For instance, in the context of science practical work, students who are able to manipulate experimental investigations are sometimes unable to explain what they do. The ability to perform and yet be unable to explain is discussed by Masters and Nott (1998). They say that knowledge acquired through regularly repeated patterns, such as in regular laboratory practical work, is not explicable. Masters and Nott observe that such
knowledge, implicit knowledge, is not explicable in the way that traditional school demands. This form of knowing is also not acknowledged by official curricula. It is worth noting that if such knowledge forms are not acknowledged, by implication they are discouraged.

The rest of the chapter is a discussion of the bases of knowing in Kirumi, that is, embeddedness and connectedness; visuality; networking and censorship.

**Embeddedness and Connectedness**

This refers to a situation where people are rooted in their environment, both spiritually and socially. It is a situation where people are governed by 'regulated conduct and customs'. It is best described by the rootedness exemplified in Lawino’s famous salutation to tradition in Okot P’Bitek’s *Song of Lawino*. This satirical comedy is set among the Acoli of Uganda. The chief character, Lawino, is bemoaning her husband Ocol, who has left his 'ways' for the White man’s 'ways'. She likens Ocol’s ways to a pumpkin. Pumpkins, a luxury food, grow wild in Acoli land and “to uproot [one] even when you are moving to a new homestead is simple wanton destruction” (Heron, 1966, p. 7). Therefore, Lawino tells Ocol that “the pumpkin in the old homestead must not be uprooted” (p’Bitek, 1966, p. 41). The emphasis is on being ‘rooted’ in your own ways while, at the same time, not despising other people’s ways.

Listen Ocol, my old friend,
The ways of your ancestors are good,
Their customs are solid
And not hollow
They are not thin
Not easily breakable
They cannot be blown away by the wind
Because their roots reach deep into the soil
I do not understand
The ways of foreigners
But I do not despise their customs
Why should you despise yours?
Mbiti (1997) explains such rootedness with reference to world views, cultural particulars, and engendered beliefs. For example, he uses the concept of time\(^9\) to explain Africans’ attachment to ‘land’, or their rootedness. Among Africans, time is phenomenological, that is, it is marked by events. It is two dimensional and is based on events that have already taken place or are taking place. What has already taken place is in the zamani period (kiswahili word for past) and what is taking place is in the sasa period (kiswahili word for present). Events in the future are only included in the time frame if they fall under the “rhythm of natural phenomena”. This future time is understood as potential time. In view of this, Mbiti (p. 26) explains rootedness as follows:

What matters most to the people is what is geographically near, just as Sasa embraces the life that people experience. For this reason, Africans are particularly tied to the land, because it is the concrete expression of both their Zamani and their Sasa. The land provides them with the *roots of existence* [emphasis added], as well as binding them mystically to their departed. People walk on the graves of their forefathers, and it is feared that anything separating them from these ties will bring disaster to family and community life.

Mbiti’s (1997) point is that the forefathers and the land that connects them with the living are central in the continuation of the web of life. He further argues that, in order to sustain this web of life, people must conform to societal expectations. To ensure this conformity, there are/ were laid down customs and social expectations. These guide/d general behaviour, significant life events, and phenomena such as birth, marriage, death; floods, famine and so forth.

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\(^9\)Mbiti’s (1997) concept of African time has been disputed by several African scholars (see for instance, Hountondji, 1983; Masolo, 1994; Oruka, 1990; Wiredu, 1996). He is especially criticized for implying that African time has no future dimension and, of course, for using such cultural materials to explain an African philosophy (see also Chapter Four). These debates make for very interesting discussions. However, a discussion on these issues will require more time and space than I can afford at the moment. I must mention that I find Mbiti’s ideas on time fascinating, original and, in my current understanding, plausible. Certainly, this is why I have used his ideas to explain ‘rootedness’. I hope in future to inquire more into this concept of African time.
In the past, all aspects of life were regulated this way, thereby ensuring stability in the family and community. Such stability guaranteed the continuance of socio-cultural values or roots of existence. One such socio-cultural value, respect, is still central to the health of the people of Kirumi. Participants in this study explained respect as reverence for relationships: relationship with oneself and others. It was also implicated in the way people related to animals, plants and the earth. The basis of respect is best understood in the context of kinship and age-grade systems, and child socialization.

**Kinship and Age-grade Systems.** Mbiti (1997) describes kinship as the strongest force in traditional African life. It is the basis of socio-cultural values as expressed or defined through relationships, such as parent-child, mother-son, mother-daughter, father-son, father-daughter, in-laws, and so on. The basic unit in the kinship system is the family (mbari). Mbari consists of all ‘near blood’ relations, that is, man and wife or wives, their children, and their grand and great grand children. Many mbaris who “descended from one family group in the remote past”, but whose identity in blood relations disappeared, form a clan (mwiriga) (Kenyatta, 1938). These lineage strata have functioned to ensure the maintenance of social coherence and the continuing survival of the mbari, mwiriga and the larger society, the ethnic group. From within the mbari and mwiriga, elders were selected on grounds of wisdom, tact and honesty. They stipulated, mandated and executed matters pertaining to social values, work organization (including the organization of physical defense), interpretation of unusual events (for example, droughts, floods, epidemics and the birth of twins and associated rituals), and so forth (Kenyatta, 1938).

These elders, both men and women, were also members of an age-grade created through initiation (Imanyara, 1992; Kenyatta, 1938; Njiru, 1981). Note that among the Meru, for instance, initiations were instituted once every seven years. (This was, however, dependent on other factors, like the availability of food.) Thus, roughly once in seven years, all young men and women in one mwiriga who had attained the age of maturity
were initiated. Currently, most people “initiate” their children privately and there is no control of when or where this can be done. Moreover, many will have the circumcision carried out at the hospital under anaesthesia, and the initiate will not have a chance to train in physical endurance, resilience, life obligations and other knowledges and skills, as was the case in earlier initiations. Nevertheless, parents attempt to provide the morals and values teaching as they were given in earlier days.

Men and women who were initiated in the same season belonged to one age-group (men’s age groups were separate from women’s). People of one age-grade (rika rimwe) are joined by ties of great importance, just like those established through blood or marriage. The age grading system solidified the whole tribe in its activities. For instance, the council of elders comprised men whose sons had reached warrior-age. One could not reach warrior-age without going through initiation; only the initiated went to war.

War was the preserve of unmarried men. Because married men had a responsibility to their wives and children, it was considered unwise to send them to war. Going to war meant serious deprivation in their roles as husband and father; and death resulted in a permanent absence of husband and father. Absence of husbands and fathers would disrupt the mbari, the core of the kinship system, and organization of life in Kirumi.

**Child Socialization.** As discussed above, the age-grade system has been altered by the abandonment of traditional initiation rites and the kinship system has been weakened by schooling, migration, church and other forces in contemporary living. However, women and men still appeal in the upbringing of children to the values that were perpetuated through kinship and age-grade systems. For instance, from a very early age, a child learns of his or her place in the mbari and the mwiriga. Children learn that their father’s brothers and sisters are to be accorded similar respect to that accorded their own parents. Also, men and women of the same age as the parents are to be accorded similar
respect as one's own parents. Therefore, children are taught that they are part of a larger group which must be protected if the child is to survive.

While still young (before the age of six), children are mainly in the company of their mothers and other females. Before the introduction of schooling, boys would move on to be socialized by their father, and other older males in the family, while girls would continue under the instruction of the mother and other females. Nowadays, many families are without older males because men have migrated to the towns and other districts in search of waged labour. Also, at 6 years, children go to school, where they spend most of their waking time.

In some cases, children have been socialized in the basic knowledge of plants and what they cure before they enter school, as the following episode illustrates. While I was interviewing a woman as she was gardening, she reached out for a number of herbs to show me a few examples of the sources of medicine around her. She told me their names and what they can cure. However, she could not find one of the herbs she had mentioned, but said she knew where to find it. Subsequently, she requested her five year old daughter to get the herb (*kimuku*). The girl went to where the mother had directed and brought *kimuku*.

School leaves little time for such integration with the natural environment. However, the majority of children growing up in Kirumi will have a chance to grow crops, to herd cows, sheep and goats in the natural environment and, through such experiences, will become familiar with various plants and mineral products, including their names and the diseases they cure. As previously mentioned, parents also make an effort to inculcate social values in children whenever possible. Overall, the knowledge that is acquired of cures, social values or other things, however, is fragmented and does not provide useful skills for the management of health and healing.
In my findings, for instance, women younger than thirty years possessed little information about the use of local medicine for the cure of illnesses. The little knowledge they had was also limited. They would say things like, “I heard this plant is used for a certain illness, although I do not remember which illness” (JE, p. 24). On the other hand, women older than thirty, often with less than five years of schooling, were aware of which plant parts to combine in order to cure specific illnesses. They were apt to experiment with the knowledge and skills they had acquired at school or at home.

Overall, people are very versatile in their environment. This encourages a lot of trial and error. In the previous chapter, I discussed the use of observation, experimentation and trial and error in health and healing. I discussed how people integrate aspects of their rootedness and of schooled knowledge that they consider valuable and amenable. The skills and knowledges described in the previous chapter, as inherited, are used to create and design new ways of responding to illnesses. I will now discuss visuality as a way of knowing.

**Visuality**

The term visuality, coined from the noun “vision”, describes a situation of seeing not just with the eye, but with other senses. Vision is “something supposedly seen by other than normal sight; something perceived in a dream, trance, etc., or supernaturally revealed ... a mental image” (Neufeldt & Guralnick, 1991, p. 1492). Visuality connotes ‘seeing’ with the mind. The ability to ‘see’ with the mind, also referred to as intuition, is cultivated through meditation, prayer, contemplation and reflection.

Whereas visuality describes the condition of seeing with the mind, intuition describes the cognitive dimensions of this condition. Thus, intuition is:

...the power of obtaining knowledge that cannot be acquired either by inference or observation, by reason or experience. As such intuition is thought of as an original, independent source of knowledge, since it is designed to account for just
those kinds of knowledge that other sources do not provide. (The New Encyclopedia Britannica, 1992, p. 360)

According to The New Encyclopedia Britannica, intuition may well be understood as the source of all knowledge that portrays the world as an interconnected whole. It may well be, as claimed by Bertrand Russell, "that all our knowledge of truths depends upon our intuitive knowledge" (Agyakwa, 1988, p. 1). For instance, intuition is the source of some statements about logic and morality, axioms in mathematics and moral principles. This is because such axioms depend on basic rules whose existence the axioms presuppose. Basic rules “cannot themselves be established by inference”; they are self-evident (The Encyclopedia Britannica, 1992).

Logic in mathematics and principles of morality are intuited because, [they] do not require for their interpretation a special source of knowledge, since neither records discoveries; rather, they record resolutions or conventions, attitudes that are adopted toward discourse and conduct, not facts about the nature of the world or of man. (The Encyclopedia Britannica, p. 360)

This is a priori knowledge, that is, knowledge that does not presuppose experience. Arner (1972, p. 101) observes that “mathematics gives us a shining example of how far, independently of experience, we can progress in a priori knowledge. It does indeed occupy itself with objects and with knowledge solely in so far as they allow of being exhibited in intuition”. Arner continues, “but this circumstance is easily overlooked, since the intuition, in being thought can itself be given a priori, and is therefore hardly to be distinguished from a bare and pure concept” (p. 101).

That intuition does not arise from experience is not an absolute certainty. It is possible that some forms of intuition build from experience. Indeed, the connection of intuition with experience is implied in the writing of Michael Polanyi (1962), who pointed out that intuition has a role to play in all skilled performance involving both practical and theoretical knowledge. He observed that “into every act of knowing there enters a passionate contribution [emphasis added] of the person knowing what is being known,
and that this coefficient is no mere imperfection but a vital component of his knowledge” (p. viii).

When intuition is observed in skilled performance, for instance, it is because the mind of the performer has a stored repertoire of meanings that she or he draws upon or “a mass of subconscious memories of past experiences” (Montague, 1962, p. 66). However, because a ‘passionate contribution’ is part of skilled performances, such performances appear to be “beyond all limits of experience” (Arner, 1972, p. 100). This Polanyi (1966) referred to as tacit knowledge. Those who know tacitly are not able to explain how they know. Schon (1983) explained the idea of tacit knowing by using the concept of reflection and contemplation. He pointed out that professionals such as engineers, teachers, physicians, social workers, lawyers, architects, and so forth, use contemplation or reflection to cope with “unique, uncertain, and conflicted situations of practice” (p. viii). Their performance is some kind of art or practice of “intuitive judgement and skills” that Schon describes as “non rational, unanalyzed, knowing-in-practice”. It appears that a most salient feature of intuitive knowledge is that it eludes explication. Agyakwa (1988) describes several different dimensions of intuition: Not Seeing but ‘seeing’; Seeing and perceiving; Seeing and ‘seeing’; Seeing.

**Not Seeing but ‘seeing’** involves “precognition, telepathy and clairvoyance or psychological intuitiveness”. Agyakwa explains this type of intuition with the example of an African woman who, living 150 kilometers from her teenage son (her son was attending boarding school in another town), woke up one morning with the news that there was something wrong with him. Convinced that there was something wrong with her son, she visited his school and was informed that he was taken ill the previous night and was hospitalized. In the realm of epistemology, as established in western scholarship, this type of intuition requires a “rigorous process of justification”. Agyakwa uses Ayer’s conditions of knowing to establish the claim of the woman as knowledge, that is, to
establish that the woman knows what she claims to know. These conditions of knowing are: what one is said to know be true; that one be sure of it; and that one should have the right to be sure (also see Amer, 1972).

Because the woman acted upon a claim and the end result was consistent with the claim, she can be said to satisfy the first condition of knowledge. She acted upon her claim (her truth) that there was something wrong with her son, and she subsequently found there was something wrong with him, that is, he was sick. The second condition of being sure of what one claims is also fulfilled by the fact that she was willing to travel fifty kilometres on the basis of her conviction. The third condition, "have the right to be sure", is interpreted by Agyakwa to mean: "could she have produced a strong evidential argument to back up her claim?" (p. 171). This condition is not satisfied, Agyakwa says, because it can only be backed up by "feelings", a subjective attribute. Previously, I mentioned that the official science curriculum does not consider the 'subjective' a source of permissible knowledge. Agyakwa (p. 171) further observes that most subjective knowledge forms are inadmissible within the normative genre of knowledge because they yield little evidence, if any.

The woman’s state was a kind of feeling, analogous to, say, having a headache or feeling happy. If a child cries saying ‘My head is splitting,’ would it be appropriate to ask the child to produce evidence to support the claim that he has a splitting headache? The same query would be raised about other feeling states or moods such as ‘I’m happy,’ ‘I’m in love,’ or ‘I’m in pain’.

But the subjective form of knowing has great value in knowledge production (see Haraway, 1991; also Chapter Four). It may be true, as Polanyi (1962)observes, that subjective knowing is the very basis of knowing.

Agyakwa’s **seeing and perceiving** category of intuition constitutes “cases or instances of self-evident truths involving abstract logical and arithmetical or geometrical principles”, mostly aided by visual images (Agyakwa, p.166). Although people ‘do not know how they know’, the evidence condition that is not fulfilled in the case above, is
fulfilled here by the visual images. An illustration would be when an untutored person is introduced, by use of diagrams or illustrations to a concept in geometry, and is able to "see" the geometrical truth that, for example, a double square is the square of the diagonal" (Agyakwa, p. 166; also see Fischbein, 1987). Agyakwa uses a diagram (see figure below adopted from Scheffler, 1965, p. 108) to explain this form of intuition.

**Figure 1**

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**Problem:** 'to determine what square is twice the area of the shaded square. The boy is led to see that the large square made by doubling the side of the shaded square yields a figure of four times the area which is itself halved by the internal square made of the diagonals, since each diagonal cuts its small containing square in half. The conclusion is that the square of the diagonal of the shaded square has double the area of the latter' (Agyakwa, p. 166)
In Agyakwa’s seeing and ‘seeing’ category, the first ‘seeing’ is literal, and the second one is figurative. “Intuitive insights in the aesthetic and moral domains” belong in this category. This seeing and ‘seeing’ is the mode of perception exhibited when one looks at a work of art and acknowledges its appeal, or when one falls in love and describes the experience as ‘finding someone I have been looking for’. But, as in the category -- ‘Not Seeing but seeing’ (see above), -- this category does not satisfy Ayer’s third condition of knowledge: “that one should have the right to be sure”. The evidence for propositions in this category is also subjective.

“Seeing” describes a situation where experience and “intellectual good taste” provide one with the insight to say, ‘I see’ (Agyakwa, 1988, p. 168). This seeing could also be described as the “enlightened eye” (to use Eisner’s [1991] term that describes the eye that sees because of its connoisseurship). It is seeing that requires “the magical and mysterious feat through which the content of our consciousness is given public form” Eisner (p. 1). An example is the “spontaneous preference which a scientist might feel [emphasis added] for one hypothesis rather than another in a field with which he was very familiar” (Montague 1962, p. 67) or to use Agyakwa’s (1988, p. 168) personal example, “I take my automobile to my mechanic and complain that the engine does not pull when I try to get up a steep grade, the mechanic says, ‘I see.’” In Agyakwa’s case, the mechanic may go on “directly to clean the carburetor of the engine that won’t pull ...[and] his intuitive performance turns out to be correct”. The correctness of the performance provides the evidence for the claim to truth.

When observing an expert perform such a task, a lay person is likely be awed by the ‘hard to explain skill and knowledge’ displayed by the expert. Actually, this knowledge is not only hard to explain for the observer or novice; it is also hard to explain for the expert. It is tacit knowledge, a component of the personality of the knower, that is best described as personal knowledge. Another individual can only learn this knowledge by
apprenticeship, that is, by experience, especially experience of working along with someone who already has it, and exhibits it, and can talk about it. Claims of truth in this category satisfy Ayer’s three conditions of knowledge.

More than anything else, visuality testifies to the limitlessness in the forms of knowing available to humankind (see Agyakwa, 1988; Medawar, 1969). Indeed, it is known that visuality is the basis of notable achievements. Some examples recorded in the West:

The German opera composer, Richard Wagner (1813-1883) was said to have ‘heard’ his music spontaneously, i.e., intuitively. Charles Darwin (1809-1882), after years of gathering scientific data, was said to have suddenly ‘realized’ his theory of evolution while he was having a ride in a carriage. It is believed that Michelangelo (1475-1564) could only create in a cataleptic situation which he called a ‘seizure of the soul’ to which he claimed he was elevated by the ‘spirit of God’, whatever that meant. Even Albert Einstein (1879-1955) was reported to have revealed that he did not discover his theory of relativity through analysis, but rather by ‘the way of intuition’. (Agyakwa, 1988, p.173-174)

I must add that I have discussed only those forms of visuality that have been identified as intuition by others in the published literature and by myself in this study.

In this study, the majority of women used prayer, meditation, contemplation or reflection when looking for a solution to health problems. At the same time, they acknowledged the presence of God in their everyday lives. Kanjiru exemplified learning through visuality better than anyone else. In telling me how she acquires her knowledge of herbs, she provided eloquent testimony about the significance of visuality.

I sit in a quiet place then fall asleep. At such times I get very heavy sleep. Like yesterday I went to the bank at Kianjagi … when I sat on the grass to wait for a chance to withdraw money … I fell asleep. You know, I slept because I was in deep thought about the herbs, about a cure. When I woke up at mid-day, others had left … later I met with Mutonga’s wife and she wanted to know if I got a
chance to do my banking transactions. She recalled that while she was withdrawing her money, I was lying under a tree... asleep. So my practice is to go into very deep sleep. It is in the sleep that the herbs are revealed to me. (IT, p. 108)

Like many people, I found it hard to believe that Kanjiru, or anybody for that matter, could find out information through visions. My academic training in schooled science did not give me a lot of sympathy for these kinds of claims. However, Kanjiru’s story about her daughter who was nearly dying with seizures (see previous chapter) and information from many people who believe in the efficacy of her medicine enabled me to keep listening. She continued on to explain:

You see all the time when we meet, I tend to be disturbed by the acne on your face. When I go into a deep sleep these pimples disturb me a lot and I envision a smooth skin; and I think deeply about a cure for you. Actually, when you came in this morning, you found when I was telling them [her colleagues at the market] of a vision I had. That one of those people selling carrots over there has acne all over the face. I was telling them that I have to prepare medicine for that person... . When they heard this vision they were surprised and told me, “even that girl of yours was here” ['that girl’ was referring to me. At the time I had a serious case of acne. I had been to see her but she had not arrived so I left a message that I would be back]. (IT, p. 108)

Kanjiru is a believer in the Christian teachings, as espoused in the Bible. Consequently, apart from constant prayer and meditation, faith plays a significant role in her practice. She is not alone in this; other women, too, are dependent for the acquisition
of knowledge on prayer, meditation and faith. Our ancestors also relied on faith for most of their healing practices.

Because these people believed, God granted it [knowledge and skills] to them ... our ancestors did all this with much faith because what they did is all they knew. There were not many alternatives then. They would look at the plant and 'know' that the plant is likely to help: and faith was instrumental. They knew this by faith ... there was nothing else to look up to. God would direct the person and if the person believes then God granted it. These medicines from plants got here that way. By faith. No other way than faith. (Mwiki, IT, p. 186)

However, not everyone embraces this faith concept, especially as postulated by Kanjiru. One of the participants was very critical of Kanjiru’s brand of faith. Jiakathuku, reaffirming that she inherited her knowledge, reacted to Kanjiru’s claims as follows:

I never heard of praying to be shown a cure. Pray! What! Would you pray for maize in this time of famine and get it. God will never give it to you unless you grow it, or look for money to buy some ... there is nothing like praying for God to show you. Unless you are praying to God for help with your pain [illness], in this case He will help... (IT, p. 77)

Jiakathuku has no patience with any other ways of knowing apart from 'schooled ones’. Although she had very little schooling, her children went to school, and currently her son is training as a schooled doctor. Therefore, Jiakathuku is not lost about the place of indigenous knowledges vis-a-vis schooled ones. She knows that ‘schooled science is the knowledge of most worth’. 
In her health and healing, Mwiki works with the faith concept, and, like all others who profess their faith in God, she also acknowledges the physical working of the medicine. For instance, she drinks and washes with her medicine because she believes that this is the way to get a cure. She told me about the effect of washing with the *dawa*.

And whenever I wash with the *dawa*, it gets inside the body through the skin pores and the effects go inside ... even if you close your mouth as tightly as possible, you still get a bitter taste in the mouth: because when you wash with the warm mixture, it goes right into the body and starts the healing process. I think the mixture goes through the sweat pores, I mean, the fact that we sweat through these sweat pores means that something else could go through them. (IT, p. 187)

Faith in what you do is also emphasized with regard to determining dosage. You would need to have faith to trust that you can determine the right dosage for yourself. Gyekye (1997), writing on Africa, doesn't agree with the point I am trying to make. He sees having faith as a "cultural defect".

Traditional healers were not short of prescriptive capabilities: they were capable in a number of cases of prescribing therapies often found to be efficacious. But their methods generated two problems: one was the preparation of the medicine to be administered to a patient; the other was the dosage—the quantity of the medicine for a specific illness. ... The failure to provide *exact measurement* [emphasis added] would affect the efficacy of the concoction as well as the therapeutic effect of the dosage; in the case of the latter, there was the possibility of underdosage or over dosage. Yet the need for exact measurement does not seem to have been valued and pursued by our cultures, a *cultural defect* [emphasis added]. (p. 33-34)

Irai (IT, p. 45) offers some suggestions for compromise when he says one has to "listen to the body".
Somebody may tell you, ‘I took a certain amount of medicine yesterday’, but how do you know of ‘their dosage’? What if that person is weak ... only your body, yourself, can determine your own strength. You feel the strength of the dosage with your body. (IT, p. 45)

The message is clear. In preparing miti a trusting feeling is required, especially when one is doing the measurements. Note that many people such as Gyekye (1997), who do not trust miti had great concerns with dosage: How much do you use? For how long? How many ingredients do you use? With how much water? How long do you boil? and so on. These questions are important, especially because miti contains chemicals that may, if used without proper guidance, cause harm to the body. These questions also reflect on the mind-set of the people concerned.

Irai explained that such people are motivated by the need for convenience brought by schooled science: they do not want to take the time to learn something that will benefit them on a long-term basis. They are satisfied by going for Panadol (over-the-counter pain killer) whenever they have a headache. They do not want to search for a more permanent cure for that headache. Such people are driven by their faith in schooled science and doubt of indigenous science and technology. It is worth noting that those who have been fully educated in traditional health and healing know ‘the how of measurement’.

Mwambia explained how one can ‘measure’ ingredients:

To boil, just size a pot with the plant parts that you have. In putting water, you could put two cupfuls of water, for instance, knowing that one cup will boil away as the plants cook and you will have the other cup left. That is the measurement. (IT, p. 165)
At this point, during my interview with Mwambia, the research assistant, Mumu, shared her experience (IT, p. 4). She had, the previous night, prepared miti for her cold. Again, there is an emphasis on ‘trusting your feelings’.

(Mu) I washed, and put in the pot [majuthi leaves] with some water. I used a small pot. The pot was nearly full with water. I covered it, it boiled and bubbled. By the time it was ready there was very little water left, about three glasses of water.

(Mw) That must have been concentrated.

Notice that Mwambia is able to speculate on the concentration even though he has not seen the ingredients or the size of the pot. He continued:

(Mu) So then, like three glasses … because this is the water that was remaining. Later I added some water which I had boiled, just a little bit, like one cup. The total amount was four glasses. You hear, I had a feeling about what I was doing. (IT, p. 165)

As the conversation continued (IT, pp. 166-168), Mwambia advised Mumu how to take the dawa.

(Mu) Tell me, about how many days would one take this dawa?

(Mw) This one is not dependent on a prescribed number of days. Since you already took some in the morning, do the same in the evening. Take a cup in the evening before you go to bed. You will not take some the following morning. Then, you pay attention to how you feel and if you are feeling well then do not
use anymore ... You are not foolish, you know your body, so listen to it as you take the dawa. (IT, p. 166)

Mumu is accustomed to schooled ways of determining dosage and she seems to expect Mwambia to determine dosage that way, but Mwambia is accustomed to another way of determining dosage, certainly not mathematically. He is accustomed to ‘listening to the body’. Similarly, when administering miti to people, Mwambia normally gives them enough “to satisfy how they feel” (IT, p. 13). This means, the patient is given dawa according to the progress they report, as communicated by their bodies.

With regard to mixing different miti when one is confronted with a chronic illness, Mwambia still appealed to the inner senses:

Even for chronic cough, if you boil these leaves [majuthi leaves] and preserve them in a bottle and take some everyday ... later you may want to mix with something else. You may say to yourself, since I had majuthi the other day, today I will try something else. I will try tucugucugu and mukawa, or mwiria leaves. (IT, p. 169

To become successful in a herbal practice like Mwambia’s, one needs to engage fully in visuality. Mwambia, who prays to God each morning before setting out to look for miti or to treat his patients, offered this advice.

There is a way in which you would engage in this practice and end up having many people come to you. God himself makes it possible for you. People will normally spread news with regard to who helped them get well. Everyone you treat will normally come back. If you help heal someone and they come back, then
treat them again because the person has ‘come back home’... God grants to those who search. (IT, p. 173)

Notice Mwambia’s sense of moral obligation. Moral obligation was discussed earlier.

Knowledge acquired through embeddedness (inherited knowledge) or visuality is shared in the community, as described below.

**Inter-Generational Networking and Censorship**

The teaching and learning of this knowledge was, and is still to an extent, dependent on social-cultural embedding, a notion that was discussed above. Part of this embedding is the respect accorded to older people. Not surprisingly, inherited knowledge relied for its dissemination on the authority or seniority of older persons. A great deal of health and healing knowledge in Kirumi was, therefore, passed down vertically. Knowledge and skills were passed to the younger generations from older generations through the process of networking. Later it was shared, longitudinally, within the same generation. Mwiki told me of this as the source of her knowledge and skills.

I learned about plant extracts for cure from older people. That is when there were no hospitals. So, I got to know things like: if you pluck *majuthi* leaves and boil them, and wash with them and drink the rest, you will be healed of some illnesses such as malaria. I do not know much about other cures. So for me, my knowledge is from older people. That is how I learned about this medicine because this was the kind of medicine people were using when there were no hospitals... and there is a long list of them [cures]. All these were used in place of medicine. With education people abandoned the plants and adopted hospital medicine. But come to think of it, even that hospital medicine is prepared from plants. (IT, p. 179)
And Kago reiterated:

You were told by older women. Just like I am telling you now, and you are writing to go tell others. That is the way we learned as young women. (IT, p. 154)

Similarly, Jiakathuku has a very strong sense of how she acquired her inherited knowledge. In a poetic style, she recounted how she inherited some of the knowledge.

I inherited this knowledge:
this is Kiinu, go steam in it,
Muthanduku is here go steam in it,
Here are Miguruka, rub on yourself,
apply it on the child together with Ndago
and the Kiara of the child will go. (IT, p. 76)

As will be discussed below, all knowledge is not shared freely. Some forms of knowledge are censored or retained in particular family lineages. Indeed, censorship is a reflection of how people interpret the place of knowledge in society, that is, its value and the consequences of its transmission (Kenyatta, 1938; Imanyara, 1992; Njiru, 1981). Even in other parts of Kenya, this was the case.

In earlier times, some knowledge and skills such as boat making, sailing, smithing and medicine were the preserve of specific families and lineages (Otiende, et al., 1992). One reason why medical knowledge was censored, for instance, was in order to avoid a situation where persons who lack knowledge use plant extracts improperly and risk injury to themselves and/or others. The other reason is that the learning of skills required apprenticeship and a close relationship between expert and novice. Such close
relationships were only feasible in a family situation. Also, the socio-cultural set-up did not encourage entrepreneurship. Communities were small and the need for many doctors or smiths did not arise.

Currently, in Kirumi, the criteria for sharing knowledge is based on how ‘sincere’ the recipient of the knowledge is deemed to be. Sincerity could be based on family lineage, for instance, how the so-and-so’s view traditional knowledge or what they are likely to do with the knowledge; will they ridicule the knowledge, misuse it or appreciate it? Notably, if the recipient(s) of the knowledge are judged to be intolerant of traditional ways (maybe because they are schooled or Christians) then the knowledge is withheld from them. Irai was able to share ideas about the cure for chronic coughs with a missionary, Dr. Jevi, because Dr. Jevi “ni muntu waiji mila” (“Dr. Jevi respected our traditions”) IT, p. 64. Irai also said that the reason he was willing to talk with me is because he ‘knows’ my grandfather and our family ‘well’.

The Christian faith plays a big role in the way Mwiki, an ardent believer in the gospel of Christ, shares her knowledge. When I asked her if she had shared her knowledge of miti with other believers, she said that she could not because most of them would ridicule her and even think that she was losing her faith. For similar reasons, Kawira had to conceal her involvement with herbalists.

Censorship of knowledge still predominates in most indigenous medical practices in Africa. Such censorship may be one reason why valuable technologies and scientific knowledges disappeared in most parts of Africa, but some value is still attached to it. In fact, the Kirumi people regret, to an extent, the ‘uncensoring’ approach to knowledge. They are quick to cite sexually transmitted diseases, especially AIDS, as a case in point. For instance, Harriet regrets the situation of her teenage granddaughter becoming involved with sex. In her reminiscence of ‘good old days’, she recounted:
...there were no illegitimate children although unmarried women did much folk dancing in the night. These days girls do not want to listen even when you advise them, they think because they have learned *science* ... they should not listen to you. (IT, p. 176)

Her reference to 'science' is noteworthy. Harriet is referring to the knowledge and skills acquired in school science that impress upon young people that schooled science has the truth. In Chapter Three and Chapter Four, I explained how school has promulgated erroneous notions of schooled science, consequently elevating schooled science as the knowledge of most worth: as pure, universal and objective Truth. The implications of these erroneous notions are clear from Harriet's observations and Irai's comments below. Other implications are discussed in Chapter Eight and Chapter Nine.

In fact, if the older generation had its way with regard to premarital sex, young people would still be practicing *ngweko*, which Kenyatta (1938, pp. 155-156) describes as "platonic love and fondling" and not the "full experience of sexual intercourse". *Ngweko* ensured that two people who were sexually attracted to one another did not have intercourse; it was practiced throughout the Mount Kenya region "in order not to suppress entirely the normal sex instinct" (Kenyatta, p. 155). *Ngweko* was done in the context of the age-group system with all the accompanying taboos, customs and expectations (Kenyatta, pp. 155-162). For instance, one would not engage in *Ngweko* or share possessions with somebody of a different age group.

Irai's contention echoes the stand of many people with regard to the devaluing of moral principles.

So, then people tell you nowadays is not like in the olden days: now, when they tell you nowadays is not like the olden days, yes, it is not like in the olden days,
but in the olden days if you found a piece of stick on a *kiroroma* [*Kiroroma is a fruit tree that produces ndoroma*], you could not take its fruits, you just walked by.

These teachings are in the Bible as they were in our traditions, *exactly as they were*. You did not go against matters that were prohibited or taboo, whether as in the Bible or tradition ... even in all your schooling, in this day, wisdom is to be found there [in tradition and in the Bible]. (IT, p. 50)

Recall the discussion, in the previous chapter, with regard to the place of respect in the attainment and sustenance of good health; recall also the illustration of disrespect involving a woman and her mother-in-law.

Knowledge that is not censored is shared freely. It is exchanged as information with regard to what to do to relieve pain or to avoid illnesses. Along with sharing, there is caring about one another’s misfortunes. For instance, when one’s illness limits the ability to engage in family and social activities, well wishers empathize by trying to ‘diagnose’ the problem. They suggest medication and life style changes and so on. Kawira’s story, for instance [See full story in Appendix G] exemplifies the principle of sharing and caring.

**Integration and Legitimation of Knowledge**

Two other principles that emerge from Kawira’s story, and from other participants’ experiences with healing, are integration and the legitimation of knowledge. Like Kawira, many people integrate what they believe is appropriate and amenable schooled healing with appropriate and amenable indigenous healing. This integration is dependent on peoples’ beliefs, what works, and what is affordable. I found that many who cannot afford doctors’ fees, prescription drugs, or over-the-counter drugs, experimented more often with indigenous healing. On the other hand, some who can afford schooled medicine, like
Kawira, look for a cure in indigenous medicine when conventional medicine is unsuccessful. Individuals have their own way of determining what is appropriate in their particular situations, depending on their personal experience. In other word, what works in individual circumstances is what is ‘legitimate’ knowledge for that individual.

There are, of course, some external sources of legitimate knowledge. Because of their place of authority in the lineage system, ancestors are one such source of trustworthy knowledge. Arguably, seniority, to use Oyewumi’s (1997) term, has a significant place in legitimating knowledge. In contemporary living, the authority of the person is backed by his or her specialization in healing, for example, the trust that people have in indigenous and schooled doctors. Further, as in Kawira’s case, the radio is also a source of authoritative knowledge. When she heard about herbs on the radio, Kawira’s reaction was: “if this is being announced on radio it must be a good thing” (IT, p. 4). She was referring to miti. Of course, the other source of legitimation is the school. In view of this, many participants expressed their desire to have traditional knowledge taught at school. If it is taught in school, the argument goes, the school-going generations will have some respect for it. As it is now, many schooled people are contemptuous of indigenous knowledge. In fact, participants were surprised at me because I was eager to learn about our indigenous knowledge. Since I have been schooled, it was expected that I should have no interest in indigenous matters.

Many remarked, ‘I am surprised you are interested in this’. They were surprised at me because they have frequently experienced rejection by schooled people. For example, Kanjiru told me that her son, who had completed form four and was currently working for the local tourist company, would not even taste her medicine. Her preteen daughter is willing to learn, however, and Kanjiru hopes that the young girl will continue this way. Irai and Mwambia, who are also herbalists, have similar stories. They have found it hard to interest their children in indigenous healing. In describing how hard it is to teach
somebody who is not interested, Irai used an analogy of two people, one attempting to
climb a tree, while another was pulling down the feet of the one climbing the tree.
Surprisingly, like Kanjiru, one of Irai’s and one of Mwambia’s daughters are interested in
indigenous ways of healing. However, neither has been able to interest their sons. Of
young people, Kanjiru said:

Young people will even tell you that this medicine is harmful or it is witchcraft. I
thank God that you are even willing to take this medicine. Only very few young
people will agree to take it: but when they do they get well. However, they will
not tell anyone because of the pressure from others. If it is in a school setting, they
will be willing, but if you approach them with your roots all by yourself, they will
run away from you. (IT, p. 161)

This echoes Harriet’s problem with young people’s unwavering faith in the science
taught at school. Kanjiru knows, without any doubt, that if her knowledges and skills of
health and healing were to be taken cognizance of in the school curriculum, young people
would eventually acquire a positive attitude toward these knowledges and skills. No one
can doubt the power of school to put in the mainstream previously marginalized
knowledges and skills. This is an important point, but not directly relevant to this thesis.
Therefore it will not be discussed further.

I agree with Kanjiru that the school should take cognizance of indigenous
knowledges. Even a cursory look at the “Human Health” topic in the Kenyan school
curriculum shows that the current approach to human health de-emphasizes indigenous
knowledge. I will explain this in detail in the next chapter.
Summary

This chapter has demonstrated that the people of Kirumi know about health matters on the bases of embeddedness and connectedness; visuality and inter-generational networking and censorship.
Chapter Eight
Pedagogical Issues

Preamble

This chapter will make the following observations:

1. Attempts to ‘indigenize’ the Kenyan curriculum have been deterred by the persistent view of schooled science as pure, universal and objective Truth. These erroneous attributes, and the view of schooled science as the only worthy ‘science’ have made it difficult for science curriculum reformers to think beyond schooled science. In the “Human Health” topic of a form four biology text, for instance, the allopathic approach to health and healing is emphasized, despite mounting evidence that a large portion of the world population relies on the holistic approach. Similarly, the lived experience of the people of Kirumi, and no doubt the majority of other rural dwellers, reflects a bi-cultural model of health and not the bio-medical approach that is emphasized in the “Human Health” topic.

2. The goal of secondary ‘science’ education, that is, to facilitate the application of knowledges and skills learned at school in everyday problem solving, may not be achieved if the curriculum continues to under-emphasize self-determination, that is, to omit the “Self-as-Explainer” emphasis (Roberts, 1982). An emphasis on the “Self-as-explainer” means that the curriculum would depict schooled science as a human construction and a cultural institution with a human purpose, not as an indisputable and un debateable domain of knowledge and skills. The message is, therefore, that learners can also participate in the construction of knowledges in their own particular settings. This message is in itself very empowering. The “Self-as-Explainer” emphasis is particularly important given that, one the one hand, schooled and indigenous knowledges are informed by radically different epistemologies, and, on the other hand, schooled science is portrayed as the ‘worthy’ knowledge.
3. An attempt to stress the "Self-as-Explainer" emphasis is likely to engender a genuine integration of indigenous knowledges into the science curriculum, thereby not only resolving the problem of 'everyday problem solving', but also facilitating a **conscious contribution** to the global bank of knowledges of universal importance. The notion of 'knowledges of universal importance' was discussed in Chapter One.

To address these points, I will, first of all, set a *general* context by analyzing the general objectives of Kenyan secondary science. Secondly, I will set a *specific* context by analyzing specific objectives of the "Human Health" topic. Thirdly, I will pay closer attention to the problem of 'indigenization' by analyzing the contents of a "Human Health" topic in a form four biology text, in view of the findings from Kirumi. I will be mainly concerned with curriculum objectives and science content that help to foster self-determination in students and in teachers. Subsequently, I will make suggestions about how to incorporate indigenous knowledges and skills into the school science curriculum.

Discussion in this chapter is conducted within the context of discussions and theoretical frameworks outlined in Chapter Three, Chapter Four and Chapter Five. In these chapters, I attempted to debunk erroneous notions that have become the defining attributes of schooled science. I problematized popular notions to do with the nature of schooled science and issues of ethnicity and gender. I will not deal directly with these limitations of schooled science here because they have already been addressed. However, it will be necessary to keep them in mind as one reads on.

Chapters Three, Four and Five provided the larger context of issues in science education. This chapter will pay closer attention to a Kenyan context. Subsequently, secondary science objectives and the content "Human Health" topic will be analyzed. This chapter is in five parts. Part One will discuss the analytical framework. Part Two will provide a review of pertinent literature in science education and medical anthropology. Familiarity with this literature will be useful for understanding the
analyses. Part Three will use the notion of a “hidden curriculum” and Roberts’ (1982) curriculum emphases to identify emphases in the general objectives of secondary science and in the specific objectives of the “Human Health” topic. Part Four will use the notion of “hidden curriculum” and “curriculum emphases” to compare and contrast the content of a “Human Health” topic with the field work findings. Part Five will discuss and comment on possible future directions for the Kenyan science curriculum.

Part One: A Discussion on Hidden Curriculum and Roberts’ Seven Curriculum Emphasis

The discussion in part one will proceed as follows:

1. A discussion on hidden curriculum
2. A discussion on Roberts’ seven curriculum emphases.

“Hidden Curriculum”

The concept of a “hidden curriculum” enables one to “read between the lines” of a curriculum in order to ascertain what is implied rather than explicitly stated. The term ‘hidden’ connotes the act of concealing. Hence, Eisner (1992, p. 341) posits that the hidden curriculum is often believed to serve the interests of the power elite, which the school itself is thought to serve covertly, a notion that is well articulated in critical pedagogy (Giroux & Simon, 1989). A good example of such hidden messages can be found in Jean Anyon’s (1981) study on “Social Class and School Knowledge”. Schools in contrasting social class settings were found to inculcate different knowledge forms, leading Anyon (p. 31) to observe that “what counts as knowledge in the schools differs along dimensions of structure and content”. Similarly, in his seminal book, “Knowledge and Control: New Directions for the Sociology of Education”, Young (1971) describes schools as a “mechanism for selecting, preserving, and passing on conceptions of
competence, ideological norms and values” (Apple, 1976, p.209). To a large extent, then, any curriculum is a reflection of the assumptions embedded in the orientations, ideologies or emphases that are adopted by the curriculum designers (Eisner, 1992; Eisner & Vallance, 1974; Giroux & Penna 1989; Hodson, 1992; Jackson, 1992; Roberts, 1982; Vallance, 1973/74). Similarly, any attempt to reveal the “hidden” will reflect the orientation, ideologies and curriculum emphases of the evaluator (Vallance, 1973/74).

Roberts’ (1982) interpretive framework, developed in the context of science curriculum, is very useful in analyzing curriculum materials for hidden messages. He referred to his framework as “curriculum emphasis”.

**Curriculum Emphases**

Curriculum emphases are a “coherent set of messages to the student about science rather than within science. Such messages constitute objectives which go beyond learning the facts, principles, laws and theories of the subject matter itself” (Roberts 1982, p. 245). These emphases are drawn from statements of the overall intent of the curriculum; the kind of statements that influence the “meta-lessons”, the big picture of the learning process. Curriculum emphases point to the:

...logical difference between kinds of statements that make up the content of a school subject... and statements used to express the intent of having students learn the stuff... while subject matter objectives flow readily from content statements, meta-lesson objectives must be derived from statements of overall intent - that is, from the substance that makes up a given curriculum emphasis. (Roberts & Orpwood, 1982, p. 9)

Roberts distinguishes seven curriculum emphases: the “Everyday Coping”; the “Structure of Science”; the “Science, Technology, and Decisions”; the “Scientific Skill Development”; the “Correct Explanations”; the “Self as Explainer”; the “Solid Foundation”. I will explain each briefly.
1. The "Everyday coping" is when curriculum stresses the need for the functional understanding of science, that is, the application of scientific principles to everyday situations.

2. The "Structure of Science" is an exposition of how scientific subject matter is developed and structured, with stress on elements such as "interplay of evidence and theory", the "adequacy of a particular model for explaining phenomena", the "changing and self-correcting nature of scientific knowledge", "the influence of an investigator's 'conceptual principles' on the kind of theory developed" and so on. It is akin to the "nature of science".

3. The "Science, Technology, and Decisions" distinguishes science from technology and, at the same time, shows their limits as warranted knowledges in practical decision making. The message to the student is that practical affairs require value laden considerations, as seen in personal or political decision making, and not scientific or technological decisions.

4. The "Scientific Skill Development" stresses the development of fundamental skills required in scientific activities. This emphasis is central in curricula that adopt the process approach to science (Wellington, 1989). Most of the laboratory work aims to show the processes that are required in the building of scientific knowledge.

5. The "Correct Explanations" stresses the authority of scientific knowledge. A curriculum with this emphasis identifies scientific facts as the basis of learning science.

6. The "Self as Explainer" emphasis portrays science as a construction and a cultural institution with a human purpose. The context boundedness of science is stressed. The message is, therefore, that learners can also participate in the construction of knowledge in their own particular settings. Curriculum content provides discussions pertaining to the historical, sociological and philosophical dimensions of science.
7. The "Solid Foundations" gives "long-term consistency to the students’ instruction" by organizing content in a way that facilitates the understanding of future science instruction.

**Part Two: A Review of the Literature**

The discussion in Part Two will provide:

1. A review of science education literature.

**A Review of Science Education Literature**

I am interested in science education literature that speaks to the notion of science as a subculture and takes cognizance of the importance of context in knowledge construction and knowledge use. Such literature makes use of the theory of situated cognition.

**Science as subculture.** Literature addressing the "disjunction between classroom learning and cognition in practice" supports the notion of science as a subculture (Hennessy 1993, p. 1). Science can be seen as a subculture because, like other cultures, it has ‘norms, values, beliefs, expectations and conventional actions’ (Aikenhead, 1996; Bazin, 1993; Hodson, 1998; Krugly-Smolska, 1995, 1996). A parallel literature speaks to the fact that the knowledge and skills that people use in everyday problem-solving (including science) are, for the most part, not learned at school. These skills and knowledge are carved out of the day-to-day experiences of the natural world and the need to effectively explain, understand and survive in situations both intellectually and emotionally. The theory that seeks to explain the social, physical and goal situatedness of knowledge and skills is situated cognition theory.

**Situated cognition.** Situated cognition theory posits that styles of thinking and learning, and of ideas and knowledges generated, differ in relation to the contexts in
which they were initially learned and the contexts in which they are or are to be expressed (George, 1995; Hodson, 1994, 1998; Layton, et al., 1993; Lave, 1988). Arguably, this assertion begs for a distinction between common sense and theory, and different levels of common sense and theories for different contexts (Horton, 1971). I will not discuss this distinction here. Neither will I discuss the roles in life of commonsense and theory.

Suffice it to say that ‘common sense’ and ‘theory’ are used for different purposes, but that their roles are not necessarily in conflict. Indeed, Horton (1971, p. 218) observes that, “ideally, a process of deduction from the premises of a theory should lead us back to statements which portray the commonsense world in its full richness”. As Horton (p. 218) observes, in the case of the chemist:

...at this point, someone may ask: ‘And which does he think is the real salt; the salt of common sense or the salt of theory? The answer, perhaps is that both are equally real to him. For whatever the philosophers say, people develop a sense of reality about something to the extent that they use and act on language which implies that this something exists.

Indeed, within the theoretical framework of this study, that is, anti-colonial critique and feminists’ discursive frameworks, theory is not privileged over commonsense. That is, theory is not regarded as a better knowledge structure than commonsense. Of course, positivistic epistemologies have always depicted commonsense as a less refined form of theory. However, given the framework of this study, the two, in so far as they help to explain and understand nature, are one and the same thing, as the following discussion of situated cognition will make clear.

A youngster who knows how to compute numbers for purposes of selling farm produce at the market may fail to solve a logically similar mathematics problem in another setting. As Hodson (1998) observes, “highly personal methods of solving problems are often developed and used successfully in practical situations by those who seem unable to solve logically similar problems in a formal mathematical test” (p. 114).
Similarly, an industrial chemist may use different reasoning in the laboratory than in his kitchen (Horton, 1971, p. 218).

Take the example of an industrial chemist and his relationship with common salt. When he uses it in the house, his relationship with it is are governed entirely by common sense. Involving chemical theory to guide him in its domestic use would be like bringing up a pile-driver to hammer in a nail. Such theory may well lend no more colour to the chemists’s domestic view of salt than it lends to the chemically uneducated rustic’s view of the substance. When he uses it in his chemical factory, however, common sense no longer suffices. The things he wants to do with it force him to place it in a wider causal context than common sense provides; and he can only do this by viewing it in the light of atomic theory.

With regard to schooling, it may be rightly stated that most of what students learn may not be of use in their everyday lives. The pedagogical issue then becomes, what can educators do to make what students learn at school more meaningful to their everyday lives? Educators who have grappled with this issues have made some insightful observations and expositions.

1. That it is paradoxical that students are ‘trained’ to think like scientists when there is clear evidence that everyday problem solving does not rely on “explicit propositional formal logic” (Aikenhead, 1996; Solomon, 1994).


3. That students’ ideas of the natural world are their tools for “problem-solving … ground in social practice”; and that students’ conceptions of the world (their “conceptual ecology”) are part of another subculture (Aikenhead, 1996; Hennessy, 1993; Hewson &

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10 Other frequently used terms are: alternative viewpoints, cognitive ecologies, ‘untutored’ beliefs, naive assumptions and commonsense beliefs. However, use of such terms as ‘untutored’ beliefs to describe students’ conceptions may engender a view of students’ conceptions as “inferior, intuitive knowledge acquired in the outside world” (Hennessy, 1993) or underdeveloped commonsense. (Hills, 1989)
4. That requiring students to learn schooled science is akin to asking them to cross sub-cultural conceptual borders (Aikenhead, 1996; Hennessy, 1993; Hills, 1989; Hodson, 1998) or asking them to resolve 'conflicts of cognition' as existing theories compete for the explanation of phenomena (George & Glasgow, 1988; Jegede, 1995; Krugly-Smolska, 1995; Ogawa, 1995; Swift, 1992).

5. That the role of the teacher should be that of an anthropologist. In this capacity, the teacher helps students to "gain an understanding of... alien cultures (the subculture of science, school and school science, each with its language, beliefs, theories, values, attitudes and code of conduct) and to assist them in moving freely and painlessly within and between them" (Hodson, 1998, p. 139).

Such pedagogical and epistemological issues concern science educators from both industrially and agriculturally based societies (Fensham, 1988). Given that definitions of science evolve within the context of industrially based societies, these definitions are better understood in industrially based societies than in agriculturally based societies. Subsequently, difficulties with science pedagogy and epistemology are less pronounced in the former than in the latter (UNESCO, 1983; Fensham, 1988; Jegede, 1995).

Given the subculture of science, the problems of "border crossings", as suggested by Aikenhead (1996), may be more pronounced in agriculturally based societies than in industrially based societies (Jegede, 1995). In Hewson and Hamlyn's (1985) study of the Sotho of Southern Africa, for instance, it was demonstrated that schooled and urbanized Sotho men and women used the traditional heat metaphor as a conceptual tool in the construction of knowledge, despite the fact that they had acquired the scientific notion of heat. This tendency to revert to traditional cognitive tools, a tendency that could be described as "cognitive continuity", may contribute significantly to the establishment of a
much wider border-to-cross for science students in agriculturally based societies as compared to the "border crossings" required in Western societies (Aikenhead, 1996). This is because, in industrially based societies, students have ample opportunities in their day-to-day lives to interact with many technological gadgets that operate on the various assumptions and complex principles of SS (Hewson & Hamlyn, 1995; Hodson, 1998). They are always amid cars, computers, traffic lights, battery operated toys, televisions and so on. Arguably, the students’ socio-cultural, environmental and associated world views are not far removed from the assumptions of SS. "In the industrialized world, different conventions operate, people understand nature, not through people (unfamiliar and problematic) but through machines ... through matter whose workings we find comfortably familiar" (Bates, et al., 1993, p. 127).

The other difficulty is created by the 'myths' or assumptions about science projected by school curricula. As Hodson (1998, p. 136) observes, with reference to the writing of Nadeau and Desautels (1984):

...border crossing is inhibited not so much by the cognitive demand of the learning task as by the discomfort caused by some of the distinctive features of science, features that are often exaggerated and distorted by school curricula into a scientific cocktail of naive realism, blissful empiricism, credulous experimentation, excessive rationalism and blind realism.

As argued earlier, school science incorporates the following assumptions: nature as simple; scientists as distanced, isolated and rigorous; knowledge as value-free; the scientific method as the only means of building SS, and a step-wise procedure. A current move among some science educators is to make school science more meaningful to students' everyday lives. This is a challenging situation. If, as suggested, science is a subculture with norms, values, intellectual tools and so forth, then this exercise of making school science more meaningful may require more than figuring out how to transfer knowledge from one context to another. As already discussed, SS is not innocent of cultural baggage. Consequently, some educators have found it a necessary move to
expose and attempt to rid SS of cultural baggage. In Chapter Three and Chapter Four, I discussed at length some of this baggage that is transmitted as the ‘nature and context of science myths’.

An example of such a myth is that the ‘scientific method’ is the only way to do science; that the ‘scientific method’ yields knowledge that is objective, true and universal, and so on. The ‘nature of science myths’ is communicated within science (that is, as a part of the principles and procedures of science, as explicit SS content). Other baggage is communicated about science, as the hidden message that accompanies what is expected of SS and the context in which it thrives. Some of the messages about science have been labelled as imperialist, sexist, individualist, anti-social and racist (see Gill, et al., 1987; Harding, 1997; Hodson, 1993; Vance, 1987; also see Chapter Three and Chapter Four).

In a move to make science more meaningful, educators have done various things. Some have focused on messages within SS, while others have focused on messages about science. Others have focused on both. In the context of this thesis, it is important to highlight what African educators have focused on.

1. The ways in which alternative viewpoints influence the learning and teaching of SS (Jegede & Okebukola, 1991; Ogunniyi, et al., 1995);
2. Aspects of African indigenous science of value to SS education (Dei, 1999b, Ogunniyi, 1986; Urebvu, 1987; Yakubu, 1994); and,
3. Gender, racial and class biases and disparities in the curriculum and in the outcomes of SS education (Eshiwani, 1990; Kinyanjui, 1993; Lewis & Lewontin, 1993; Njuema, 1993; Vance, 1987; Woodhouse & Ndongko, 1993);

These pedagogical issues may be broadly categorized as approaches to teaching and learning science. I may add that these approaches are not mutually exclusive. The intent
and the literature they draw from overlap in many places. In fact, a common denominator in this science education debate is what has become known as ‘constructivist views of learning’.

**The constructivist views of learning.** The constructivist paradigm is an old concept. In the context of schooled education, it is traceable to the philosophies of Plato, Socrates, Peirce, and Dewey (Hawkins, 1994). It is based on the understanding that learners actively build knowledge based on their interactions with physical events in daily life (Carr, et al., 1994; Driver, 1994; Layton, 1991; Wittrock, 1994). Traditionally, science teaching emphasized concepts, ideas and theories that were of interest and importance to scientists, but not necessarily to the learner (Hodson & Reid, 1988). Science teaching emphasized, albeit naively, the theoretical tenets of rational empiricism (see Chapter Four and Chapter Seven). The purpose was to “assimilate” the learner into the “sub culture of science” (Aikenhead, 1996). This tradition is traceable to the hypothetico-deductive model of doing SS and to the rational humanist philosophies of Locke, Berkeley and Hume (von Glasersfeld, 1995).

Consequently, school science depicted the learner as passive and SS knowledge as ‘truth’. In that case, all that a learner needed to do was use SS processes to discover the laws of the universe (Cawthron & Rowell, 1978; Hodson, 1986). Notice the implications: the learner was considered not to have any valuable conceptions, outside of SS, about the way the natural world functions. It is sad, that in many situations, these assumptions still inform the teaching and learning of SS.

Wittrock (1994, p. 33) observes that, within the constructivist framework, science teaching involves:

1. **Learning about students’ alternative conceptions, beliefs, attributions and related cognitive and affective thought processes.**
2. Teaching students to use their knowledge, beliefs and metacognitive and affective thought processes to generate new, fruitful and transferable conceptions that have personal and everyday meaning and significance.

The nature and quality of student constructions are taken as starting points for conceptual change. They are indicators of the conceptions that students currently hold (Cobb, 1994). From them, the teacher charts a strategy for facilitating the learning of new concepts and ideas and making an impact on problem-solving attitudes (Dewey, 1929; 1938; Carr et al. 1994). Some techniques that a teacher may use for purposes of conceptual change are discussed later.

The constructivist approach has been criticized, however, for laying too much emphasis on the constructions of the individual, thereby de-emphasizing the societal dimensions of knowledge construction. Yet societal factors do have a direct bearing on the knowledge that students construct (Bereiter, 1994; von Glasersfeld, 1995). In contrast, Vygotsky's socio-cultural theory lays great emphasis on the role of the social or “others in knowledge development” (Hodson, 1998; see Vygotsky, 1962). That is because the construction of knowledge is dependent on language and the development of language is very much dependent on interaction with others. Therefore, cognitive development is regarded as a “socially mediated process” (Hodson). Also, holistic education discourses (transformation position) theorize about the importance of “others” in the learning processes (Bowers, 1993; J.P. Miller, 1993; R. Miller, 1993). It is noteworthy that, since the middle of the twentieth century, epistemologists have been committed to free epistemology from this individualism or what Toulmin (1985, p. xv) aptly refers to as the “excess individualism of the Cartesian tradition”.

An approach in science teaching and learning that has a greater emphasis on “others” is the science, technology, society and environment (STSE) approach.
**Science, technology, society and environment (STSE) approach.** Teaching science through STSE ensures that meaningful contextual and evaluative dimensions of technology, society, and environment are included (Hodson, 1994,1999a; Pedretti, 1996; Solomon, 1994). Historical, philosophical and sociological (HPS) aspects of the epistemology of science are also central in this approach. The inclusion of HPS is done in order to portray science as a human purpose, with all the twists and turns that have plagued other human ventures throughout history (Harding, 1993; Hill. 1992; Hodson, 1992; Longino, 1990). At the same time, it helps to develop "higher reasoning capabilities associated with creativity and critical thinking" (Aikenhead, 1988, p. 4).

HPS gives science a human face. In this strategy, SS theories are studied within the contexts in which they were developed (Mathews, 1994). The human characters and the social forces that shaped these theories are not left out of the learning process. The purely "logical and methodological analysis" traditional in the epistemological studies of SS is now substituted by an HPS approach (Nadeau & Desautels, 1984). According to Mathews (1992), the type of skills and understanding fostered through HPS are, for instance:

1. Distinguishing between claims and arguments based on scientific data and evidence and those that are not.
2. Considering how the development of a particular scientific idea or theory relates to its historical, cultural, [including the] spiritual and moral context.
3. Studying examples of scientific controversies and ways in which scientific ideas have changed. (p. 13)

Using an HPS strategy has the potential of exposing the epistemological, historical and cultural stance against which the substantive structures (Gardner, 1975) of scientific knowledge were constructed (Solomon, 1994). By so doing, STSE education sets the stage for an articulation of both a personal world view and a scientific world view. This is an important aspect in the teaching and learning of science (Kilbourn, 1974; 1980; 1980/81; 1982). As discussed later, an explication of world view provides students with
the knowledge and skills with which to integrate scientific concepts with other world views, without a sense of alienation and confusion (Jegede, 1997; 1998; Ogunniyi et al., 1995).

Such instruction ensures that students make personal and political sense out of science concepts (Pedretti & Hodson, 1995), thereby challenging all forms of deterrents, for instance, gender (as an example, see the use of the pronoun "he" to refer to all students in the introduction to curriculum objectives, below) and racial inequity in SS achievement and performance; and anti-social, anti-human and destructive tendencies of SS (Gill & Levidow, 1987; Hodson, 1994; Jegede, 1994). The benefits that accrue from such a challenge are such that girls and boys from all cultural backgrounds will be prompted to reconsider their career choices, and actively challenge the social markers that structure their subjugation (Baker & Leary, 1995; Belenky et al., 1986; Harding, 1998; Hodson, 1998; Layton, 1991; Solomon, 1994; Whyte, 1986).

The making of personal and political sense out of science concepts is also addressed by transformative strategies.

**Transformative strategies.** A number of educators have pointed to the need for consciousness raising (Freire, 1985) with regard to racist, sexist, anti-humanist and classist views that are transmitted through science (Fryer, 1987; Gill & Levidow, 1987; Hodson, 1993; Lewontin, 1987; Montagu, 1982; Pike & Selby, 1988; Vance, 1987). I refer to these approaches as transformative because they reveal where the biases are while aiming to develop a positive attitude towards SS. J.P Miller (1993, p. 60) argues that the transformative position is rooted in a philosophy that focuses on:

1. The interconnectedness of reality and the fundamental unity of the universe.
2. The intimate connection between the individual’s inner or higher self and this unity.
3. The cultivation of intuition and insight through contemplation and meditation in order to "see" this unity more clearly.

4. The realization of this unity among human beings, leading to social action designed to counter injustice and human suffering.

Similarly R. Miller (1993, p. 20) observes that the transformative position (also referred to as holistic education) is concerned with "connectedness, relatedness, and integration in human experiences; sense of reverence toward nature and life". Also, this approach to education promotes the view that, "people create meaning, and culture consequently evolves" (p. 21). Miller adds that: "it is essential that we draw upon our deepest source of renewal and creativity: the imagination" [emphasis in the original](p. 22).

In other contexts, educators have aimed at critically confronting biases in the curriculum with the aim of developing in students an awakened and a critical view of reality (Dei, 1994; Freire, 1985; Montagu, 1982; Pike & Selby, 1988)\textsuperscript{11}. This is done by responding to "the variety of human experiences" and the "history and achievements of all peoples" based on "race, ethnicity, gender, sexual preference, and one's place in the world's economic system" (Dei, p. 8-10; see also Lewontin, 1987). The overall aim of this approach is to problematize the taken-for-granted and to engender critical questioning of anti-social and anti-humane attitudes.

This approach is suitable as a tool for deconstruction and subsequent reconstruction of the context of schooled science. Deconstruction may involve, for example, the problematizing of some stereotypes like the existing model of cultural ignorance as the cause of epidemics in the tropics (Vance, 1987). In the context of humane education,

\textsuperscript{11} Quijano (1974, pp. 1-3), while addressing the First World Conference of the World Council for Curriculum and Instruction, pointed out that "critical thinking and moral values should be the prerogative of every individual".
students are made aware of the exploitative life style of humanity and encouraged to embrace positive human qualities such as love for and cooperation with other humans, animals, plants and all nature (Selby, 1995; Pike & Selby, 1988).

The goal of consciousness raising in the transformative approach overlaps with the goal of "developing informed choices in students" in STSE (Pedretti & Hodson, 1995), but is of a more radical nature. Admittedly, reconciliation strategy is likely to raise a higher level of emotions than STSE because of the nature of its discourses (humane issues such as race, gender, disablement, animal rights, sexuality, class biases and so on). These are areas that touch on very fundamental beliefs buried in historicity and self-identity. In view of this, Dei (1994, p. 13) suggests that teachers can make students "aware about the legitimacy of taking the issues that bring pain to students, particularly minority students in the class".

STSE and transformative approaches depict SS as a human construct that renders the world "logical, comprehensible and predictable" (Hodson, 1992, p. 9), not as a true description of the world. At the same time, they carefully and systematically consider the ways in which various people around the world make sense of their world. This provides the basis on which to engage pupils in a kind of "cultural awareness". A cultural awareness that Hodson (1999a, p. 13) says "involves students understanding the social location of beliefs and practices, acknowledging the context-dependence of most of what they think and do, and recognizing the existence of different modes of discourse, each having a distinctive socio-cultural origin".

A Review of Literature in Medical Anthropology

Bio-medical and bio-cultural models. The bio-medical model was introduced in the 1940s and early 1950s by medical anthropologists who were involved in the study of human physical characteristics as a way of determining biological adaptations in different
cultures (Anderson, 1996; Baer, et al., 1997; and Moore, et al., 1980). These anthropologists based their research work mainly on the positivist and post-positivist paradigms. On the basis of this theorizing, students of anthropology measured width of nose, size of skull, colour of skin, hair form, stature and so forth. The emphasis was on physiological diversity and human variability in biological functions such as body temperature, work capacity, and infant and childhood growth patterns. An example of such a study done in Kenya is the Orr & Gilks (1931) study. "Studies of Nutrition: The Physique and Health of Two African Tribes". Orr and Gilks measured average heights of Maasai and Gikuyu women and men, the nutritional values of their diets, their blood compositions and so forth. This emphasis on physical and physiological characteristics ignores the role of culture and environment (political, social, historical and economic) in biological adaptation. It is, as already mentioned, indicative of the tendency to treat schooled science as value-free, that is without any cultural influence whatsoever. The approach to health implicit in the bio-medical model is the allopathic approach, the focus being the elimination of biological elements believed to be interfering with the adaptation of the organism. It includes the surgical removal or medical treatment of specific organs that have failed in their regular physiological functions.

In the 1960s, research in medical anthropology began to pay particular attention to the role of culture and environment (Anderson, 1996). The inclusion of culture in the study of medical systems introduced a holistic approach to the discipline of medical anthropology and to the practice of medicine. The holistic approach carefully and systematically integrates cultural and environmental factors in the study of biological adaptation and views illness as a process, not a deviance (Loustauanau & Sobo, 1997). There is an attempt to combine both biological and psychological explanations for illness (Smith, 1997).
Just as there is a recognition of the biological and physical basis of illnesses, there is also a recognition of magico-religious and ritual aspects of health, illness and healing (Slikkerveer, 1995). Examples of healing systems that are based on the holistic approach are the humoral systems. These systems (Slikkerveer, 1995, p. 17) “incorporate[s] an equilibrium model to explain health and disease and to indicate proper cure, a conception of elements with ascribed values, the significance of bodily fluids or humours and the belief in a metaphysical ‘breath of life’”. Other examples are the systems that incorporate the principle of opposites, that is, “hot or cold”, “wet or dry”, “sweet or bitter” and so on (Slikkerveer, 1995). In these systems, practices and beliefs of health, illness, and healing form a “coherent logical system” (Lindenbaum & Lock, 1993; Foster & Anderson, 1978; Yoder, 1982). Also in these systems, it is acknowledged that “humans are open to external non-human communication…. [and] [therefore], dreams, religious experience, symbolic items, and the like are significant in generating medical facts” (Pearce 1993, p. 157).

A fundamental difference between the allopathic and holistic approaches is found in their response to illness. In the allopathic approach, illness is viewed as a deviance and something to be ‘exorcized’ out of the body, while in the holistic approach, illness is viewed as part of a process of the body, the mind and the social aspects of living. Consequently, in the allopathic approach, the illness has to be removed, something which can only be done by others, such as disease specialists, who are specialized in ‘excising’ elements of illness. On the other hand, in the holistic approach, the individual is responsible for restoring his or her own health. It is required that individuals reflect on all aspects of their lives in order to begin the healing process. At such times, the individual will not only reflect on the possible infections, but also on the relationships s/he has with others and with the spiritual beings. Other differences between the two approaches are outlined in the figure below adopted from Moore et al., 1980, p. 244.
A. Medical health model: looks for illness and health at a microbiological level and heals individual to return to normal functions in society. B. Holistic health model: looks for illness and health at the societal level. Society is structured to provide a healthful living environment. It is believed that an ill society begets ill members.

**Health and healing in the bio-cultural model.** Health within the bio-cultural model is defined as “the state of complete physical, social, mental and psychological well-being” (Ityavyar, 1992). This definition is, incidentally, consistent with the World Health Organization’s definition of health. Health in the bio-cultural model is “inextricably bound with cultural norms, beliefs, and values as well as with social structure and environmental conditions” (Loustauanau & Sobo, 1997, p. 3). For this reason, diagnosis in
bio-cultural models includes socio-cultural analysis and reflects the need for amicable
social relations (Ityavyar, 1992). For the same reason, economic profit is not a prime
motive for health practitioners. Instead, the guiding principle is the restoration of social
cohesiveness that is threatened when a member of the group is taken ill. In the Pacific
islands, for instance, indigenous people will not seek medical care until illness threatens
to remove them from their cultural or social setting (Finan, 1994).

In most indigenous knowledge systems, there are two models of understanding health
and other natural phenomena, that is, personalistic and naturalistic. Within the
personalistic model, causation is seen as an active intervention of supernatural powers.
The personalistic model yields to a “broad psychosocial religious context” (Foster &
Anderson, 1978, p. 125). Witchcraft and sorcery are under this model. On the other hand,
the naturalistic model seeks to explain causation through empirical means. For instance,
“illness is explained in impersonal systemic terms, conforming to an equilibrium model
of heat, cold, imbalance, age, social environment, and so on” (Foster & Anderson, p. 9;
also see, Richards, 1980). Further, accepted medical evidence may include dreams,
visions, intuition, and feelings, as well as empirical signs (Lindenbaum & Lock, 1993).

The reason for such a wide range of medical evidence is that the web of life is such
that humans are open to non-human communication. Such intervention by way of dreams,
visions, religious experience, symbolic items and so on lead people, through faith, to
create facts and reasons that constitute their repertoire of medical knowledge (Le Mai’tre,
1994). Note that most of this repertoire of medical knowledge is not readily acceptable in
the practice of schooled medicine. But, as Sitaleki (1994, 56) aptly puts it, “the health
practices of each culture must be examined in the context of its world view and general
culture, if its elements are to be understood and not seen like a medley of disconnected
and meaningless customs”. Last’s (1981, p. 390) experience with traditional medicine in
Malumfashi, Nigeria, is a clear example of how such disconnection can occur. Because
he started off wanting to find out if traditional medicine constitutes a medical system such as schooled medicine does, and not trying to understand this system in its context, he was able to observe that “the traditional segment of Malumfashi’s medical culture, ... is extremely un-systemized in practice”. In any case, the reason indigenous health practices have persisted through generations, despite the ‘mixing of cultures’, or are found of worth by the populations who use them, is because they are amenable and attainable. At the same time, the principles and processes that guide these practices point to the existence of a distinct world view. The concept of a world view was discussed in Chapter Four.

I will now look at the Kenyan secondary curriculum.

**Part Three: The Kenyan Secondary Science Curriculum**

Part Three will proceed as follows:

1. A presentation of the Kenyan secondary science education objectives.
2. Refer the reader to Appendix H for specific objectives of the “Human Health” topic.
3. Provide a discussion of the emphases in the objectives.

**The Kenyan Secondary Science Objectives**

The following is the “introduction and objectives” of the biology and biological sciences courses (Kenya National Examinations Council 1990, pp. 108-109 and p. 234) recommended for use throughout Kenya. Two points should be noted: (a) the course objectives for physics and chemistry are in Appendix I, (b) the course objectives for physics are similar to those of the physical sciences. (Physical sciences are offered in schools that are not well equipped with laboratory facilities, mainly harambee schools [see Chapter Two for a description of harambee schools]. Physical sciences and biological sciences courses are designed to make less demand on experimentation than
pure physics and biology courses.) The objectives of the biological sciences are similar to those of biology (see KCSE, p. 234 and p. 108); so are those of physical sciences and physics (see KCSE, p. 191 and p. 145). Therefore, in the discussion on science curriculum emphasis, I will only refer to the course objectives for biology, chemistry and physics.

**Introduction and objectives.** (Kenya National Examinations Council 1990, pp. 108-109 and p. 234. All emphases are added. Those in italics will be discussed shortly. The underlined portions will be referred to later.)

The biology course consists of basic principles of biology and their application to real life situations. This course pays special attention to the needs of the majority of learners who terminate their biological sciences course at the end of the secondary level. It also caters for the need of the learner who may pursue his studies in the subjects and its related disciplines.

The study of this course should be based on practical investigation as much as possible. Emphasis is laid on the understanding of biological processes requiring the application of analysis, synthesis and evaluation. This therefore necessitates a far greater variety of learning experiences in contrast to the old talk-and-chalk method. It calls for practical investigations, projects, discussions and other problem-solving methods relating to both familiar and unfamiliar biological situations.

Throughout the course, emphasis should be laid on improvisation of equipment and use of locally available materials. A large portion of the examination questions will demand a knowledge and understanding of practical situations. A candidate will thus be at a considerable disadvantage if he has not adopted an investigative approach towards the course.

The main objectives of the biology course are for the learner to:
(i) Communicate biology information in a precise, clear and logical manner.

(ii) Develop an understanding of the interrelationships between plants and animals and between man and his environment.

(iii) Apply the knowledge gained to improve and maintain the health of the individual, family and the community.

(iv) Make use of locally available materials and information in improving the quality of life.

(v) Relate and apply relevant biological knowledge and understanding to social and economic conditions in rural and urban settings.

(vi) Recognize and observe features of familiar and unfamiliar organisms, record observations and make deductions about functions of the whole organism or its parts.

(vii) Develop positive attitudes and interest towards biological sciences and the relevant practical skills.

(viii) Demonstrate resourcefulness, relevant technical skills and scientific thinking in familiar and unfamiliar situations.

(ix) Design, carry out and evaluate experiments and projects.

(x) Create an awareness of the value of co-operation in solving problems.

An Identification and Commentary on the Emphases in the Science Objectives

First, I will use Roberts' (1982) categories, as discussed earlier in the chapter, to identify the emphases in the science objectives: then I will comment on the curriculum emphases.

**Everyday coping.** This emphasis is featured more than any other in the biology, chemistry and physics objectives. For instance, the introduction to the biology objectives
begins with this emphasis: “the biology course consists of basic principles of biology and their application to real life situations”. This emphasis is repeated in paragraphs two, three and four. In the listed objectives, the everyday coping emphasis is featured in objectives two, three, four, five, eight and ten. The last of the chemistry objectives (f) also largely features this emphasis. All the seven objectives for the physics course feature the everyday coping emphasis.

**Structure of science.** This emphasis is not featured in biology, chemistry or physics objectives. However, the first objective of biology, that is, to “communicate biology in a precise, clear and logical manner”, may imply this emphasis.

**Science, technology and decisions.** This emphasis is not featured in biology, chemistry or physics objectives.

**Scientific skill development.** In the introduction to the biology course, this emphasis is prominently featured in paragraph two. Objectives six, seven and nine of the biology course feature this emphasis. The first, second and third objectives of the chemistry objectives feature this emphasis. It is not featured in the physics objectives.

**Correct explanations.** This emphasis is implied by the first objective of the biology course, to “communicate biology in a precise, clear and logical manner”. It is, however, negated at paragraph two of the biology course, which states that “emphasis is laid on the understanding of biological processes requiring the application of analysis, synthesis and evaluation. This, therefore, necessitates a far greater variety of learning experiences in contrast to the old talk-and-chalk method”. It is not featured in chemistry or physics objectives.

**Self as explainer.** This emphasis is not featured in any of the science courses.

**Solid foundations.** The first paragraph of the biology course indicates that the course “caters to the need of the learner who may pursue his studies in the subjects and its related disciplines”. This implies the “solid foundation” emphasis. This emphasis is also
featured in the last objective of the physics course, that is, "prepare the learner for further studies and/or vocational training". The "solid foundations" emphasis is not featured in the chemistry course.

Discussion

The outcome of this analysis reveals a contradiction. On the one hand, the Kenyan educator desires that students acquire knowledge that is useful for everyday situations ("Everyday Coping" emphasis) and, on the other hand, the educator has omitted other emphases that may help to engender this knowledge effectiveness. For instance, the "Self as Explainer" is lacking. It is likely that the goal of secondary 'science' education, that is, to facilitate the application of knowledges and skills learned at school to everyday problem solving, may not be achieved if the curriculum continues to under emphasize self-determination, that is, to omit the "Self-as-Explainer" emphasis. An emphasis on the "Self-as-Explainer" means that the curriculum would depict schooled science as a human construction and a cultural institution with a human purpose, and not as an indisputable and undeniable domain of knowledge and skills. If the "Self as Explainer" emphasis is incorporated, the learner will get the message that s/he can participate in the construction of knowledges in his or her own particular settings. This message is, in itself, very empowering. As already mentioned, the "Self-as-Explainer" emphasis is particularly important given that, on the one hand, schooled and indigenous knowledges are informed by radically different epistemologies and, on the other hand, schooled science is portrayed as the 'worthy' knowledge.

As well, an attempt to stress the "Self-as-Explainer" emphasis is likely to engender a genuine integration of indigenous knowledges into the science curriculum, thereby not only resolving the problem of 'everyday problem solving', but also facilitating a conscious contribution to the global bank of knowledges of universal importance. Such a
contribution will make rural boys and girls partakers in school bound knowledge and, subsequently, knowledges and skills of universal importance.

The "Self-as-Explainer" emphasis is promoted by the STSE and transformative teaching approaches discussed above. These teaching and learning approaches endorse science as a subculture and address the situatedness of knowledge, something that would specifically promote the aims of the Kenyan secondary science, that is, the need for "practical scientists" that permeates all the endeavours of science education in Kenya. For instance, during the setting up of the second university in Kenya, faculties of science were required to work more closely with industry in order to "relate all the attributes of learning to the real problems of society" (Republic of Kenya, 1981, p.7).

It is paradoxical that there is very little attention given, in the written curriculum, to the "Correct Explanations" emphasis, yet in the experienced curriculum there is significant emphasis, albeit hidden, on the giving and reproduction of facts as they appear in selected textbooks.

Also, although the "Solid Foundations" is not prominent in the objectives, it is in practice a guiding principle in how the subject content is organized and structured throughout secondary education (see for instance, specific objectives of the "Human Health" topic, Appendix H). The "Solid Foundations" emphasis, because it provides the "long-term internal consistency in the students' instruction" (Roberts, 1982, p. 249) has served to orient students to only one way of understanding and explaining natural phenomena. For instance, the privileging of the 'visual' over other human senses and constructs has been enabled by a curriculum that makes sure to keep building on earlier themes of observable and measurable attributes of phenomena (see Chapter Nine).

Subsequently, students are well socialized in the messages given about and within schooled science. The implication is that such students tend to be impatient with other ways of understanding and explaining natural phenomena. In this study, for instance,
women who have been inculcated into the values, practices and procedures of schooled science, find it hard to comprehend indigenous ways of health and healing (see Chapter Nine). These students probably believe in only one view of understanding and explaining natural phenomena, the SS view.

The “Structure of Science” emphasis is absent. Arguably, this emphasis would complement the “Self-as-Explainer” emphasis. Because the “Structure of Science” emphasis enables students to understand the “interplay of evidence and theory”, the “adequacy of a particular model for explaining phenomena”, the “changing and self-correcting nature of scientific knowledge” and “the influence of an investigator’s ‘conceptual principles’ on the kind of theory developed” (Roberts, 1982, p.247), it would necessarily provide a suitable context for problematizing the nature of science. Such problematizing would consist of a questioning of the relationship between evidence and theory, and of a critical analysis of the sources of evidence, especially observation as a source of evidence (see Chapter Three). It would clarify the place of models in scientific explanations and help teachers and students understand the use of axioms such as ‘nature in simple’ in explaining natural phenomena. Students and teachers would learn not to take such axioms literally but to utilize them for the understanding and explaining of certain phenomena. The “Structure of Science” emphasis would also help explain the place of societal influences in the “self-correcting nature of scientific knowledge”. Such explaining would demystify schooled science and it would inform students of factors that influence theory development in addition to an “investigator’s conceptual principles”.

The overall effect would be to humanize schooled science to the extent that wrong messages about pure, universal and objective Truth, and those concerned with gender and ethnicity, are weakened.

An inclusion of the “Science and Technology Decisions” emphasis would help to distinguish between ‘science’ and technology, thereby demystifying the role played by
science in current socio-economic situations. Often successes of technology are credited to science, thereby resulting in a false image of what ‘science’ can do and greatly exaggerating the ‘purity, objectivity and universality’ of science. Arguably, it would help to bring to light how ‘science’ influences technology and, subsequently, the extent to which ‘science’ may be relied upon as a source of ‘life’s conveniences’ (Layton, 1991).

The “Science and Technology Decisions” emphasis may also help to ameliorate discussions on the ‘value-ladeness’ of knowledge in general and of ‘science’ and technology in particular. That is, the emphasis would bring about an understanding of the fact that although ‘scientific’ and technological decisions are based on values, they are seen as less so when compared to personal or political decision making. The former rely on a well structured and controlled knowledge system, while the latter do not.

The “Scientific Skills Development” emphasis, which stresses the development of fundamental skills required in scientific activities, is prominent in biology and chemistry objectives. In this emphasis, most of the laboratory work aims to show the processes that are required in the building of scientific knowledge, which would be a ‘noble thing’ if there were such a thing as ‘a scientific process’. But, even within the domain of schooled science (not to mention other domains of science and indigenous sciences) there is no such thing as a typical scientific process. This makes reliance on “Scientific Skills Development” problematic, because this emphasis focuses heavily on the promotion of certain ‘fundamental skills’. For instance, in most science curricula, and the Kenyan one is no exception, this emphasis promotes ‘a scientific method’ with neat clear steps to follow (Hodson & Reid 1988). As discussed in Chapter Three, this is a fallacy, especially when it involves the isolation of a ‘hypothesis-making step’ in the biological sciences (see Schwab, 1964). Furthermore, the emphasis on ‘a scientific method’ gives students the message that this is the only way to build SS knowledge and leaves out other ways that may be equally relevant and valid (Hodson, 1998 Worsely, 1997).
Two important features of the science objectives that may not fit in any of the Roberts' (1982) categories, but fit well with STSE and transformative approaches, are the biology course objective (10), that is, "create an awareness of the value of co-operation in solving problems" and the physics course objective, that is, (5) "enable the learner to appreciate the responsibility of the scientist to the society".

**Part Four: Analysis of “Human Health” Topic in a Form Four Biology Text**

Part Four will:

1. Refer the reader to Chapter Seven and Chapter Eight.
2. Refer the reader to the “Human Health” topic in the Appendix J.
3. Compare and contrast experiences and knowledge emphases in Kirumi with the content of the “Human Health” topic.

**Experiences and Knowledge Emphasis in Kirumi**

Health and healing skills and knowledge in Kirumi were discussed in Chapter Six and Chapter Seven, and the following emphasis identified:

1. Embeddedness and connectedness with the social, spiritual, emotional and physical aspects of living, as a consequence of which learning is expected to engender cooperation and humane behaviour.
2. Visuality, that is, the place of intuition and other subjective modes of knowing is not disputed. In fact, it is respected. Learning is also required to emphasize the web of life. Subsequently, individuals are encouraged to take matters of health and healing into their own hands, as discussed in the section on the holistic approach to health.
3. Inter-generational networking and censorship: there is a lot of trial and error and sharing of information, knowledge and skills.
The "Human Health" Topic

Details of the Human Health topic as presented in the Kenya National Examinations Council (1990) are provided in Appendix H (pp. 287), while Appendix K provides an analysis of the Human Health topic using Roberts' (1982) categories of curriculum emphasis. I have used the course outline for the secondary school programme. Most of the emphasis is on the categories of "Everyday coping" and "Correct Explanation", with a substantial portion in "Scientific Skill Development" and "Solid Foundation". There are three items that feature the "Self-as-Explainer" and a few that feature the "Structure of Science". The "Science, Technology and Decisions" emphasis is absent. Most of the items are featured in two emphases. As seen in Appendix K, these items are indicated with a symbol (*).

To provide an understanding of how the content of a course in "Human Health" is delivered in Kenyan schools, Appendix J includes an actual "Human Health" topic in a very popular and widely used form four text book. For the purposes of this thesis, it is important to compare and contrast this content with the experiences and knowledge emphases in Kirumi. The "Human Health" topic has some excellent material. Hodson\(^{12}\) suggested that the content of the Topic is very comprehensive; in fact he referred to it as "encyclopaedic". I will be arguing that this material needs to be reinforced and made more immediately relevant by the inclusion of indigenous knowledge, and that it should provide a wider range of curriculum emphasis, and teaching and learning methods that foster independence. Most of what appears in the Human Health topic (hereafter referred to as the Topic) is identical with the detailed human health course outline for the entire secondary school (see Appendix H). There is indication that the content does not vary, whether one is looking at Forms One (average age fourteen years), Two (average age

\(^{12}\) Based on personal communication.
fifteen years), Three (average age sixteen years) or four (average age seventeen years).

What varies across the different levels is the complexity and the details of the presentation. This attests to the “Solid Foundation” emphasis.

**A Comparison of the Content in the Topic and Experiences and Knowledge Emphasis in Kirumi**

In Chapter Four, I stressed the importance of world view as a basis for engaging in meaningful pedagogical activities. A child born and raised in Kirumi will bring to the classroom an anthropomorphic world view and ‘nature continuity’ framework incorporating embeddedness, visuality, inter-generational networking and censorship as bases of knowing. This section is concerned with the extent to which the Kenyan science curriculum and the Topic in particular acknowledge or ignore this distinctive framework of understanding.

For the purposes of this analysis, the findings from Kirumi and the Topic are discussed in terms of two categories.

1. Factors of body health.
2. The primary responsibility for health.

**Factors of Body Health**

**Biological, physical, chemical and mechanical dimensions.** In the Topic, body health is portrayed as having biological, physical, chemical and mechanical dimensions. In the section on “human diseases” (pp. 159-169), for instance, the student is introduced to the biology and physiology of disease-causing micro-organisms. There is an intricate exposition of how people catch some common illnesses from micro-organisms, how to prevent them, and their recommended courses of treatment. In the sections on “the meaning of good health”, “eating habits and health” and “cultural practices and the
balanced diet" (pp. 149-159), the importance of a balanced diet is explained, with examples of deficiency diseases and numerous tables of recommended daily intakes of nutrients, and average food calorific values and chemical compositions.

More of the chemical dimension is provided in the section on “Immunity” (pp. 172-176), with a description of how the body gets natural and acquired immunities, together with an account of how immunity can be conferred artificially through the use of antibodies, that is, proteins. Chemical and physical connotations are projected via such language as: “antibody reaction”, “reaction between”, “neutralization”, “precipitation”, “agglutination”, “lysis” “clumping together”, “readily engulfed” and “bursting open”. The section on “organ transplant” (p. 175) presents the mechanical dimension of the body, the use of allografts, isografts, xenografts and so on, and confers on the body an image of a machine that can be fixed by a surgeon.

In Kirumi, the chemical and mechanical dimensions are much less emphasized. While there is a fair emphasis on the biological and physical dimensions, there is a considerable emphasis on the social and spiritual dimensions of health. Kawira’s story in Appendix G is an example of the kind of concerns that people have when they get ill. Kawira and her sympathizers were concerned about the cause of her illness, with regard to the physical and biological causes. She pondered over the fact that her husband may have been ‘fooling around’ and thus contracted the dreaded disease AIDS. Others suggested that her illness may be psychosomatic; they asked if she was “thinking too much”. In all this, she appealed to a spiritual being, God, for a cure. Overall, there was an effort to appeal to all dimensions of life, that is, the social, spiritual, emotional, physical, environmental and so forth.

**Environment.** The section on “sewage and refuse disposal in rural and urban situations” (pp. 168-172) portrays the physical environment as very important for human health. For example, physical elements created by humans like sewage and waste, can be
sources of disease. It should be noted that deforestation and soil erosion are not included here. Their effects on the quality of food, air and water, and the dangers they pose to indigenous fauna and flora, especially medicinal herbs, are not mentioned. Nor is there any mention of other types of environments and their effects on health. (It may be that these aspects are emphasized in the books for forms one, two and three.) The curriculum is silent on the ways in which social, political and economic environments affect human health, save for a comment on page 149 that “psychological” factors and “living in harmony with the environment” contribute to health. However, there is no further elaboration of these two factors. Hence, the impression on students is that these two factors are trivial and are not deserving the kind of attention given to other factors. In a sense, this is a hidden curriculum by omission. In Kirumi, by contrast, the effects of psychological, spiritual, and emotional factors on health are recognized as being of great importance.

**Diet.** In the Topic, emphasis is laid on the benefits conferred on health by ‘good food’ and ‘good food habits’, such as eating a balanced diet and retaining beneficial cultural foods in the regular diet. Chemical and physical details of calorific and nutritional values of foods are provided, together with details of the deficiency diseases arising from inadequate diets.

In Kirumi, too, there is emphasis on proper nutrition. Although there is no knowledge about the chemical and physical details of various foods, there is an appreciation of the role of nutrition in health. In addition, Kirumi people emphasize the avoidance of processed foods, commercial sugar and excessive salt and frying oils, because these do not confer ‘real’ health benefits on the body. In fact, it is believed that an over consumption of processed foods may result in an imbalance of *nyongo*, that is, make *nyongo* too diluted or concentrated. An imbalance of *nyongo* predisposes the body to illnesses. *Nyongo* imbalances may be corrected by herbs and by maintaining a balance of
bitter and sweet things in the diet. Regrettably, the concept of *nyongo* is not featured in the Topic. Clearly, further investigation is required to generate information about how ‘dis-ease’ is linked to an imbalance of bitter-sweet.

In the Topic, the effects of processed foods are mentioned in connection with oil, and obesity is identified as one of the resulting complications. The other adverse effect is high cholesterol levels in the blood that could result in hypertension and kidney malfunctioning. The Topic does not emphasize the harmful nature of processed foods, or emphasize sufficiently the importance of fresh foods. Also, the Topic does not draw a connection between health, nutrition and the use of agricultural chemicals. (Note, it is possible that these are included in forms one, two or three texts.) In Kirumi, people do link nutrition and agricultural chemicals; they do recognize that agricultural chemicals have a harmful long-term effect on people’s health.

**Herbs.** Herbs are featured prominently in Kirumi, as previous chapters have illustrated. An important observation is that herbs used in prepared foods, such as in soups and fermented ground gruel, are regarded both as part of nutrition and as medicine. Their role is preventive, palliative and curative. It is notable that there is a complete omission of herbs from the Topic.

The overall message in Kirumi is that body health is a process to be attended to in all aspects of life. Therefore, people incorporate body health concerns into many aspects of their daily lives: what they eat, how they consume the food (for instance, do they waste, do they share with others?), how they relate to and with others, and with whom they relate, all have elements of concern for body health. Such an holistic approach does not leave health concerns to particular decision points, such as: at what point to immunize for measles; when to watch out for this and that microorganism; and so on. By contrast, the Topic’s analytical approach to body-health distinguishes among aspects of the body that are chemical, biological, physical and so forth. Such a view, although it has many benefits
for body health, is likely to fragment our concerns for health, so that individuals will take marijuana or engage in irresponsible sex and not see how these may affect their health.

**The Primary Responsibility for Health**

Who is responsible for health? There is a sense in which the Topic emphasizes that there is "specialized knowledge" for health. Of course, specialized knowledge usually resides with "other" people, such as environmental engineers, nurses, doctors, surgeons and health workers. In the section on "water" and "water supplies to urban areas" (p. 177-178), "rapid filtration" and "slow filtration" are illustrated as processes that make water safe to drink. It is also explained that lakes and rivers are usually contaminated by feces from domestic animals, improper sanitation, industrial effluents, people who bathe in the water, and so on (p. 177). The recommended treatment for lake and river water, which incidentally is the kind of water available to the majority of rural people in Kenya, is slow or rapid filtration. It is worth noting that slow or rapid filtration is out of reach for the people of Kirumi. Fortunately, the women of Kirumi know that they can kill microorganisms by boiling their drinking water.

**Specialists' responsibility.** The message that flows through the Topic is that responsibility for health should be left to health experts or specialists. This is a powerful "hidden curriculum" that is partly acquired in the context of 'wrong messages' about science. In Chapter One, it was argued that the portrayal of schooled science as pure, universal and objective Truth, and as the only 'worthy' 'science', together with other 'wrong messages' to do with ethnicity and gender, is particularly alienating to rural people. For instance, the message that science is the preserve of middle class white males makes those who do not belong to this category ascribe anything to do with science to experts or specialists. Overall, the impression given of schooled science is that it is a form of knowledge that neither belongs with majority of the students, nor with majority of the
teachers. Hodson (1994), in a different context, discusses this form of disempowerment: when everyday issues are removed from the "realm of possibility" and "left to 'experts' and officials".

The section on "immunity", "allergies" and "organ transplant" gives a similar message of 'leaving it to skilled people', especially with all the immunization schedules proposed and the 'fixing of organs' by surgeons. Further on, under "First aid" (p. 183), there is a paragraph that reads:

first aid is the skilled application of accepted principles of treatment in the occurrence of injury or in the case of sudden illness using appropriate facilities or materials available at the time. It involves giving of approved assistance of aid to casualty patients until they are placed in the care of qualified medical personnel.

The women of Kirumi spoke a lot about 'first aid'. These women know how to take personal responsibility for their health. They gave examples of herbs and techniques that they use for minor cuts, burns, broken bones, the incidence of measles, allergy reaction, snake bites, diarrhoea, and so on. They also refer to continuous experimentation with available resources to find cures for illnesses. For experimentation, women rely on inherited skills, shared knowledge and personal intuition. Inherited skills on health constitute a portion of how one can take control of one's natural immunity by including herbs in soups and fermented ground porridge. It is particularly regrettable that the Topic does not mention that some diets help in building immunity against disease, particularly malaria. Clearly, there is considerably more emphasis on individual responsibility with regard to health among Kirumi people than in the Topic.

**Family and community.** Also lacking in the Topic, but available to Kirumi people, is the notion of having the family and community as other stakeholders in body health, in addition to the medical establishment (depicted as the only stakeholder in the Topic). In Kirumi, one's family and community are directly involved in the management of each
individual's health. For this purpose, a combination of knowledge and skills is drawn from both indigenous and schooled knowledge and healing skills.

In narrating her story (see Appendix G), Kawira told of how well wishers tried to get involved with her illness. In Kirumi, family and community are involved because some aspects of ill-health, within the moral and spiritual dimension, have a direct impact on the health of other members of the family or community. If a member of the family becomes a 'mad' woman or man, for instance, s/he brings physical and emotional pain to the family and disrupts harmony in the community, for example, when a 'mad' woman or man is violent. In a situation like this, parents become concerned for the safety of their children, and so walk their children to school, accompany them to draw water from the river, and so on. The elderly, sickly people and pregnant women are also at risk.

**Discussion**

Clearly, the school curriculum approaches health from a bio-medical point of view, while the lived experience of the people of Kirumi reflects a bio-cultural model of health. As already discussed, the emphasis is on scientific facts (the “Correct Approach” emphasis), and on attempts to make these facts applicable to everyday life (the “Everyday Coping” emphasis). This attempt, however, is rendered ineffective by the portrayal of science as 'someone else's knowledge' and a lack of reinforcement through the teaching and learning approaches that favour a cultural perspective on science (the “Self as Explainer”). These approaches also make provision for discussion of the achievement of other people and other cultures in SS. As it is now, SS is portrayed as largely a middle class white male achievement. The presentation of school science as knowledge whose production and construction resides in the authority of others renders this knowledge 'out of reach' for the learners. It alienates the learners and does nothing to foster independence and awareness of the potential for anyone to produce and construct SS.
Under ‘practical activities’, the curriculum includes the evaluation of “modern and traditional methods of curing” (KCSE, p. 141, objective, 22.45). The following section shows how a teacher can ‘sincerely’ incorporate indigenous items in the school curriculum, including, for example, the empowering knowledge that immunization was procured in Africa (and it still is) way before it was ‘discovered’ by Edward Jenner (Murfin, 1994). The section is organized in terms of five key proposals.

**Part Five: Suggestions on how to Indigenize the Curriculum**

1. Krugly-Smolska (1990, p. 479) suggests the teaching of “science as a way of knowing with practical consequences”, that is, a “holistic approach”. She suggests the structuring of science education so that students can “produce” rather than “reproduce” scientific knowledge. Teachers can aim to give students problems that are relevant to their environment, such as “how can we get a plant to grow better?” This problem posing invites students to integrate knowledge and skills of growing plants that they find useful in their indigenous settings, with those of SS. If the methods generated by the two paradigms are incompatible, students can investigate why a particular one is not viable, and also reflect on why they choose to apply some knowledge and skills, and not others. Further, they can retain all the facts but use the ones applicable for the problem at hand and retain other facts for use in other contexts This notion is also espoused by Claxton (1990). He refers to it as “laminating” and observes that science teaching and learning would enhance laminating by exercising “the ability to sift questions into those where hypothetico-deductive thinking is appropriate and those where it is not” (Claxton, 1991, p. 42). Arguably, when individuals are equipped to respond adequately and “spontaneously” to situations of everyday life, then science education will have achieved its purpose. I mentioned earlier that, currently, most science teaching and learning does not take into consideration that styles of thinking and learning, and of ideas and
knowledges generated, differ in relation to the contexts in which they were initially learned and the contexts in which they are or are to be expressed. However, if science teaching and learning seek to incorporate everyday contexts into curriculum settings, then students will be equipped to respond spontaneously to situations of everyday life, that is, the knowledge and skills they learn at school will be applicable in everyday contexts. This point is emphasized below.

2. The participants of the Bangalore conference (RECSAM, 1986) proposed to organize science curriculum around major areas of concern at local, regional, national and global levels. The participants suggested the inclusion of topics identified as most significant for development, such as health; food and agriculture; energy; land, water and mineral resources; industry and technology; the environment; and information transfer (Hodson, 1994; Kelly & Lewis, 1987). The overall aim is to provide a vehicle for merging local and schooled knowledges and for applying that learning in real contexts. Students and teachers will be able to interrogate schooled knowledge in terms of what it can or cannot do for local situations. This action component is well articulated in Freire (1970, 1985, also see p. 232 in the next chapter). In this mode of curriculum delivery, the teacher will have to play the role of cultural anthropologist, as explained in (5) below.

3. Ogunniyi (1988, p. 6) proposes the fusion of school science and indigenous science through the careful examination of the following:

(i) A determination of the nature of the world view held by individuals in a supposedly traditional society;
(ii) an identification of the elements constituting that world view;
(iii) testing for mutually facilitating, inhibiting or conflicting elements within the world views;
(iv) analyzing the data obtained;
(v) drawing conclusions; and
(vi) proposing a rationale for SS education.

This thesis has provided some essential elements and aspects of indigenous knowledge with respect to health education. Further research efforts are necessary for other topics in the curriculum.

4. Jegede (1994, p. 130) suggests the use of a “conceptual ecocultural paradigm ... a state in which the growth and development of an individual’s perception of knowledge is drawn from the socio cultural environment in which the learner lives and operates”. One aspect of conceptual ecocultural paradigm can be operationalized through collateral learning which Jegede (1998, p. 83) describes as a “duality of views” that allows learners to “explore nature from the multiplicity of cultures available, and to enable them to switch from one cultural context to another in explaining any given phenomena”.

Through collateral learning, learners learn to explain phenomena using their indigenous or school science, without experiencing cognitive dissonance. The framework they choose depends on how well it helps make sense of the phenomena. Choices are made through conflict resolutions at the cognitive and meta-cognitive levels, and by considering the logical efficacy of the framework, given the problems in question. There are a variety of ways, as espoused by Jegede, in which an individual can hold different views of the same phenomena. The one likely to result in less cognitive conflict or alienation, however, is where the different views under consideration are evaluated, with the aim of reducing any epistemological disparities between them.

5. Teaching science as a distinctive subculture could help in overcoming alienating aspects of schooled science (George & Glasgow, 1988; Hodson, 1998; Jegede, 1995; Krugly-Smolska, 1995; Ogawa, 1995; Swift, 1992). Teaching science as a subculture requires the teacher to “gain an understanding of... alien cultures (the subculture of science, school and school science, each with its language, beliefs, theories, values, attitudes and code of conduct) and to assist them in moving freely and painlessly within
and between them" (Hodson, p. 139). As already explained, teaching and learning science as a set of methods, norms, standards, values and beliefs for explaining and understanding natural phenomena provide opportunities for consideration of other viable and amenable ways of understanding and explaining natural phenomena. Subsequently, students personalize and politicize their learning, that is, they can choose which ‘sub culture’ is appropriate for resolving particular everyday problems. According to Hodson (p. 135), the principal purpose of science then becomes the “pursuit of understanding” or as Claxton (1991, p. 42) observed, “what has been learnt in school actually helps in the spontaneous, interwoven, value-laden world outside”.

**Summary**

This chapter has illustrated the imbalances in the Kenyan science curriculum. There is an overemphasis on “Everyday coping” and Correct Explanation” and a fair emphasis on “Scientific Skill Development” and “Solid Foundation”. There is very little or virtually none on other emphases, for example, the “Structure of Science”, the “Science, Technology and Society”, the “Self-as-Explainer”. Because the “Self-as-Explainer” emphasis is lacking from the topic of human health, there is no provision for integrating indigenous knowledges, such as the skills and experiences of health and healing and the bases of knowing in Kirumi.

The Topic also portrays health in an analytical way, as mainly a factor of mechanical, physical, chemical and biological parameters, that is, the bio-medical approach. Arguably, this approach may be credited with the eradication of killer diseases such as smallpox and the alleviation of suffering through allopathic management of health. However, an overemphasis on this approach at the expense of the ways in which the people of Kirumi manage health and healing is in large part a mis-education. This mis-education comprises the following elements: the neglect of the socio-cultural, environmental and emotional
dimensions of health, the portrayal of health as the responsibility of experts and not the self, and the omission of herbs and diet as measures for a health body.

The wish of many of the participants in this research study is to have indigenous knowledge taught in school. This would, for instance, ensure that students take individual responsibility for their health and not look to "specialists" to do it for them. The Topic presents "specialists" as being in better control of our health than ourselves. This is an absurd situation likely to foster irresponsible behaviour, with adverse consequences for health. After all, the hidden curriculum message is that the experts will fix anything that goes wrong. A curriculum re-organization along the lines being advocated here would have important benefits. For example, students would begin to value indigenous knowledge and the role of respect and community in health and healing, and would cultivate a desire to investigate and preserve indigenous knowledges and skills, thereby engendering self-esteem and minimizing the hurdles of border crossing into the subculture of science.

I used the notion of science as a subculture, with its own values, norms, beliefs and standards to discuss the means to an effective SS pedagogy. As such, I was able to utilize ideas deriving from situated cognition, constructivism, science, technology and society (STSE), and transformative strategies. Teaching and learning approaches that can operationalize these frameworks were also considered.
Chapter Nine
Discussion and Conclusions

Overview of Study

The focus of earlier discussions has been on issues surrounding the indigenization of secondary science. I have suggested three factors that may militate against indigenizing and, subsequently, against the use in everyday problem solving of knowledges and skills learned in the secondary science.

1. Omission and underemphasis of indigenous knowledge and skills in secondary science curriculum.

2. Promulgation of ‘wrong messages’ about schooled science.

3. Incomplete secondary science objectives.

Omission and underemphasis of indigenous knowledges and skills in science curriculum. To illustrate the omission and underemphasis of indigenous knowledges and skills in the science curriculum, I analyzed a set of secondary science objectives and the content of the “Human Health” topic (Topic) in a form four biology text. A most glaring omission in the secondary science objectives and in the Topic is the principles and processes of indigenous knowledges and skills. Although there is mention here and there of the ‘use of local materials’, there is no mention of the principles involved in the production of these local materials, that is, the principles and processes by which people know. For instance, the principle of embeddedness and respect, visuality or inter-generational networking and censorship are a few of these. My argument is that the inclusion of local materials in the learning of schooled science, without integrating the principles with which people produce these local materials, may result in fragmentation and trivialization of knowledges and skills.

In this study, for instance, women who have a fair bit of schooling are unable to make use of indigenous health and healing because they do not know ‘enough’. They may know
that a certain herb or the roots of a tree is used in the treatment of malaria, but they do not know how to go about processing this herb or root. That means they do not know how much to use, or how much water to add, or if the herb should be used in water or soup and so forth. They do not know whether to harvest the roots when the tree is flowering, or not; they do not know if the required root is from the male or the female variety of the tree. Sometimes they cannot even tell the difference between the female and the male varieties. If they are harvesting roots in the bush, they may not know how to locate the correct root amongst a maze of interlacing plant roots. They worry about measurements, that is, How much water? How many roots? How many leaves? How long should I take the dawa? The only option for these women is to use the government and private hospitals and subsidized and private health clinics, but hospitals and private health clinic fees are very high. Also, the treatment provided at these institutions is not always effective because the government health clinics, though subsidized, are often short of essentials.

This is the dilemma: most of these women, and majority of other Kenyans, have spent the best part of their lives learning schooled science and negating indigenous science. By negating, I mean internalizing the hidden messages of the school science curriculum and of the popular media (see Chapter Three and Chapter Nine), such as, ‘if it is not measurable or quantifiable, it is not worth knowledge’; ‘if you are not a distanced, rigorous and isolated seeker of knowledge then you are missing something’; ‘if it is not in the books, then it is not progressive’. The reality is that these women have lost both worlds. They have not been able to pursue schooled science adequately enough to make practical use of it in their health and healing. (See next section.) At the same time, having been away for most of the time from rural living, they are unable to articulate and utilize indigenous health and healing. Moreover, being economically poor, they cannot meet the costs of schooled medicine.
In Chapter Eight, I suggested some teaching and learning approaches that may help individuals to stay in touch with 'indigenous spaces' even when engaged in full-time schooling. I discussed teaching strategies such as the holistic approach (Krugly-Smolska, 1990); organizing the science curriculum around major areas of concern (such as basic human needs) at local, regional and global levels (Hodson, 1994; Kelly & Lewis, 1987; Power, 1986; RECSAM, 1986); incorporating a social action component that requires the teacher to play the role of a cultural anthropologist (Freire, 1970, 1985; Hodson, 1998); careful examination of world views (Ogunniyi, 1988); exploration of nature from the multiplicity of cultures available" (Jegede, 1998, p. 83); and teaching science as another sub culture (George & Glasgow, 1988; Hodson, 1998; Jegede, 1995; Krugly-Smolska, 1995; Ogawa, 1995; Swift, 1992).

My argument is that teaching and learning science using these strategies will provide an integrative discourse permeating both schooled and indigenous sciences. The central theme would be to improve, with the full knowledge and collaboration of local people, on the life conditions of local communities. When a teacher and students approach local people with ideas about improving the local pestle and mortar (these devices are used for processing maize [corn]), for instance, or with an innovation on how to make the processing of maize less laborious, the local people could either resist any suggested improvement or welcome the suggestions. Assuming they welcome the ideas, they are likely to give their own suggestions about how the processing of maize can be made easier. A combination of local knowledges and skills and materials, and the knowledges and skills that the teacher and students bring is likely to make both schooled and indigenous science more attainable, useful and usable (Hodson, 1994). In short, it can bridge the gap and it can help people (especially women) to escape the trap of acquiring scientific knowledge that they cannot use in everyday problem solving.
An additional benefit of such integration is the allaying of some of the superiority-inferiority conditioning expressed by Jiakathuku, and I believe this is an attitude engendered among students. It can challenge the view that ‘Europeans [white people] civilized us’, that is perpetuated by a schooled science curriculum that depict scientific knowledge as the preserve of Europe, especially middle class European males. In Chapter Three and Chapter Four, I attempted to show that schooled science, although popularized in Europe, has in and of itself a complex epistemological and historical setting. This setting involved other world civilizations besides Graeco-Roman (Bernal, 1987; Diop, 1974; Needham, 1969; Sardar, 1988); it involved women as well as men (Alic, 1986; Easlea, 1980; Ogilvie, 1986; Stanley, 1981, 1983).

Promulgation of ‘wrong messages’ about schooled science. I have argued that schooled science is neither the only knowledge of worth, nor is it pure, universal and objective Truth. Regrettably, most teaching and learning of schooled science portrays it as such. Further, these erroneous attributes of ‘science’ have been used as standards by which to judge indigenous knowledges. Since indigenous knowledges do not claim to be pure, universal or the objective Truth, they have been deemed unworthy for formal instruction. It is not without significance that most of the knowledges and skills designated for schooling were introduced by Europeans. As a consequence, these knowledges and skills (especially science, technology and mathematics) have gradually acquired meaning synonymous with school and with Europeans. Equating important knowledge and skills with school and with middle class Europeans males has resulted in significant alienation of rural people, partly because rural people, in their everyday lives, do not interact with ‘school and school related artifacts’ or with Europeans. In the case of secondary students who come from rural environments, schooled science, therefore, is seen as ‘others’ knowledges and skills and, more importantly, as the only worthy knowledges and skills. Nothing could be more alienating!
Using the concept of 'alternative sources of knowledge production and validation outside schooled frameworks' and the notion of schooled science as 'another' culture, I propose teaching and learning approaches that will empower students and teachers to participate in the production, development and promotion of their own form of 'worthy' knowledge. I have drawn supportive evidence from 'science' literature that favours the cultural approach to the teaching and learning of 'science'. This literature has suggested ways of teaching and learning 'science' that may help to curb the alienation acquired through current approaches. Several science educators have suggested that science pedagogy should take cognizance of:


(ii) Teaching and learning strategies that aim to help students to "gain an understanding of... alien cultures (the subculture of science, school and school science, each with its language, beliefs, theories, values, attitudes and code of conduct) and to assist them in the moving freely and painlessly within and between them" (Hodson, 1998, p. 139).

(iii) The inter dependency of the individual and the community in knowledge production (Dei, 1999b; Haraway, 1991; Hodson, 1998; J.P Miller, 1993; R. Miller, 1993; Toulmin, 1985; Vygotsky, 1962, 1978). Currently, there is considerable emphasis on the role of the individual in knowledge production, but as yet there is little emphasis
on the community, especially the principles and processes of knowledge that are applied within local communities. In Kirumi, for instance, embeddedness and connectedness, visuality and inter-generational networking and censorship are central to the way people understand and explain natural phenomena. There are other principles related to the application of medicine that should be taken cognizance of, such as ‘removal of disease’, ‘dissipation of disease’ and the concept of nyongo.

(iv) The socio-economic needs of the communities in which schools are located. This approach will help structure into the curriculum a social action component that will enable students and teachers to put their knowledges into practice. Students and teachers will be able to interrogate schooled knowledge in terms of what it can or cannot do for local situations. Such scrutiny will result in devising ways of improving on everyday or schooled knowledges in situations where neither, in themselves, is adequate for resolving problems (Claxton, 1991; Freire, 1970, 1985; Hodson, 1998; Jegede, 1998; Kelly & Lewis, 1987; Power, 1986; RECSAM, 1986; Sleeter, 1996; Wiredu, 1996).

My research has indicated some ways in which these four priorities can be met in the Kenyan context. As stated in Chapter One, the problem with science education in Kenya is that the school curriculum promotes scientific knowledge that people in the rural areas do not and cannot readily use for every day problem solving. These four priorities are proposing a situation where amenable and attainable indigenous knowledges are taught and learned along with amenable and attainable schooled knowledges. The decisions about what is attainable and amenable will be made in the medium of social action. The notion of social action was explained in the previous chapter.

The depiction of schooled science as pure, universal and objective Truth, and of standard knowledge and indigenous knowledges as not pure, universal or objective Truth has perpetuated the colonial legacy of “otherizing” (Mudimbe, 1988). Further, as argued in Chapter Four, the use of ‘other’s standards’ has largely silenced African knowledges.
The use of ‘other’s standards’ has meant that African material has to meet European standards in order for it to be considered ‘worthy knowledge’. However, there is a concerted effort now to recover these silenced knowledges. Given that the world is tending more toward ‘globalization’ than ‘departmentalization’, the recovery process will involve taking ‘our good and their good and making something better out of it’. Such a process involves considerable conceptual analysis in the tradition of what Wiredu (1996, p. 151-156) refers to as cross-cultural conceptual analysis.

The African concerned should satisfy herself that there are better or equally good African alternatives to the proposed western idea and whether the categories of thought in terms of which the propositions in question are framed are intelligible with the scheme of categories embedded in her own vernacular. Should this turn out to be the case she should then have to investigate whether the problem lies with her vernacular or with the foreign medium.

Wiredu’s (1996) argument is indicative of the kind of teaching and learning approaches that I suggested in Chapter Eight. As discussed earlier in this chapter, these teaching and learning approaches help in the integration of schooled science with indigenous science. In other words, they help render schooled knowledge useful for everyday situations and foster an active interrogation with indigenous science.

The published literature that grapples with the uses of schooled knowledges in everyday situations points to the fact that, because the context of knowledge production is carved out of day-to-day experiences of the natural world and the need to effectively explain, understand and survive in particular situations, all knowledge is contextual or engendered (Haraway, 1991; Vygotsky, 1962, 1978). Moreover, styles of thinking and learning, and of ideas and knowledges generated, differ according to the contexts in which they were initially learned and the contexts in which they are or are to be expressed (George, 1995; Hodson, 1998; Layton, et al., 1993; Lave, 1988). Earlier I referred to this as the ‘psychological baggage of knowledge’. The context in which knowledge is
produced constrains it and, consequently, that knowledge is partial, contextual or engendered. Knowledge, therefore, cannot make claims to universality.

If knowledge is bound by the historical, political, and economic conditions in which it was developed, it is incumbent on those involved in its construction to acknowledge its partiality and, by so doing, make it easier for the consumers of that knowledge to identify areas of commonality and differences with their own knowledge. Undoubtedly, this would help the consumers of knowledge to determine how to make good use of it.

Arguably, as suggested in Chapter Eight, teaching and learning science through the STSE and transformative strategies is one way of acknowledging the partiality of schooled science and enabling learners to determine how they can participate in making this knowledge meaningful for their socio-cultural environments. As already stated, organizing curriculum around major areas of concern (ideas of the Bangalore conference) and incorporating an action component into the curriculum provide useful models for achieving this goal.

**Incomplete secondary science objectives.** There are strong arguments in science education literature in favour of the application of schooled science to everyday life situations. Similarly, the stated purpose of Kenyan secondary science education is ‘facilitating the application of SS knowledge to everyday life situations’. But, based on my analysis, this purpose will not be successfully attained within the existing secondary science curriculum objectives.

As argued in Chapter Eight, the Kenya secondary science curriculum objectives do not provide a sufficient range of scope in curricula emphases. For instance, there is an overemphasis on the “Everyday Coping” and, to an extent, on the “Correct Explanations” and the “Solid Foundations” emphases. There is an absence or very little emphasis on other aspects of teaching and learning science, such as the “Self-as-Explainer”, “Science,
Technology and Decisions”, the “Structure of Science” and the “Scientific Skill Development”.

I see the greatest impediment in the absence of the “Self-as-Explainer” emphasis, although, as already pointed out, the curriculum also lacks a range of other useful emphases. When present, “Self-as-Explainer” helps to depict schooled science as a ‘cultural institution with a human purpose’. As such, learners are made aware of the possibilities and limitations of SS knowledge. It is crucial that learners see an open endedness to any discourse in order for them to envision possibilities that may apply to their own contexts. It is most important that they see themselves as players in the charting of new possibilities. Consequently, this emphasis empowers students and teachers to participate in the production, development and promotion of their own form of ‘worthy’ knowledge.

In addition to the “Self-As-Explainer” emphasis, teaching and learning that aims to ‘indigenize’ must take cognizance of knowledges and skills that students from rural areas encounter in their day-to-day lives. The curriculum must aim to give adequate attention to the principles and processes that are used in everyday problem solving in rural areas. The findings from this research study provide a set of considerations that may help teachers and students to take cognizance of knowledges and skills encountered in the day-to-day life in rural areas. Although restricted to one area of concern (human health), drawn from one locality and mainly focusing on women, the findings serve as an indicator for the ‘indigenization’ of the curriculum.

The Research Questions

This research posed four questions:

1. How do the people of Kirumi define ‘healthy’?
2. What knowledges and skills do women in rural Kenya use in their daily encounter with health and healing?

3. How is this knowledge acquired?

4. How do these knowledges and skills feature in the objectives of secondary science? What follows is a brief summary of the research findings.

How do the people of Kirumi define ‘healthy’? Healthy persons take into consideration the physical, spiritual, social and emotional dimensions of life and living. The physical dimension comprises looking after our physical bodies. That means being conscious of cleanliness and what we eat, and also of how we respond to aches and pains. A large portion of the physical dimension, therefore, is managed through preventive medicine. That is why the knowledge of miti that provide protection against disease is very important.

Spiritual aspects of health take into consideration our relationship with a supreme being and other spiritual entities.

The social dimension speaks to the need for harmony with others in the community. In this regard, people are expected to meet their moral obligations. In Kirumi, it is clear what social roles everyone plays and, therefore, each individual is expected to perform accordingly. These roles and obligations were discussed in Chapter Seven under “Moral Obligations and Respect”.

The emotional dimension is very much tied to the physical, spiritual and social dimensions. If someone is physically unwell, maybe because of poor bodily hygiene, it will be difficult for them to mix with other community members, thereby making such individuals appear anti-social. When one is considered anti-social, one ultimately feels rejected and, therefore, emotionally upset. Similarly, an illness can prevent someone from performing social roles and, thereby, can adversely affect emotional health. Also, an
inability to commune with spiritual beings does not help one to fit well within a community where the majority revere and submit to a supreme Being.

**What knowledge and skills do women in rural Kenya use in their daily encounters with health and healing?** Women have a great deal of knowledge about the use of herbs, plant parts, and animal and earth products for first aid, cures and prevention of illnesses. They know where to find these healing products, how to mix them, how to apply them in daily diets and so forth. However, the majority are not well informed about the intricate processes involved in the preparation of *miti*. Most women will, therefore, ask for information from others who know. Most importantly, they know how to balance the physical, spiritual, social and emotional dimensions of the body. This balancing aims at maintaining a healthy body.

There is also a tendency to balance and be flexible with regard to the applications of allopathic and holistic medicines. I found that only two women used the holistic approach exclusively. Of the other 73, five used exclusively the allopathic approach, while the rest used a mixture of allopathic and holistic medicine. Others, like Anastasia, Harriet, Kago, Kawira, Mbai and Mwiki, lean more towards holistic medicine than allopathic medicine. The same goes for the herbalists, Kanjiru, Irai and Mwambia. However, the herbalists demonstrated a greater trust in holistic medicines than anyone else.

**How is this knowledge acquired?** Knowledge is acquired through three main modes: embeddedness and connectedness, visuality and, inter-generational networking and censorship. Embeddedness and connectedness speak to the place of the individual within society and the role of others in an individual’s construction of knowledge. In other words, they speak to the cultural forces (both enabling and disabling) that structure what an individual can do or cannot do, and what they can envision as possibilities and limitations. Embeddedness and connectedness are about allegiance, belonging, and the
desire to both preserve and foster growth in the quality and quantity of knowledge and skills that one knows and owns.

Visuality is the exercising of the 'hidden' human senses. It is the claim to see beyond mere physical vision; to feel, contemplate, meditate and 'see' with senses other than the eye. People, therefore, trust their feelings, 'hunches', dreams and visions after purposeful praying, meditating and contemplating. Thus, people are open to extra sensory communication from the world around them. These avenues are used as sources of data and knowledge.

There is a lot of sharing of knowledges and skills. Knowledges and skills are shared vertically across generations and horizontally within one generation. Notions of embeddedness, connectedness and visuality as modes of knowing are important here, too. Sharing is governed by consideration of whether the recipients will respect the knowledge and skills, and make use of them or ridicule them. Such considerations are informed by knowledge of the recipients' families and other background information concerning their faith, schooling and so forth.

**How do these knowledges and skills feature in the objectives of secondary science?** There is a glaring omission of these epistemological aspects in secondary science objectives. An analysis of the secondary science objectives shows that the curriculum does not have provision for a 'sincere' integration of indigenous science with schooled science. Moreover, schooled science does not respect some sources of data that people of Kirumi use. Schooled science does not consider as knowledge anything that is not quantifiable or manipulable in an experimental situation. Indeed, most knowledge generated through embeddedness, connectedness and visuality is discouraged by schooled science.

Even when the outcomes of these modes of knowing build knowledge similar to SS knowledge; it is the tradition that such knowledge should not be referred to as 'science'. 
but as "revealed science" (Miller, 1985). For instance, it is argued, in the published literature, that the basis of SS is the 'scientific method' and, therefore, other means of building knowledge that do not use 'the scientific method' cannot claim the status of science. This creates a huge dilemma because the schools teach and learn 'science', yet the indigenous or everyday knowledge bases of those who are teaching and learning the science are not acceptable. This is a paradox that makes the job of the curriculum reformer very challenging and frustrating.

**Concluding Remarks**

As discussed in Chapter One, this research was conducted within a framework of understanding deriving from current debate in science education. Among the tenets of the framework are the following:

1. The content of high school science in Kenya may lack a genuine connection with people's socio-cultural and environmental contexts.
2. There is a need in Kenya for the development of a science that emanates from people's socio-cultural milieu (indigenous science).
3. It is believed that both indigenous and "schooled" knowledges underpin the way people currently explain and understand natural phenomena; both could contribute to an appropriate science.
4. Indigenous ways of explaining and understanding natural phenomena are learned through apprenticeship and imitation.
5. Women provide most of the learning experiences to growing children and, therefore, the skills and knowledge that women have are easily passed on to future generations.
6. The underachievement of girls in school science is a cause for concern because the development of an appropriate science is not likely to be successful if girls do not participate fully.

7. School science content that has a genuine connection with people's socio-cultural milieu is likely to interest girls, thereby going a long way to bridge the gap between school and everyday life.

From the previous discussions, it is evident that this inquiry has been a complex undertaking. There were many issues to address. One such issue that is an encompassing theme in this thesis is the gendering (contextualization) of knowledge, or, to put it rather crudely, 'the psychological baggage of knowledge'. This notion of 'psychological baggage of knowledge' is complicated further by the inter-subjectivities involved in any meaning-making situations. As discussed in Chapter Five, meaning making situations, such as the interviewing process, are bound by the past and current experiences of the participants. In planning this study, therefore, I saw a need to use a research methodology that would help in unraveling some of these subjectivities.

The grounded theory approach enabled me to make sense of participants' views by identifying their constructs or meanings and grouping such meanings into categories. The process of meaning making consisted of theoretical sampling and constant comparisons. Theoretical sampling is when as many participants are involved as would satisfactorily answer the research question; constant comparison is a continuous process of comparing categories for differences and similarities. This comparison generates further descriptions and explanations of categories. Any new evidence provides direction for the research in general and, in particular, for the kinds of questions to ask in order to generate more information for existing categories and their properties. In other words, I used data to build theory, to collect data, to test and validate theory, to develop more sophisticated
theory, and so on. Each step was built on its predecessor; each step informed the one that followed.

The entire data gathering process was based on the premise of alternative sources of knowledge production and validation outside schooled frameworks, which are mainly Eurocentric. I relied for the ‘how’ and ‘what’ of data on anti-colonial critique and feminists’ approaches. I used these frameworks in selecting interview questions, interview settings and ways of analyzing participant responses. Based on these frameworks, research methods and techniques that generalize data, issues of validity, reliability and generalizability are dependent on the contexts of the particular study. As a consequence, I was able to generate descriptions and explanations of categories without comparing them with existing categories or standards.

I was able to resist the temptation to categorize participant views as ‘wrong’. To an extent Joseph and Maua used principles that have been established by schooled science to explain participant views as ‘deviant’ or ‘wrong’ (see Chapter Seven). For instance, Maua understood the claim that healing herbs can be determined by use of ‘feeling’ as a ‘theory of signature’. Similarly, Joseph dismissed participant claims that sap from certain trees causes fevers in some people. He understood this as a situation in which mosquitoes breed in stagnant well water and so, when people go to draw the water, they may be bitten by the mosquitoes. People then link the water to malaria fever. An interesting point, though, is that such fevers occur at certain times of the year, that is, only when plants are flowering. Joseph’s observation would make sense if it is assumed that the weather conditions favouring flowering in plants also favour the growth and development of mosquitoes. Therefore, Joseph’s explanation needs further investigation. The point I am trying to make here is that I was able to analyze and synthesize data without using ‘Other’s standards’.
Implications of Findings for Science Education

1. Kenyan science educators will have to find ways of fostering a genuine connection between people's socio-cultural and environmental contexts and school science. Arguably, such genuine connection will enhance the application of science to everyday life situations.

2. Connecting school science with people's socio-cultural and environmental contexts may help to interest more girls and women in science. Also the application of knowledge learned at school to everyday life situations, especially in the area of health and healing, will be communicated more easily to current and future generations if more women have that knowledge.

3. In line with the arguments developed in this thesis, a consideration of a 'genuine connection' entails a change of the curriculum to incorporate a social action component. A social action component will necessitate changes in the following areas:

   (i) Organization and structuring of the curriculum, subject content and teaching and learning approaches.

   (ii) Methods of assessment.

   (iii) Current methods and modes of certification.

   (iv) The role of the teacher.

   (v) Teacher-training programs.

Implications For Health Coverage

The findings in this study are also relevant to health policies and other government policies, especially with regard to the provision of primary health care (PHC). The significance is in the following areas:
1. The impact of PHC programmes on the lives of people. Health providers may wish to determine, given the findings, the extent to which primary health care (PHC) programmes have been successful in improving rural health.

2. Relevant government departments may wish to look into ways of assisting herbalists in the endeavour of rural health coverage. The herbalists interviewed in this study expressed a great need for financial assistance.

3. Policy makers may plan intervention programmes in the light of the findings. They may wish to investigate quackery in medical practice in Kirumi. Women mentioned that medical practitioners in some health clinics 'make-believe' their diagnoses. As a result, many people have been diagnosed with and treated for malaria and amoeba when they have neither.

4. The relevant government departments may wish to investigate the issue of conserving endangered herbs and plants. For instance, the menywa and mariaria are threatened with extinction and yet are invaluable sources of cure and prevention for stomach worms, especially the prevalent amoeba. Other rare plants whose barks and/or roots, leaves and fruits are used for various cures should also be included in conservation efforts.

Implications For Future Research

1. There is a need to investigate further the concepts of nyongo, kunyagaaria murimo (dissipate the disease throughout the body, as in shock-treatment, for instance, dipping a child in ice cold water to treat giteu [pneumonia] and kuruta murimo, removing the disease.

2. More research on miti needs to be done in order to provide adequate information about the impact of miti on epidemiology and other aspects of population health.
3. There is need for further investigation, documentation and critiques of the principles and processes of indigenous knowledges in areas other than health. Critiques of these knowledges and skills will allow, in the African context, for a more comprehensive “cross-cultural conceptual analysis”, as suggested by Wiredu (1996).

**Summary**

I have linked the major threads of the study with the notion of alternative sources of knowledge production and validation outside the existing frameworks, which are mainly Eurocentric. I have shown how the notion of alternative knowledge weaves through various theoretical discussions in this study, such as the issue of situated cognition, gendering or contextualization of knowledge and the discussion on ‘otherness’. The purpose of these discussions was to re-think what has come to be regarded as the norm, that is, to re-think the place of schooled and indigenous sciences in ‘science’ education. The focus of this re-thinking was the lack of use, in everyday problem solving, of knowledges and skills acquired at school.
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Appendices

Appendix A

Glossary of Ki-Meru plants with scientific names

<table>
<thead>
<tr>
<th>Ki-Meru name</th>
<th>Scientific name</th>
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<tbody>
<tr>
<td>Kiinu</td>
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</tr>
<tr>
<td>Kimuku</td>
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<tr>
<td>Kirago</td>
<td></td>
</tr>
<tr>
<td>Kioroma</td>
<td></td>
</tr>
<tr>
<td>Kithoroko</td>
<td>Vigna Unguiculata</td>
</tr>
<tr>
<td>Kiua (coffee plant)</td>
<td>Sclerocarya Birrea</td>
</tr>
<tr>
<td>Mucogene</td>
<td>Tragia Brevipes</td>
</tr>
<tr>
<td>Mucugucugu</td>
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</tr>
<tr>
<td>Muenywa</td>
<td></td>
</tr>
<tr>
<td>Mugucwa</td>
<td>Zanthoxyhim Usambaranse</td>
</tr>
<tr>
<td>Muguruka</td>
<td></td>
</tr>
<tr>
<td>Mujuthi</td>
<td>Caesalpinia Volkensii</td>
</tr>
<tr>
<td>Mukandu</td>
<td>Ocimum Suave</td>
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<tr>
<td>Mukawa</td>
<td>Carissa Edulis</td>
</tr>
<tr>
<td>Mukungugu</td>
<td>Commiphora Zimmermannii</td>
</tr>
<tr>
<td>Mukuri</td>
<td>Ocimum sp.</td>
</tr>
<tr>
<td>Mukwego</td>
<td>Bridelia Micrantha</td>
</tr>
<tr>
<td>Muraa</td>
<td>Catha Edulis</td>
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<tr>
<td>Muriaria</td>
<td></td>
</tr>
<tr>
<td>Murubaine</td>
<td>Azadirachta indica</td>
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<tr>
<td>Muthanduku (black wattle)</td>
<td>Acacia Mearsii</td>
</tr>
<tr>
<td>Mutuntu</td>
<td>Croton sp.</td>
</tr>
<tr>
<td>Mwangua</td>
<td>Millettia sp.</td>
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<tr>
<td>Mwerere</td>
<td>Tabernamontana Stapfiana</td>
</tr>
</tbody>
</table>

(Source: Kokwaro, 1976).
Appendix B

Map of Kenya

(Source: Republic of Kenya, 1993, p. xxiv)
Appendix C

Map of Kenya and Meru District, Showing People of Mount Kenya

(Source: Fadiman, 1993, Map 1)
Appendix D

Meru: Major Subgroups

(Source: Fadiman, 1993, Map 4)
Appendix F

Migration Map

Possible migration routes of Bantu from Central Sudan

(Source: Imanyara, 1992, p.7)
Appendix G

Kawira’s Story

(K) Actually after we parted that day I came and checked the receipts and confirmed that it was 1983 when I was ill and not 1987.

(W) You will now tell me about your experiences at that time.

(K) I suffered a lot. I used to walk with a cane. Your mother would come and ask what the problem is and she would suggest that I probably was thinking too much. I would protest because there was nothing disturbing me emotionally. I have enough to eat and enough to clothe myself. If I lacked those things I would have reason to worry.

I was so sick that when I moved my head, it sounded like it was full with water. I would ask people to listen to the sounds of water in my head and they would say that they did not hear anything.

People prayed for me a lot because they were convinced that I was thinking too much. God then healed me.

At one point, somebody told me that since I was suffering too much, I should seek help from various sources. He suggested that: “since you have been to the best hospitals and not gotten cured and they cannot diagnose your illness, you go out and gather roots from plants”.

(W) Did you know about those roots?

(K) No. I did not know about plants as cure for illness. I asked the person to tell me which ones I should look for in particular. The person suggested that I should get any plant that I know is used for cure. That I should use everything and also try some that are used for cows. I should try them all in a bid to get my health back. The person suggested that after I get the plants and prepare the medicine, I should take a glass in the morning, afternoon, and evening.

So, what I did is I asked one of my friends to help me get the plants. At first the person was bemused and wanted to know what I was up to. Then, I told the person my problem: “my head is full with water, my chest is feeling as hard as a stone and my legs are very sensitive to cold”.

At this time, my husband also got word that there was a renowned herbalist at Karatina (a town in Nyeri district). Subsequently, he went to this herbalist and got a full bottle of herbs prescribed for me. In the meantime I was taking my own medicine that I had prepared from plants. I was drinking a lot of it, not like the way you would drink medicine but like the way you would drink water. The herbalist also told my husband that he trusted if I used all the medicine God would heal me. My friend was assisting me in preparing the medicine. The one my husband brought was to be taken in the morning, afternoon, and evening.
I began feeling better after the first bottle. After a month I was feeling well. When I had taken three bottles I was far much better. My skin got smooth and lighter. Before it was rough and very dark.

The clinics here were diagnosing me with malaria, amoeba, and three types of stomach worms. One clinical officer even told me that I had worms inside my head. I was taken aback. I wondered if I was a cow to have worms inside my head. He was amused and insisted that I had them. I told him I could not believe that because all the while when I was under treatment with him he took blood samples and made diagnosis and suggested that I would get treatment from Nairobi to cure my illness. It is at this time that my husband suggested that I should go to Nairobi, to the best hospitals and get treatment. At this point I was beginning to think that I had AIDS and that nobody wanted to tell me so.

AIDS was not so common then.

People were just beginning to talk about it. I pleaded with them (doctors) to tell me the truth. I talked with my husband about it and pleaded with him to give me any information which he may have been withholding from me with regard to our relationship because I was sure I had not done anything outside my marriage. I told him to reflect on this. He thought I was crazy but I insisted that since AIDS has no cure, we should be frank with ourselves. My husband said that he could swear by the Bible that he was hiding nothing. He told me to believe and trust in God. This was the devil’s work. He vowed to do all he could to see that I got the best treatment. He said that if I had wanted him to spend all his money and time at the herbalists, he could do that for me. That was how we got the herbalist.

The only problem I have now is my chest.

The herbs completely healed the rest.

I was cured. My children can tell you how often I went to the clinic: I went every other day. There was no improvement but I spent all my money there. If my husband was not faithful he would have left me for death. I would be dead by now.

When I got cured I was left with a little complication in my chest. My chest heaved a lot ... maybe because my body was weak.

And then you had taken a lot of medicine.

Yes, I had taken a lot of medicine. Later, we went to the herbalist for some help because whenever it was a little cold my chest would heave. The herbalist suggested that it was because my body was weak and told me to eat well so I could regain my strength. He then gave me some powdered ground herbs so I could boil. These would last
longer. He had dried those roots especially for people who had to travel from very far. My chest improved gradually. Many people had began saying that I have asthma. But I did not agree with them. I took three doses of this medicine every day. I would take for one week and wait for a month to assess my health and when I felt unwell I went for more... My chest healed and what is left now is very minor. It does not stop me from doing anything and is not affected by cold temperatures. There has been no need to go back to the herbalist.

(W) That is a remarkable story.

(K) Yes. I was troubled, and the people of this village can even testify that I am one person who has been troubled by illness. That was a real test. Think of it: I lay down for three years and all I did was sleep, lie down in one spot and move to another spot when the grass on the one is worn out. I did not work in the farm during that period. Now, when people see me going to my farm to work they look with wonder.

(W) You were really ill.

(K) I even aged so much people who did not know me well would ask if I was older than my sisters. My sisters are much older than me. That embarrassed me and made me cry. People were even suggesting that I might have been bewitched. But I did not believe it was witchcraft. If it was witchcraft I would have been dead a long time. I believed it was malaria and amoeba given the way I was feeling in my legs. It was the herbs that cured that.

(W) So it was the herbalist who told you that you were ailing from malaria and amoeba?

(K) And when I reported that to the clinical officer, the clinical officer exaggerated and said that I even had many types and some of them were inside my head. But, the herbalist had simply said it was malaria and amoeba.

(W) All those hospital doctors could not get that: even with lab tests and all?

(K) All those hospitals had no cure. What they did finally was to send me off and tell me to go and wait for death.

(W) Oh no! Kawira!

(W) Yes. I came home and cried because of what they had told me. I was with my brother when they told me. My brother comforted me and told me not to worry. He said that so many people have been told the same and are still alive to this day.
My brother would bring for me some food stuffs and tell me to watch my diet. He told me that he would stand by me to the last minute and that he believed that I was not going to die. He was very encouraging. When my husband came home (her husband works in another district) I told him the news and he told me that the doctor I saw must have been unqualified. He said that since the doctors at one of the renowned hospitals in Kenya did not tell me that I would die, there was no reason why a doctor from a local district hospital would tell me that I was going to die. It was God's hand that intervened for me.

Even now if I feel unwell, I prefer to visit that herbalist. I have faith in herbs. Also whenever I feel unwell I drink some herbs. That helps. I do this for general wellness. There is a plant in our farm, the one with bits of thorns, it is called mugucwa. I often boil its roots. Because of this, I have not been to a hospital in a long time. You can imagine how tired the local clinic was of me because I was there all the time. It has been two years now and I can say I am very well.

You told me earlier that you were afraid of being public about your use of herbs.

I was afraid that I would be ostracized from church. The other believers would say that I have been bewitched and I was seeing a witch-doctor who had prescribed those herbs for me. I did not want anyone of them to know. A friend was very concerned and suggested that I should go to hospital just like I was used to than adopt this other treatment which I was not comfortable talking about. I quickly cautioned this person not to tell anyone lest I be ostracized from the church.

Now, since you did not really know those plants, did you always have to ask someone?

I was using the ones used by cows. Whenever I was told it was safe for cows I would use it. The herbalist then told me to use majuthi and the root of mugucwa. He suggested that I should wash with the solution of majuthi. That is how the miracle happened. ... even the woman at Chogoria (referring to Kanjiru), I know her, she is the one who helps me and she told me of her story and how God directed her to the plants she uses.

She has good herbs.

Yes, she has powerful herbs. ...

I took x-rays of the chest, of the head ... I also learned a lot from the radio programmes. I listened to one announcer give information on one herbalist. This announcer gave examples of the diseases the herbalist cures. It is at this point that I thought, “if this is being announced on radio it must be a good thing”. I got encouragement from the radio.
People are not eager to talk about these things.

People do not talk about that in the village because they are afraid to be mistaken for having visited a witch-doctor. Not too long ago people used herbs freely, but because of the church they started to shy away.

Actually one person told me that she would not use herbs because using herbs would mean that she is retarding herself.

Just imagine!! As far as I am concerned, no church will stop me from using herbs. .... ......(IN, pp. 1-4)
Appendix H

Specific Objectives of the "Human Health Topic"

22. HUMAN HEALTH

22.1 Specific Objectives

The learner should be able to

(a) discuss the meaning of good health and factors affecting it and prerequisites of good health,
(b) discuss some traditional and current eating habits in relation to health,
(c) discuss deficiency diseases in humans,
(d) evaluate various weekly diets presented by pupils,
(e) identify the symptoms of different types of human diseases and methods of transmission and control,
(f) describe the life cycles of pathogenic protozoan and helminth parasites e.g. Plasmodium, Ascaris, Schistosoma,
(g) explain immunity and describe immune responses,
(h) discuss the effects of pollution on human health in rural and urban situations and

Source: Kenya Examinations Council, 1990 (pp. 139-144)
(i) demonstrate knowledge of first aid techniques.

22.2 Eating habits and health
(a) Balanced diet and energy requirements (Refer to topic 8.).
(b) Deficiency diseases e.g. Marasmus and kwashiorkor (Refer to topic 7.).
(c) Effects of some eating habits on health.
(d) Discuss cultural practices in relation to eating a balanced diet.

22.3 Micro-organisms, Viruses and their Economic Importance
22.3.1 Specific Objectives
The learner should be able to
(a) differentiate between micro-organisms and viruses.
(b) describe the simple structure of a named bacterium and virus,
(c) carry out experiments to show the occurrence and conditions necessary for growth and dissemination of micro-organism,
(d) explain the economic importance of micro-organisms in food storage and spoilage,
(e) evaluate the traditional and modern methods of food preservation,
(f) describe the common plant and animal diseases caused by viruses and micro-organisms,
(g) Relate the economic importance of these diseases to human health (also Ref. to Agriculture syllabus).
(h) describe the methods used to control diseases caused by viruses and micro-organisms e.g. fungi, bacteria and protozoa and
(i) name and discuss the role of micro-organisms in:
   (i) carbon cycle
   (ii) nitrogen cycle
   (iii) food processing.

22.3.2 Viruses
(a) Structure of a virus.
(b) Viral diseases e.g. small pox, chicken pox, tobacco mosaic
and common cold.
(c) Control of viral diseases.
(d) Economic importance of viruses.

22.33 Micro-organisms, bacteria, fungi and protozoa
(a) Identification of various types of bacteria: rods, spiral, cocci.
(b) Structure of yeast and E. Coli.
(c) Conditions necessary for the growth of bacteria.
(d) The importance of useful bacteria in nature.
(e) Common diseases caused by named bacteria, protozoa and methods of control.
(f) The nitrogen and carbon cycles (Ref. to topic 7.0).
(g) Micro-organisms in food processing (Refer to topic 6.0 of the Home Science syllabus).
(h) Economic importance of bacteria and fungi.

22.4 Practical Activities
22.41 Examine prepared slides of malaria parasites, Trypanosoma or ringworms.
22.42 Carry out experiments on budding and fermentation using yeast.
22.43 Carry out experiments to show:
   (a) Universal occurrence of bacteria and fungi.
   (b) Environmental conditions affecting bacterial and fungal growth. (Care should be taken not to examine micro-organisms in open petri-dishes.)
       Count bacterial and fungal colonies under various temperature conditions.
22.44 Carry out microscopic examination of:
   (a) bacteria in fermented milk
   (b) micro-organisms in various samples of farm manure.
22.45 Evaluate modern, and traditional methods of curing fungal infections like Athlete's foot, ringworms, oral and urino-genital nital fungal infections.
22.46 Carry out experiments to show the antibiotic nature of some fungi by planting Penicillium ssp. on petri dishes containing other micro-organisms.
   List some of the antibiotics and the diseases against which they are used. NOTE: Dangers of under-dose should be discussed.
22.5 Human diseases
Discuss at least one example from each of the following categories:
(a) Bacterial diseases e.g. cholera, typhoid.
(b) Viral diseases - e.g. measles.
(c) Protozoa diseases - e.g. malaria, amoebic dysentry.
(d) Diseases caused by nematodes e.g. Roundworm/Ascaris (hookworm).

22.6 Respiratory diseases
(a) Asthma, bronchitis, pulmonary tuberculosis, pneumonia and whooping cough.*
(b) Discuss the causes, symptoms and prevention of respiratory diseases.
(c) State the common diseases of the circulatory and lymphatic systems and suggest possible methods of control/prevention.
(d) Diseases and defects of the heart (coronary thrombosis), (varicose veins) and arteries, how to control them.
(e) Diseases of the blood e.g. haemophilia, anaemia, leukemia, septicaemia, sickle cell anaemia. (Refer to topic 19.)
(f) Diseases and disorders of the lymphatic system e.g. oedema and elephantiasis.
(g) Common kidney and liver diseases, their symptoms and possible methods of prevention/control.
(h) Common dental diseases, their causes and treatment.

22.7 Sexually transmitted Diseases (STD) *
Gonorrhea, simplex Herpes, AIDS (Acquired Immune Deficiency Syndrome), Syphilis, Hepatitis B, Trichomoniases.

22.8 Identify the symptoms and explain the methods of transmission and prevention of Sexually Transmitted Diseases (STD).

22.9 Immune Response
(a) Natural immunity.
(b) Artificial immunity.
(c) Allergic reactions.
(d) Organ transplants and associated problems.
(e) The role of vaccinations and the vaccination time table in children against diseases like typhoid, poliomyelitis, whooping cough etc.
22.10 Water
(a) Sources of water (bore holes, rivers, lakes, springs and rain).
(b) Water purification and supply at individual and community level.

22.11 Sewage and refuse disposal in rural and urban situations
(a) Necessity for proper sewage and refuse disposal.
(b) Methods of disposing sewage and refuse at home, in small and large communities.
(c) Sewage treatment plants and pit latrines.
(d) Proper methods of disposing refuse and water.

22.12 Effect of pollution and human health.
(a) Effect of heavy metals from industrial and agricultural sources and from automobiles. (Refer to such diseases as emphysema, asthma and skin problems).
(b) Air pollution - carbon dioxide, heavy metals, carbon monoxide, automobile emissions and radioactive waste.
(c) Water and food pollution from pesticides, weed killers, food preservatives, tinned food poisoning.
(d) Sound pollution (Refer to topic 20.)
(e) Pollution from cosmetics.

22.13 First Aid
Simple treatment of the following: cuts, burns, snake bites, nose bleeding, drowning in water, intake of poisonous substances, simple fractures, artificial respiration and diarrhoea.

22.14 Practical Activities
22.141 A guided visit to a district, provincial, rural training centre or a nutrition centre to learn
(i) how to make full use of medical services and the
(ii) role of dispensaries and hospitals in the community.

22.142 A guided visit to a local market, sewage treatment plant and a slaughter house (abattoir) etc.

22.143 Demonstrate basic skills in simple treatment of cuts, burns, snake bite, nose bleeding, drowning in water, intake of poisonous substances especially food poisoning, simple fractures and artificial respiration.

22.144 Carry out observation of some of the following diseases: kwashiorkor, marasmus, malaria (details of
paroxysms due to individual Plasmodium species is not required).

22.145 Demonstrate techniques of preserving food (both traditional and modern) e.g. vegetable drying, smoking, freezing.

22.146 Construct a simple water filter.

22.147 Carry out an antigen/antibody immune response by injecting a male frog with urine samples from a pregnant human female.

22.148 Effort should be made to invite speakers like public health officers.

22.149 Films can be borrowed from United Nations Environment Programme (UNEP), National Christian Council of Kenya (NCCK), International Planned Parenthood Federation (IPPF), World Health Organization (WHO), African Medical and Research Foundation (AMREF), Kenya Institute of Education (KIE).
Appendix I

Chemistry and Physics Objectives

**132 Physics** (Kenya National Examinations Council, 1990, p. 145)

**General Objectives**
This course is intended to:
1. Help the learner to discover and understand the order of the physical environment.
2. Make the learner aware of the effects of scientific knowledge in everyday life through application to the management and conservation of the environment, the utilisation of resources and production of goods.
3. Enable the learner to reason critically in any given situation.
4. Enable the learner to appreciate the responsibility of the scientist to the society.
5. Inculcate in the learner a willingness to co-operate in using scientific knowledge to foster development in the society.
6. Prepare the learner for further studies and/or vocational training.

**133 Chemistry** (Source: Kenya Examinations Council, 1990, p. 166)

**General Objectives**
At the end of this course the learner should be able to:
1. Handle apparatus, make accurate observations and draw simple conclusions during experimental work.
2. Select and use appropriate apparatus for experimental investigations.
3. Recall safety procedures and follow experimental practices.
4. Write chemical symbols of elements and formulae of compounds and equations for simple reactions.
5. Identify patterns in the chemical behaviour of substances.
6. Use ideas, concepts and skills acquired in learning chemistry to solve problems in everyday life.
Appendix I

"Human Health" Topic

THE MEANING OF GOOD HEALTH

Good health is the proper functioning and balanced state of the body physically, physiologically and psychologically. There are several factors which enable the body to be healthy. Good health does not mean the absence of disease alone. It also means living in harmony with the environment. People who live in poorly managed, overpopulated areas suffer from environmental stresses due to the difficult circumstances they have to endure. For instance, they may be residing near a noisy factory, airfield, night club, bus station or near a nuclear plant. Living near sewage or refuse disposal area can cause diseases.

The main factors affecting human health are inadequate food, pollution and diseases.

EATING HABITS AND HEALTH

A balanced diet should contain correct quantities of proteins, carbohydrates, fats, vitamins, mineral salts, roughage and water.

Proteins

The proteins supplied to the body should contain all the ten essential amino acids. (Ref. Book 1, Chapter 3, page 94). These should be in sufficient quantities depending on age and sex of an individual. Growing children and pregnant mothers require a larger proportion of protein in their diet than mature adults above the age of 21 years. Males require a larger proportion of proteins than females. Children who do not get enough proteins in their diet suffer from a food deficiency disease called kwashiorkor. Such children have poorly developed brains and can be mentally retarded.

Kwashiorkor affects children who are between the ages of six months and four years. It may be caused by early weaning and feeding on non-protein foods which results in protein deficiency in the body. Breast-feeding alone supplies sufficient proteins and energy to the child up to the age of six months.

The signs of kwashiorkor include the following:

1. Loss of appetite and diarrhoea.
2. Swollen legs and hands — a condition known as oedema.
3. Scaly skin with dark patches that peel off.
4. Decolourised hair which easily falls off.
5. The child is retarded in growth and may not start walking or crawling at the expected age.

A child with kwashiorkor is easily prone to other diseases. The only cure is by feeding the child on food rich in proteins, e.g. milk, beans and eggs.

In normal adults the protein intake should be between 10% to 12% of the diet. A minimum of 55gm. of protein for an adult man and 40gm. for an adult woman per day is adequate. Both animal and plant proteins should be included in the diet so that there is sufficient intake of essential amino acids. In adults too much animal protein, especially excessive eating of beef, leads to a disease called gout in which there is retention of "water" in the joints, e.g. knee and ankle joints. The retention of the liquid makes the joints very painful and leads to difficulty in walking. Generally, too much protein in the diet can lead to overweight in both children and adults. This condition is referred to as obesity. An obese person can also develop hypertension or high blood pressure.

Fig. 5.1: An overweight (obese) person.
<table>
<thead>
<tr>
<th>Person</th>
<th>Energy (kilojoules)</th>
<th>Protein (g)</th>
<th>Calcium (mg)</th>
<th>Iron (mg)</th>
<th>Vitamin A (mg)</th>
<th>Thiamine (mg)</th>
<th>Riboflavin (mg)</th>
<th>Niacin (mg)</th>
<th>Ascorbic acid (mg)</th>
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<td>800</td>
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<td>(per kg weight)</td>
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<td>500</td>
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tr = trace quantities.
### Table 18

**Table of Average Food Values**

(Amounts given per 100 g edible food)

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<th></th>
<th>Energy (kilojoules)</th>
<th>Protein (g)</th>
<th>Calcium (mg)</th>
<th>Iron (mg)</th>
<th>Vitamin A (mg)</th>
<th>Thiamine (mg)</th>
<th>Riboflavin (mg)</th>
<th>Nicotinic Acid (mg)</th>
<th>Ascorbic Acid (mg)</th>
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<tr>
<td><strong>Cereals and Bread</strong></td>
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</tr>
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<td>Maize (whole grain)</td>
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*tr = trace quantities.*
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<th>Protein (g)</th>
<th>Calcium (mg)</th>
<th>Iron (mg)</th>
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<th>Thiamine (mg)</th>
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<td>(fresh with pods)</td>
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<td>1.0</td>
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<td>0.1</td>
<td>tr</td>
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<td>Cabbage and similar leaves</td>
<td>80</td>
<td>tr</td>
<td>40</td>
<td>tr</td>
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<td>0.1</td>
<td>0.1</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>Onions</td>
<td>100</td>
<td>tr</td>
<td>30</td>
<td>tr</td>
<td>0</td>
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<td>tr</td>
<td>0.3</td>
<td>10</td>
</tr>
<tr>
<td>Spinach</td>
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<td>tr</td>
<td>70</td>
<td>3</td>
<td>3.9</td>
<td>0.1</td>
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<tr>
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<td>tr</td>
<td>200</td>
<td>3</td>
<td>2.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>100</td>
</tr>
<tr>
<td><strong>Fruits</strong></td>
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<td>Banana (sweet)</td>
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<td>0.1</td>
<td>0.1</td>
<td>1.0</td>
<td>10</td>
</tr>
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<td>Lemons and limes</td>
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<td>tr</td>
<td>15</td>
<td>tr</td>
<td>0</td>
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<td>35</td>
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<td>Mango</td>
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<td>tr</td>
<td>20</td>
<td>tr</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
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<td>Oranges</td>
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<td>tr</td>
<td>30</td>
<td>tr</td>
<td>tr</td>
<td>0.1</td>
<td>0.1</td>
<td>tr</td>
<td>45</td>
</tr>
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<td>Paw paw</td>
<td>160</td>
<td>tr</td>
<td>30</td>
<td>tr</td>
<td>0.8</td>
<td>tr</td>
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<td>Pineapples</td>
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<td>84</td>
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<td>0.1</td>
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<td>40</td>
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<tr>
<td><strong>Nuts, Sugar, etc.</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cashew nuts</td>
<td>2 400</td>
<td>20</td>
<td>50</td>
<td>5</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td>Coconut kernel</td>
<td>1 720</td>
<td>5</td>
<td>25</td>
<td>2</td>
<td>0</td>
<td>0.1</td>
<td>—</td>
<td>0.5</td>
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</tr>
<tr>
<td>Dates (dried)</td>
<td>1 200</td>
<td>tr</td>
<td>70</td>
<td>2</td>
<td>tr</td>
<td>0.1</td>
<td>tr</td>
<td>2.0</td>
<td>0</td>
</tr>
<tr>
<td>Seed</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower seed (kernel)</td>
<td>2 400</td>
<td>25</td>
<td>100</td>
<td>7</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>—</td>
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tr = trace quantities.
Table 18 (Concl.)

<table>
<thead>
<tr>
<th>Energy (kilojoules)</th>
<th>Protein (g)</th>
<th>Calcium (mg)</th>
<th>Iron (mg)</th>
<th>Vitamin A (mg)</th>
<th>Thiamine (mg)</th>
<th>Riboflavin (mg)</th>
<th>Nicotinic acid (mg)</th>
<th>Ascorbic acid (mg)</th>
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<td>Sugar (white)</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
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<td>Sugar (brown)</td>
<td>1 630</td>
<td>tr</td>
<td>30</td>
<td>2</td>
<td>0</td>
<td>tr</td>
<td>0.1</td>
<td>0.2</td>
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<tr>
<td>Jam</td>
<td>1 120</td>
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<td>15</td>
<td>1</td>
<td>0</td>
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<td>0</td>
<td>11.0</td>
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<tr>
<td>Beverages, etc.</td>
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<td></td>
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<td></td>
<td></td>
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<td>Cocoa powder</td>
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<td>20</td>
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<td>0.1</td>
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<td>Coffee powder</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>9.8</td>
<td>0</td>
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<td>Tea leaves (dry)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.9</td>
<td>5.9</td>
<td>0</td>
</tr>
<tr>
<td>Insects</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Lake fly</td>
<td>1 220</td>
<td>50</td>
<td>140</td>
<td>66</td>
<td>—</td>
<td>1.3</td>
<td>3.4</td>
<td>18.0</td>
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<tr>
<td>Termites</td>
<td>520</td>
<td>10</td>
<td>25</td>
<td>1</td>
<td>—</td>
<td>—</td>
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</tr>
</tbody>
</table>

tr = trace quantities

CARBOHYDRATES

These are energy-giving foods. Generally energy is required for both physical and physiological activities of the body including growth, reproduction, nerve-impulse transmission, temperature regulation and movement.

A person doing heavy manual work (like digging, felling trees) or an athlete, requires relatively more energy than an office worker who spends most of his time sitting down. Generally, men require more energy than women of the same age and size. Also because of his high metabolic rate, a young man of 25 years requires more energy than a 50 year old man. The energy expenditure will also vary with the health conditions of the body e.g. a patient requires more energy than a healthy person.

It is therefore important that carbohydrates are included in the diet every day. The minimum energy required just to maintain life at complete rest is called Basal Metabolic Energy. (See page 86 of Book 2).

Table 19: Average energy expenditure per day by both males and females of different ages.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Energy use per day (kJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>2</td>
<td>5 500</td>
</tr>
<tr>
<td>3</td>
<td>7 000</td>
</tr>
<tr>
<td>8</td>
<td>8 800</td>
</tr>
<tr>
<td>11</td>
<td>10 000</td>
</tr>
<tr>
<td>14</td>
<td>12 500</td>
</tr>
<tr>
<td>18</td>
<td>14 200</td>
</tr>
<tr>
<td>25</td>
<td>12 100</td>
</tr>
</tbody>
</table>

MARASMUS

This is a deficiency disease that affects children who are below the age of five years and who are undernourished. It usually occurs in children who are weaned too early and are provided with food containing few calories. This disease is usually associated with
poor standards of living especially in the rural areas. The disease is characterised by the following symptoms:

1. Very high appetite.
2. Very thin body which appears to be dehydrated. The ribs and other bones show through the skin.
3. Muscle atrophy, i.e. poorly developed muscles.
4. Very low weight indicating poor growth.
5. The skin is wrinkled.

For treatment of marasmus, the child should first be treated for parasitic infections should there be any. Then the child should be fed on enough proteins, fats, carbohydrates and vitamins. In areas where tea with milk is taken in plenty, cases of kwashiorkor and marasmus generally do not occur.

For adults, excess intake of carbohydrates may lead to obesity. This is because most of the excess carbohydrates are converted into fat and stored under the skin, around the heart, alimentary canal, kidneys and other body organs. Cholesterol, which is a derivative of fat, can accumulate in the blood vessels and cause high blood pressure (see pages 37 and 40 of Book 2). If too much carbohydrates, especially sugar, are consumed and little manual work or exercise is done much of the excess carbohydrates are converted to fat deposits or adipose tissue, leading to obesity.

FATS AND OILS
As has already been pointed out in Book 1, fats and oils can be derived from plants and animals. The vegetable fats and oils are extracted from seeds or fruits, e.g. linseed, sunflower and groundnuts. Fats provide more energy than all the other food substances. Generally, fats should form only 20-25% of the daily food intake for providing energy. Fat is necessary in the diet because once in the adipose tissue, it insulates the body against external cold temperatures. Most of it is oxidised to produce heat energy to maintain constant body temperature. As mentioned before, excess fat stored around body organs and under the skin can lead to obesity. Similarly, excess cholesterol in the blood can cause hypertension and kidney malfunctioning.

MINERAL SALTS
Animals get all the mineral salts they require from the food they eat and the fluids they drink. Salts are required for the various functions in the body. First, the mineral salts serve as electrolytes in the body fluids (or plasma) thus maintaining the osmotic balance of the body (see Book 3). Sodium ions (Na+) and chloride ions (Cl-) are present in extra-cellular fluids, while potassium ions (K+) are present in intra-cellular fluids. Calcium and phosphorus are important constituents of bones and teeth. Calcium, sodium and potassium play an important role in nerve impulse transmission. Calcium also plays an important role in the generation of action potential in the contraction of skeletal or striated muscles. Poor muscle functioning therefore may be as a result of excess or too little calcium. Deficiency in phosphates and calcium in the diet of children can cause rickets, a condition in which the teeth and bones do not develop well and the child becomes bow-legged. Phosphorus plays an important role in energy transfer system of the body. It occurs as a phosphate in a compound called Adenosine Triphosphate (ATP) which is energy-rich (see Books 1 and 2). Phosphorus and sulphur form components of some proteins e.g. nucleo-proteins.

Iodine is an important mineral of the hormone thyroxine. Deficiency of this element leads to enlargement of the thyroid glands, a condition known as goitre. Enough supply of iodine can be ensured by including iodised salt in one's diet. Dental fluorosis is a disease caused by deficiency of iodine, causing tooth decay. If the amount of fluorine in water falls below 1 ppm, the teeth are prone to decay very easily. However, when there is too much fluorine in water, the teeth develop brown stains. People living in areas with inadequate fluorine compounds in the drinking water may
Plate 8: A child suffering from marasmus.
use tooth-pastes containing some fluorides to make up for this deficiency.

Iron is an essential component of blood haemoglobin. The erythrocytes or red blood cells need iron for the formation of haemoglobin. This is the pigment which combines readily with oxygen to form oxyhaemoglobin and it is in this form that oxygen is transported to the cells in all tissues of the body. Deficiency of iron in the diet results in iron-based anaemia and so the transport of oxygen is inefficient. To correct this, food rich in iron compounds should be included in the diet. Iron tablets may be taken on a doctor's prescription.

Minerals also function as co-enzymes in the body metabolism.

VITAMINS
Vitamins have already been described as organic substances that are essential for the maintenance of good health. They are required by the body in very small quantities. Some vitamins are soluble in fat while others are soluble in water. A diet would not be complete or balanced without the inclusion of vitamins. Some vitamins are involved in protecting the body against some diseases, while others are vital in some of the metabolic reactions in the body.

The absence of vitamins or an inadequate supply of them in the diet can lead to deficiency diseases. Deficiency of a particular vitamin leads to a specific deficiency disease (see page 144 of Book 1).

Fig. 5.2.
Vitamin A
Vitamin A or retinol, is synthesised from a plant pigment called carotene. It is necessary in the synthesis of the visual pigments — rhodopsin and iodopsin. Deficiency of this vitamin leads to nightblindness. A person suffering from nightblindness can only see distinctly in bright light.

Other functions of vitamin A include its role in the synthesis of the epithelium of the respiratory system and maintenance of a healthy eye cornea.

Vitamin B complex
This consists of a group of at least 12 vitamins and have similar sources.

Vitamin B1 (Thiamine)
It is vital in carbohydrate metabolism. Its deficiency in the diet results in a disease called beriberi, and the malfunction of both the nervous and the circulatory systems. Deficiency of vitamin B2 (riboflavin) results in skin disorders or dermatitis and pellagra.

Vitamin B12 (Cyanocobalamin)
This is also very important in the Kreb’s cycle stage of respiration. Deficiency of vitamin B12 causes pernicious anaemia, since it is involved in the production of erythrocytes.

Vitamin C (Ascorbic acid)
High intake of the vitamin in the diet reduces cholesterol in the blood. This is beneficial because cholesterol is associated with hypertension. Deficiency of this vitamin causes scurvy in which there is breakdown of connective tissue and blood vessels, bleeding of gums and various other organs (skin, intestinal lining, muscles).

Vitamin D (Calciferol)
This vitamin is manufactured in the skin under the influence of sunshine. It stimulates the absorption of calcium from the alimentary canal and its subsequent deposition in bones. Deficiency of the vitamin leads to malformation of bones, a condition known as rickets.

Vitamin E (Tocopherol)
This vitamin is thought to be responsible for spermatogenesis in men. Its deficiency can lead to sterility.

Vitamin K (Quinone)
This vitamin is responsible for the production of prothrombin. Its deficiency may lead to excessive bleeding.

Roughage
For proper peristalsis during digestion some indigestible material such as cellulose should be included in the diet. The undigestible materials are collectively called roughage. Inadequate supply of roughage in the diet leads to poor muscle contraction during peristalsis.

Water
Sufficient amounts of water are required in a balanced diet mainly because it is the most necessary solvent in which all body substances are either suspended or dissolved. Water also maintains the osmotic and electrolytic balances of the body. Deficiency of water leads to dehydration and eventually, death.

CULTURAL PRACTICES AND THE BALANCED DIET
Several cultural practices by communities and religious groups may have some effect on the provision of balanced diet to their members. Some of the effects are beneficial while others are detrimental to good health.

Religious practices which bar members from eating certain types of food may have detrimental effects on the provision of a balanced diet if no suitable alternative is given. Some religious sects, for instance, prohibit the eating of meat or certain types of meat, but supplement the diet with milk, beans, lentils, etc. This is all right.

In some communities certain types of food, e.g. fish or eggs are not eaten due to customs or taboos. Pregnant women may not be allowed to eat certain foods for fear that they will give birth to deformed children.

Good traditional feeding habits should be encouraged. It should be noted that a diet
which consists of meat, blood and milk provides more protein than a diet containing only starch foods. Traditional foods like millet, cassava, sorghum and some traditional vegetables should continue to form part of the diet. Also, hygiene in the preparation of the food must be encouraged.

Traditional eating habits are quickly changing because of rapid urbanisation, change from subsistence to cash crop farming, etc. Healthy subsistence crops like simsim and groundnuts are being replaced with cash crops like sugarcane, coffee and tea. This has contributed to unbalanced diets in some areas of the country. People living in urban areas obtain their food supply mainly from food stores and groceries. This food may not be fresh.

**HUMAN DISEASES**

There are a number of pathogenic organisms that cause diseases in human beings. These include: viruses, bacteria, protozoa, platyhelminthes (especially trematodes and cestodes) and nematodes. Some of the bacteria-caused diseases are cholera and typhoid.

**VIRAL DISEASES**

Viruses are sub-microscopic organisms ranging in size from 25nm to 500nm. All viruses are obligate parasites and this is why they cause diseases. They reproduce only when they are inside a living cell of their host.

Some of the diseases caused by viruses include smallpox, chickenpox, acquired immune deficiency syndrome (AIDS), mumps, measles, poliomyelitis, influenza, yellow fever and hepatitis. There is as yet no cure for some viral diseases which, however, can be prevented by immunisation. AIDS and smallpox are two well-known deadly viral diseases, but it is now assumed that smallpox has been completely wiped out from the earth; the last case was reported in India in November, 1973.

**Measles**

This is a viral disease which mainly affects children. It is transmitted through nasal discharges, sputum and discharges from the eyes of infected persons. It is therefore spread by droplet infection.

The incubation period lasts from seven to fourteen days with an average of ten days. The patient is infectious two days before the symptoms appear. A person who is infected but appears healthy during the incubation period can therefore transmit the disease to others.

The symptoms of the disease start with fever and a cold, accompanied by coughing and a watery discharge from the eyes. A rash appears on the face on the third day which later spreads to the whole body. Eventually the respiratory tract is infected and the fever increases. Spots appear in the mouth. The patient usually recovers within three weeks of treatment. Normally the disease is not fatal if the patients are well treated and nourished, but it lowers the resistance of the body to other infections such as bronchitis, pneumonia and encephalitis. The mucous membranes of the body may also be heavily infected.

Recovery from measles gives permanent immunity to this disease. A vaccine which provides permanent immunity is also available from health institutions.

**Prevention and treatment**

It is advisable that children should be vaccinated at the right time. Due to the very infectious nature of the disease quarantine or isolation of the patients having the disease for four weeks is necessary.

**BACTERIAL DISEASES**

**Cholera**

This is a water-borne disease caused by a bacterium known as *Vibrio cholerae*. It is a killer disease in the tropics. These bacteria are normally found in infected water and are passed on by flies to food thereby contaminating the food. People living in unhygienic conditions, i.e. where sanitation is poor and the domestic water supply is contaminated, can easily contract the disease. Once there is an outbreak of the disease, it spreads rapidly and can cause an epidemic.
on bacteria. At certain times, they invade the mucosal wall of the colon and produce a tissue-dissolving enzyme called histolysin (hence the name histolytica). This results in the formation of ulcers on the colon wall and the parasites then feed on red blood cells at the site of the ulcers. This condition usually leads to diarrhoea or amoebic dysentery and the faeces contain blood.

The disease is usually characterised by diarrhoea, dehydration, fever and abdominal pains. The infection may also become systemic (i.e. invade the blood stream), and the parasites may reach other tissues or organs of the body e.g. liver, lungs, brain, etc. where they produce abscesses which may be fatal.

Prevention and control
Prevention of the infection aims at avoiding the contamination of food or water with cysts. Control measures include boiling water for drinking, proper food storage and proper faecal disposal.

Treatment
A number of amoebicides can be used.

Malaria
Malaria is an insect-borne disease transmitted by the female Anopheles mosquito. The disease-causing protozoan is Plasmodium. There are four well known species of Plasmodium which cause malaria in man: P. vivax, P. falciparum, P. ovale and P. malariae.

Mosquitoes spend the larval and pupal parts of their life cycle in still water, hence the disease is prevalent in areas where there is stagnant water, as in marshy areas, ponds, dams, puddles and also in vessels, tin cans, etc.

Symptoms of malarial infection
The incubation period is between eight and 14 days with an average of ten days. The early symptoms are:
(a) A dry skin due to constriction of the blood vessels.
(b) Deeply stained urine which is passed out in small quantities.

(c) Increased pulse rate.

These symptoms are followed by high fever, headaches, pain in the body especially in the joints. The next stage is marked by alternating cycles of violent shivering with feeling very cold, and high fever accompanied by sweating. (This is referred to as paroxysms which correspond to the release of merozoites from the burst red blood cells). Depending on the frequency of incidence of merozoites released from the red blood cells, malaria can be described as follows:

(a) Benign tertian malaria
The fever cycle is repeated every 48 hours and so occurs every third day. It is caused by P. vivax and P. ovale. With good treatment the disease is usually not fatal.

(b) Quartan malaria
The fever cycle is repeated every 72 hours and so occurs every fourth day. The disease is relatively mild. The causative agent is P. malariae.

(c) Malignant tertian malaria
The fever cycle is repeated every 48 hours and is fatal if not treated well. It is caused by P. falciparum. This parasite causes cerebral malaria which leads to mental disorders due to the clogging of the red blood cells in the blood vessels supplying the brain tissues.

Life cycle of Plasmodium
While four species are known to attack man, the life cycle of only P. vivax will be described here. Its life cycle is complicated but can be divided into two main cycles as illustrated in Fig. 5.4:
1. Asexual cycle in man and mosquito;
2. Sexual cycle in the mosquito.

1. Asexual cycle
A human being becomes infected when sporozoites of Plasmodium are injected into his blood by a female (Anopheles) mosquito. After 30 minutes the sporozoites migrate to the liver cells
The incubation period in a person varies between one to six days depending on the magnitude of the infection and state of health of the individual. The bacteria reach the intestines and multiply rapidly. They secrete an enzyme called mucinase which digests the mucus of the inner lining of the intestines. The exposed intestinal wall then becomes irritated and damaged by the toxins produced by the bacteria, and this causes violent diarrhoea and vomiting. This is accompanied by severe abdominal pains. The disease develops rapidly and leads to general body debilitation owing to the high frequency of defecation, accompanied by loss of large quantities of water. Death by cholera can be rapid — within 24 hours of infection in extreme cases.

**Prevention and cure**
Sanitary disposal of faeces and refuse is needed to prevent the contamination of water and food. The pit-latrines in rural areas should be deep. They should be kept clean to keep away flies. Personal hygiene should be maintained. Domestic water should be boiled and filtered, or chlorinated before use so as to kill bacteria and their spores.

**Treatment and cure**
The infected persons are infectious and so should be isolated and treated as soon as possible. The cure involves administering of antibiotic drugs in order to kill the bacteria.

**Typhoid**
This is a water-borne disease caused by a bacterium called *Salmonella typhi*. The bacteria are passed out in either urine or faeces. Poor disposal of urine and faeces may cause contamination of the water supply from rivers, dams, etc. and so infect healthy individuals.

Its incubation period lasts about two weeks after which a fever and rash develop, followed by severe watery diarrhoea. The bacteria attack the walls of the intestines and cause patches of sores. In severe attacks the sores may burst and cause perforation in the intestines. This may result in death if the patient is not treated early enough. The bacteria invade the lymph glands around the intestine and then pass into the bloodstream.

Sometimes the bacteria can be present in sweat and saliva and so the clothes and beddings of the patient can be sources of infection. If the patient recovers from the disease, permanent immunity is ensured. Patients are advised not to eat solid food as this might irritate the intestinal sores and cause bleeding.

**Prevention and treatment**
There should be proper disposal of faeces and urine to prevent spread of the bacteria. Domestic water should be boiled or chlorinated before drinking to kill the bacteria. Hands and cutlery should be washed clean before eating. Fruits should be washed with clean water before being eaten. Food handlers should be clean, and should be subjected to regular medical check-ups. Healthy people may be inoculated with attenuated (weakened) typhoid bacteria in order to provide immunity, for at least two years. The Typhoid Attenuated Bacteria (T.A.B.) vaccine contains weakened typhoid bacteria. Cure involves administering of antibiotics.

**PROTOZOAN DISEASES**

**Amoebic dysentery**
This is a water-borne disease caused by a protozoan called *Entamoeba histolytica*. When the amoebae cysts are ingested, the cyst's membrane is digested and the protozoa are released. When they reach the large intestines and the colon, the *E. histolytica* multiply.

Normally *E. histolytica* live as commensal within the lumen of the colon and feed
2. A sporozoite enlarges and develops into a schizont in the liver cell. Schizogony and formation of merozoites in liver cell.

EXOERYTHROCYTIC OR TISSUE PHASE

Sporozoites invade liver cell.

Schizont in rbc.

ERYTHROCYTIC PHASE

Some invade red blood cells.

rbc bursts and releases merozoites

Release of merozoites from liver cell.

IN HUMAN

Sporozoites from mosquito saliva.

Microgametocyte

Macrogametocyte

These sexual forms develop further into gametes in the stomach of a female Anopheles mosquito.

Sporozoites in the salivary glands are injected into human blood as mosquito feeds on blood.

IN MOSQUITO

Microgamete

Macrogamete.

Oocyst burst releasing merozoites into the haemocoel.

SEXUAL CYCLE IN MOSQUITO.

An oocyst on the outer surface of stomach.

1. The zygote is motile and is called ookinete.

2. It penetrates the stomach wall and encysts on the outer surface.

Fig. 5.4: Life cycle of Plasmodium vivax.
where they grow rapidly to form schizonts. The schizonts then divide by a process called schizogony to form hundreds of merozoites which enter liver sinusoids. This phase of the cycle is referred to as pre-erythrocytic or ex-erythrocytic phase. The merozoites then pass into the blood stream where they attack red blood cells, grow and mature up. They feed on the red blood cells and eventually cause them to burst. The invasion and bursting of the red blood cells to release the merozoites is repeated every 48 hours. This phase is now called the erythrocytic phase.

Some merozoites that invade the red blood cells differentiate into sexual forms or gametocytes. This marks the end of the asexual reproduction, and the further development of the gametocytes is completed only in the mosquito.

Note that prolonged lysis (bursting) of erythrocytes by the merozoites and sporocytes eventually causes anaemia, and also the release of toxins into the blood stream. The body reacts to these toxins by sweating, rise in temperature and shivering.

2. Sexual cycle

When a mosquito sucks blood from a malaria infected person, it takes in blood that contains merozoites and gametocytes. In the gut of the mosquito the merozoites do not develop further, but the gametocytes mature into male and female gametes. The male gamete is called a microgamete and the female gamete is called a macrogamete. The two gametes fuse to form a zygote. The zygote burrows through to the outer wall of the mosquito stomach and forms a cyst. Within the cyst, cell-division occurs and sporozoites develop. When a ripe cyst bursts it releases the sporozoites which travel through the haemolymph of the insect to the salivary glands. These sporozoites may be transmitted via the mosquito saliva to a human host when the insect next feeds. In this way more people become infected and so the disease spreads.

Prophylaxis and cure

The prevention and control of malaria involves eradicating the Anopheles mosquito or protecting man from it. This calls for the following measures:

(a) Placing mosquito nets over the bed when one is sleeping.

(b) Biological control such as introducing fish into ponds or dams. The fish feed on the larvae and pupae of mosquitoes.

(c) Drainage of all unnecessary standing water, like puddles and swamps.

(d) Disposal of all discarded containers near buildings or habitation to prevent accumulation of water in them.

(e) Clearing away of bushes near buildings as these provide breeding sites for mosquitoes.

(f) Water pools and dams should be covered with a thin layer of oil to suffocate the mosquito larvae.

The cure involves use of drugs usually sold under the trade names such as Paludrine, Malarazine, Nivaquine, Camoquine, Fansidar, etc. The drugs kill the parasites at various stages of development — merozoites, gametocytes and sporozoites. Some of the drugs may cause harmful side-effects, while some people show allergy to them. The side-effects include itching, "noise" in the ears, damage of the eyes and liver.

TREMATODES OR FLUKES

Bilharzia or schistosomiasis

This is a parasitic disease of the blood. The parasite is found in fresh water, canals, lakes, rivers, dams, rice-growing fields, etc. Bathing or wading in bilharzia-contaminated water can lead to infection.

The disease is caused by flatworms of the phylum Platyhelminthes (Class: Trematoda; Order: Digenea). There are three species which affect man. They include Schistosoma mansoni: which occurs around the Mediterranean, East Africa, West Africa, the Middle
East, South America and southern states of U.S.A.; *Schistosoma haematobium* which is prevalent in the Nile Valley (where 95% of the rural population is infected), the Lake Victoria region and Cyprus. *Schistosoma japonicum* is confined to the Far East countries of Japan, China, Indonesia and Indochina. The parasites are generally called blood-flukes.

**Life cycle and infection**

Infection of the human host begins when the cercariae stage of the *Schistosoma* worms found in stagnant water become attached to the skin. With the help of enzymes they burrow through the human skin and enter the blood vessels or lymphatic system. If the cercariae do not find a human host they die.

Within the human host the cercariae move to the lungs, taking about four days, and then travel to the blood vessels of the liver in the next four to five days. After 20 days they enter the blood vessels of the intestines and urinary bladder where they mature into adult worms. Coupling of adult worms occurs for the first time in the veins of the intestines and the portal veins of the liver. The female does not become sexually mature until it pairs up with the male which then carries the female with it.

The worms are approximately 1cm. long. The male is flat but it rolls up ventrally to form a gynecophoric canal in which it carries the female worm. This ensures that the eggs produced by the female are fertilised before they are shed into the blood vessels. The worms which invade the blood vessels have sharp spines which they use to tear through the veins and enter into the intestine or the urinary bladder. The worms invade blood vessels close to the intestines and urinary bladder because they are rich in nutrients.

The apical and penetration glands of the eggs secrete digestive enzymes that rupture the walls of the intestines and the urinary bladder which then become infected while blood may appear in the urine or in the stools.

![Fig. 5.6: Mature egg of *S. mansoni*.](image)

After about another ten days, (i.e. 35 days from initial infection), the female parasite starts to lay eggs. The eggs can remain in a viable state for 20 days only. If they do not find a suitable medium to hatch in, they degenerate. Those eggs which do not reach the urinary bladder or the intestines are destroyed by the leucocytes through phagocytosis.

If the infected faeces or urine infected with *S. mansoni* eggs are disposed of into rivers or pools, the eggs hatch into small larvae called miracidia. The larvae swim by means of the cilia on their body surface. When they find the fresh water snail, *Lymnaea natalensis*, they penetrate into its soft body and continue.
to develop there. Another snail vector is *Biophalaria*.

Within the snail, the miracidia undergo morphological changes to form sporocysts. The sporocysts migrate from the foot of the snail to its digestive gland where they form the other types of larvæ, the cercariae. The male and female cercariae are then released into the water where they can now infect human beings that stand or bathe in such water.

When the cercariae locate their human host they attach themselves to the skin and produce enzymes which digest the epidermis. This may cause itching. They then enter the veins or the lymphatic system. If they do not find a human host, the cercariae die within two days.

**Disease symptoms**

The entry of the cercariae into the body causes itching while its presence in the blood stream results in fever. The loss of blood also causes anaemia. The infection can also be identified by the presence of a rash on the skin.

**Prophylaxis**

Schistosomiasis or Bilharzia can be prevented by sanitary disposal of both faeces and urine. Urine and faeces should not be passed into rivers, dams, etc. Deep pit latrines or water-flushed toilets should be used. All drinking water should be chemically treated or boiled in order to kill the eggs, miracidia and cercariae that may be present. This prevents direct infection through the intestine. People should not bathe or swim in infected water. People should avoid walking in bare feet in swampy areas. (The snails should be killed by spraying the water with molluscicides). Infected persons should receive proper medical treatment.

**CESTODES**

(Refer to Pupils' Book 1, Chapter 3, pages 138-140).

**NEMATODES**

**Hookworms**

The hookworm is a parasitic roundworm or nematode which belongs to phylum: *Nematode*; class; *Phasmodia*; order: *Strongyloida*; and family: *Ancylostomatidae*. There are two well-known types of hookworm which affect man. They are *Ancylostoma duodenale* which occurs in the northern districts of China, Japan, Western Asia, Europe and North Africa; and * Necator americanus*, which predominates in all parts of the tropics. It is generally known as American hookworm.

**Life cycle of Ancylostoma duodenale**

The males are about 8-11mm. long and the females are about 10-13mm. long. The vulva opening of the female is located at almost one third of the body's length from the posterior end. The conspicuous buccal cavity has a pair of chitinous palates which are either like teeth, *A. duodenale* or like sharp blades *Necator americanus*. The copulatory bursae are well developed in both species.

*Fig. 5.7: Ancylostoma duodenale, internal structure.*
The adult hookworms live in the human small intestine, attached to the mucous membrane and feed on blood and tissues. Large numbers of eggs, up to 20,000 per day, are shed from the host with the faeces. In favourable conditions of moisture, temperature and oxygen the eggs hatch into larvae which feed on bacteria. After two moults, the larvae become infective and climb to the exposed part of the moist ground.

When the larvae come in contact with a bare human skin they penetrate through it and enter the blood stream. They travel through the veins and lymphatic channels until they reach the heart. The parasites then pass to the lungs and emerge into the alveoli. From here, larvae pass up along the trachea and into the back of the mouth causing irritation. They are then coughed out and swallowed with the sputum into the small intestines where they grow, mature and start to lay eggs, so continuing the life cycle.

**Symptoms of infection**

Hookworms cause ill-health and anaemia. Entry of the worm causes itching of the feet but stops soon after. Because the patients eventually become anaemic they can easily contract other diseases. Death is usually brought about by weakness, if the disease is not treated.

The disease is spread through lack of personal cleanliness and bad sanitation. Going about barefoot increases the chances of becoming infected. Prevention is achieved by maintaining high standards of hygiene and proper sanitation. The disease is diagnosed by the presence of eggs in the faeces.

*Ascaris lumbricoides*

*Ascaris lumbricoides* is a parasitic roundworm which belongs to the phylum Nemastoda; class: Phasmida; order: Ascaridida. All members of this phylum are coelomate, i.e. possess a body cavity. Roundworms are cylindrical, unsegmented and have no body appendages.

![Diagram of the life cycle of *Ascaris lumbricoides*](image)

*Fig. 5.8: Summary of the life-cycle of *Ascylostoma duodenale*.**
The coelom contains the reproductive organs. The males are usually smaller, with curved posterior ends. The body of nematodes is covered with a resistant cuticle.

**Symptoms of infection**

The symptoms are mild but if the infection is heavy a lot of digested food is consumed by the parasite in the intestine and this leads to malnutrition in the host, especially if it is a child. During their cycle in the human host, the parasites feed on blood and therefore can cause anaemia to the host. Very heavy infection can also lead to intestinal blockage. Children with blocked or partially blocked intestines develop large round stomachs. The worms may also enter the bile-duct, pancreatic duct and appendix, causing further complications.

*Ascaris lumbricoides* is widespread in distribution and infects small intestines of pigs and man. It also occurs in other organs of the body. The genus *Ascaris* is the largest nematode parasitic to man. It is characterised by a brownish yellow colour with mouth parts having three lips. The male is about 25cm. long and 4mm. in diameter, while the female is 35cm. long and 5mm. in diameter.

![Diagram of Ascaris](image)

**Fig. 5.9: Ascaris lumbricoides (dissected to show internal reproductive organs).**

The life cycle

The adult female lays eggs in the small intestines of the host. At this stage the eggs are not infective though the infective larvae are

![Diagram of the life cycle of Ascaris](image)

**Fig. 5.10: The life-cycle of Ascaris.**
still developing inside the eggs. The eggs are passed out with the faeces. After a few weeks in the soil the larvae develop further inside the eggs and moult. After that the eggs become infective. When they are swallowed by a host, the egg shells are dissolved, releasing the larvae. These penetrate the intestinal wall and enter the blood stream. They move to the liver and then to the heart and lungs. In the alveoli they grow and moult twice. The larvae then migrate up the trachea where they cause irritation and so are coughed up and swallowed down into the oesophagus, stomach and small intestines.

The fourth moult occurs in the small intestines and the larvae mature into adults. This migratory movement within the body takes about ten days. The adult then begins to lay eggs which are passed out of the body with the faeces. If faeces contaminate vegetables or fruits, the eggs could be ingested if these vegetables or fruits are not washed or cooked well before being eaten.

Diagnosis is by examination of faeces for Ascaris eggs.

**Fig. 5.11: Infective egg 60-70cm diameter.**

**Prevention and control**

Proper sanitary disposal methods of human faeces and high standards of personal hygiene should be followed. This requires the availability of good toilet facilities. Also hygienic handling and cleaning of fruits and vegetables is necessary.

**SEWAGE AND REFUSE DISPOSAL IN RURAL AND URBAN SITUATIONS**

Sewage is the liquid containing mainly faeces and urine from toilets or latrines and outflow from drains. On the other hand refuse is the dirt and the unwanted left-overs of food, discarded paper and empty tins, etc.

It is very necessary that sewage and refuse be properly disposed of. Bad methods of refuse and sewage disposal can lead to contamination of food and water. A number of diseases including dysentery, cholera, typhoid and worm infections are spread through contaminated food or water. In rural areas where flush toilets are not available, deep pit latrines should be built to keep off flies. The habit of defecating in open fields or near bushes should be discouraged. The types of latrines used depend on the nature of the soil and availability of good water supply. The following types of latrines are in general use throughout the topics.

**Pit latrines**

The pit latrines are built over a pit at least three metres deep into which the faeces and urine are passed. A lid to cover the hole is essential to prevent the escape of smells and the entry of flies. The liquid must drain away, so porous soil is essential. Clay soil is not suitable while sandy soil is good. The decomposition action of bacteria on faeces converts it into a liquid which later drains away. Disinfectants therefore, should not be added since they kill bacteria and stop their decomposing action.

**Ventilated improved latrines**

This is a modified pit latrine. A ventilation pipe is connected from the pit to an outlet covered at the top by a wire gauze. The pipe is painted black and so absorbs heat and becomes hot. The flies from the pit are attracted by light to the top of the pipe. When the flies fly to the top of the pipe, they are trapped and killed due to the heat there. The pipe also helps to ventilate the latrine providing an outlet for the bad smells from the
pit. This type of latrine is now built in many rural areas of Kenya, where flush toilets are not yet installed.

![Diagram of ventilated improved pit latrine.](image)

The disadvantage of this type of latrine is that the borehole could easily come into contact with the underground water thus contaminating the water supply of a nearby well.

A bucket latrine
A bucket latrine consists of a container into which sewage is passed and emptied daily into large pits. Sometimes chemicals are added to coagulate the raw sewage. These chemicals include aluminium sulphate and ferric chloride. The coagulated sewage settles at the bottom, where it undergoes biological degradation. The liquid so formed soaks away into the soil. The buckets are difficult to keep clean and so this type is not very hygienic.

Borehole latrines
To avoid repeated digging of pits, borehole latrines may be constructed. A mechanical borer is used to dig a deep hole seven or more metres deep and 30cm. in diameter. (However, in places where the water table is shallow, the borehole might reach it and so contaminate it). A concrete platform is built around the borehole. This type of latrine can be used for a longer time. The faeces and urine are passed into the hole and the bacteria decompose the faeces so that the solid is converted to liquid which drains away.

![A borehole latrine.](image)

**REFUSE DISPOSAL**
Refuse rots quickly and attracts flies which can contaminate food and water, leading to outbreaks of diseases. In towns the refuse is collected mainly by special disposal vehicles. The vehicles have sections and each section has a sliding cover. When the refuse has been tipped in, the cover is shut. The sections are provided with sharp blades which rotate and chop up the rubbish into small pieces. There are many methods used for the disposal of refuse:

(a) **Incineration**
The refuse is burnt to ashes in controlled chambers called incinerators. This is the most hygienic method of disposal. The process can produce heat which
could be used for steam and electricity production. Ordinary paper and polythene material which do not rot quickly should be incinerated.

(b) Composting
The refuse is sorted out and then organic materials are buried in a pit for controlled microbial degradation into compost which is used as fertilisers.

(c) Salvage industry
The sorted-out rag papers, glass or scrap metal can be recycled. In Nairobi, there is a large industry which makes tissue paper from waste papers. Also, aluminium containers are sold to factories which smelt them down and recycle them.

(d) Sanitary land fill
This is a large-scale planned burial of solid wastes. The refuse is confined to the smallest practical area and volume, and then covered with a layer of earth. In Nairobi, there are several such pits for refuse disposal e.g. in Kawangware and Kariobangi. Burying and compresion of wastes result in increased temperatures that kill most pathogens besides decomposing organic wastes.

(e) Volume reduction method
The organic wastes are chemically reduced to disposable volume. At the same time useful by-products, e.g. biogas can be produced to provide energy and tar liquids can be used as pesticides. The remains or slurry can be used as fertilisers.

SEWAGE DISPOSAL IN URBAN AREAS
Most urban areas use water sewage system. Underground pipes lead directly into the drain known as sewers or septic tanks. Connected to the septic tanks are the outlets leading into seepage pits which remove liquids. The solid materials undergo biological degradation.

When the septic tank is full the urban authority brings in special vehicles to suck out the sewage and dispose of it. In some cases the sewage may be treated to produce fertilisers, as in some sewage treatment plants (Ref. Fig. 5.14).

Sewage treatment plant
Primary sludge is pumped up from the sludge tank and passed on to the digestion tank. The digestion tank is circular and about 5-8 metres deep. The raw primary sludge in the digestion tank is heated to 35°C by hot water circulating in the heating coils. Bacterial activity can also generate this temperature. The

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Fig. 5.14: Septic tank.
sludge is digested in the heated tank for 30 days.

Anaerobic bacteria form a thick scum on the surface of the sludge. Methane and carbon dioxide gases are given off during the digestion process. These gases collect at the top of the tank and are led off by pipes. The methane can be burnt to provide heat to warm the water used in the heating coils.

Digested sludge is drawn off at the bottom of the tank. The digested sludge is then placed on drying beds. The beds are made of a 25cm layer of sand and gravel. The beds are protected from the rain by glass screens. The dried sludge is then ready for use as fertilisers.

The liquid sewage from the sedimentation tank is passed into activated sludge channels. The sewage takes 4-8 hours to pass along the channels. The incoming sewage is inoculated with biologically activated sludge. The process is aerobic and depends on the sewage and the sludge being well mixed and well aerated. Compressed air passes along the main air pipe. The air is blown through the sewage and mixed thoroughly with the activated sludge. Then a fully digested solid sewage is deposited. The solid activated sludge formed is used to inoculate new incoming sewage. From the activated channels the liquid passes to a settling tank, from which pure water can be drained off.

Oxidation ponds
This is a sewage disposal method suitable for
small urban centres of communities with a population not exceeding 50,000 people. Sewage from waterborne toilets is led into one large open pond designated primary pond. In this pond green algae like chlamydomonas, Euglena and Spirogyra grow and during photosynthesis they release oxygen which decomposes and deodorises the sewage. Later the treated sewage passes into a secondary pond where aerobic bacteria complete the treatment of the sewage.

This method is called oxidation pond method, because the micro-organisms use oxygen to oxidise the sewage. The ponds are also known as waste stabilisation ponds.

**IMMUNITY**

Immunity to disease is the ability by a person to resist infections due to the presence of specific antibodies in the blood cells in the body.

Antibodies are proteins produced by white blood cells in response to the presence of a harmful protein or organism — viruses, bacteria, etc. in the blood. These antibodies combine with the antigens to inactive viruses or to precipitate them before being ingested by the phagocytic white blood cells. The production and presence of antibodies in the bloodstream gives one resistance or immunity to the harmful effects of viruses or diseases. For this reason, birds never get anthrax, though cattle and man are susceptible to it.

There are two types of immunity, natural (or innate) and acquired immunity. Natural immunity is inherited and controlled. This trait can be transmitted from parent to offspring. For example, rats are naturally immune to diphtheria, while man and guinea pigs are not.

Acquired immunity can either be naturally or artificially induced. When attacked by diseases like smallpox, chickenpox, measles, poliomyelitis, mumps, etc., the people who recover completely from these diseases develop a resistance to any subsequent infections. So if these people become infected again by the same disease organisms, they do not become seriously ill. This is known as acquired immunity. In some instances people who have been exposed to milder forms of a disease develop a resistance to the acute form of the disease, e.g. those who have been exposed to some mild forms of tuberculosis bacteria may not be affected by the more harmful forms although they had never suffered from the acute disease before. On the other hand, a person who has never been exposed to the tuberculosis bacteria is very likely to get seriously ill with the disease.

Artificial acquired immunity occurs when a mild form of a disease organism is injected into the body of a healthy person. The infection stimulates the production of the corresponding antibody which then destroys the disease organisms. The body thereafter retains the "memory" of the structure of this antigen in its lymphocytes. When the body is attacked by the same disease, it produces the specific antibodies which destroy the disease organisms. This type of immunity is called artificial acquired immunity. What happens is that, on coming into contact with specific antigens a group of B-lymphocytes (called "committed" cells) in the lymph nodes undergo cell division to produce a group of large plasma cells. The plasma cells synthesise the antibodies which are released into the lymph and eventually reach the blood. In the blood the antibodies destroy the invading organisms. A small number of plasma cells remain in the lymph nodes for years, even after the antibodies have eliminated the original infection and are removed from the blood. This system provides a very rapid response to any subsequent infection by similar antigens.

These methods of artificially inducing immunity has now been adopted in many countries and so many lives are saved against various diseases like smallpox, measles, poliomyelitis, tuberculosis, etc. The first work of immunisation was started by a British doctor called Edward Jenner in 1797 when he used a vaccine successfully to prevent smallpox. He had observed that most milkmaids did not suffer from smallpox after they had suffered from cowpox. He carried out an
experiment by first making some scratches on a healthy boy and introducing some pus from a pox vesicle of a woman suffering from cowpox. Later he introduced some pus taken from a woman suffering from smallpox into the boy's body. Doctor Jenner observed that the boy did not contract smallpox, though he only developed mild symptoms of the disease. Thus the boy had been immunised against the deadly disease because a mild antigen (cowpox virus) produced antibodies against the smallpox.

Currently, the method of producing vaccines involves the treatment of the disease organisms so that they are weakened or attenuated. This treatment of disease organisms is called attenuation. The attenuated bacteria or viruses are then introduced into the body of a healthy person or animal by either vaccination or inoculation. The attenuated bacteria or viruses stimulate the production of specific antibodies by the body such that next time the body gets infected by the disease organisms, there will be no serious illness caused.

Vaccines generally contain attenuated disease organisms. These vaccines are currently produced commercially. The reaction of the body to cowpox vaccine is an example of active immunisation. Similarly, the body actively makes its own antibodies against some antigens, e.g. measles, whooping cough, poliomyelitis, etc. In some cases the artificially acquired immunity is permanent and immunisation is done only once in a lifetime. In some cases a "booster" vaccination is required to maintain immunity, e.g. against cholera, since the immunity lasts for a short time.

Artificial passive acquired immunity is achieved when antibodies from another source, e.g. serum, are directly introduced into the body of a person. The serum containing the antibodies is called antiserum, and it may be effective for only a few weeks. This type of immunity is called passive because the body is not activated to produce its own antibodies. In newly born babies antibodies pass from milk produced by the mother, so providing the babies with passive immunity to some diseases for a period.

The role of vaccination
Vaccination protects individuals from infections of many diseases such as smallpox, tuberculosis, poliomyelitis, etc., and it prevents the spread of the diseases. Diseases like smallpox, tuberculosis, tetanus, etc., used to be killer diseases but now, due to the development of vaccines, individuals can be protected from them. It is now believed that smallpox has been eliminated from the world since as far back as 1777. Pregnant mothers should be immunised against tetanus at least once before they give birth.

In children, vaccination against certain diseases is done at different times. Immediately after birth, the baby should be immunised against tuberculosis and polio. The baby should then receive a compound vaccine against whooping cough and tetanus. The same compound vaccination should be repeated after 10-14 weeks. At the age of nine months, the child should be vaccinated against measles. Measles is a major child-killer disease.

Vaccinations should be given at regular intervals (see table 14 below). For example, booster injections of vaccines against polio in babies have to be given regularly after every four weeks, for the first 16 weeks. It is also recommended that healthy children should be exposed to chickenpox when young for the attack is severe when the children are mature.

Immunisation against other diseases should be done as advised by the health officers. Usually, people of all ages are vaccinated if there is an outbreak of diseases like cholera.

Apart from immunisation the control of diseases can also be done by restricting movement of people into and out of infected areas. This method is called quarantine. It can be done at international, national or local levels. In Kenya, at the local level, it is done by village elders who place leaves or branches or sticks at the entrance of a home where there is an outbreak of an infectious disease, so that other people do not enter that home as they
Table 20: Immunisation for children.

<table>
<thead>
<tr>
<th>Name of disease</th>
<th>Cause of agent</th>
<th>Age of immunisation</th>
<th>Type of immunisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuberculosis</td>
<td>Bacterium</td>
<td>At birth</td>
<td>Vaccination</td>
</tr>
<tr>
<td>Poliomyelitis</td>
<td>Virus</td>
<td>At birth, 6 weeks, 10 weeks, 14 weeks</td>
<td>Oral inoculation</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>Bacterium</td>
<td>6 weeks, 10 weeks, 14 weeks</td>
<td>Injection with vaccine</td>
</tr>
<tr>
<td>Whooping cough</td>
<td>Bacterium</td>
<td>6 weeks, 10 weeks, 14 weeks</td>
<td>Injection with vaccine</td>
</tr>
<tr>
<td>Tetanus</td>
<td>Bacterium</td>
<td>6 weeks, 14 weeks</td>
<td>Injection with vaccine</td>
</tr>
<tr>
<td>Measles</td>
<td>Virus</td>
<td>9 months</td>
<td>Injection with virus (weakened)</td>
</tr>
</tbody>
</table>

may get infected. Facilities like water wells, etc. should not be shared as long as the quarantine is in force. Internationally, before one enters another country, one must be vaccinated against various diseases, and certificates of vaccination obtained. In schools and in homes, people suffering from infectious diseases should be isolated to avoid infection of healthy people. This minimises the spread of disease.

Production and functions of antibodies
As mentioned before an antibody is a chemical substance, usually a protein, which is formed in the blood when an antigen is introduced into the tissue of a human being or any other animal. An antibody has a chemical composition which is complimentary to the antigen against which it reacts. This means that a particular antibody combines with or responds only to a particular antigen to make it harmless.

There are two types of white blood cells or leucocytes: the polymorphs (or phagocytes) produced in the bone marrow and the lymphocytes produced in lymph glands (or nodes) and thymus. The antibodies are produced by the lymphocytes. When harmful organisms or proteins invade the body, some lymphocytes start producing antibodies which are complimentary to them. The bone marrow and the thymus gland also begin to produce more polymorphs (phagocytes) and lymphocytes respectively. Those produced by the bone marrow are called B-cells (B-cells for bone-derived) and those produced by the thymus are called T-cells (T-cells for thymus-derived). The T-cells kill the bacteria that may attack the body and the B-cells produce antibodies and also engulf and immobilise antigens by phagocytosis.

There are four types of antigen-antibody reactions: neutralisation, precipitation, agglutination and lysis.
Neutratation is the reaction between antibodies and soluble antigens e.g. toxins, rendering the latter ineffective.

Precipitation involves the linking of many antigen-antibody complexes to form insoluble precipitates which are readily engulfed by phagocytes.

Agglutination is the clumping or sticking together of antigen-carrying cells, rendering them ineffective. These clumps are then engulfed and destroyed by the phagocytes.

Lysis is the bursting open of antigen-bearing cells. The antibodies which attack these cells contain digestive enzymes which dissolve the cell membranes thus breaking them open.

ALLERGIES

An allergy is a hypersensitive reaction to an antigen by the body. This occurs when the combination of an antibody with an antigen produces a violent reaction or severe damage to the body. Allergic people are hypersensitive to materials like dust, pollen grains, some foods, some drugs and certain air pollutants.

The allergy manifests itself in various ways. In some people, on eating certain foods, rashes appear on the skin. Some drugs e.g. penicillin, chloroquine and aspirin can also cause rashes on the skin. Other allergic reactions are itching, sneezing, vomiting or difficulties in breathing.

The allergic conditions are brought about when the body reacts by over-producing antibodies against harmless antigens. The antibody-antigen reaction takes place on the surface of cells which burst open, releasing a chemical substance called histamine. Histamine increases the permeability of the epithelial cells thus making them take in fluid and swell up. The intercellular spaces too become filled with fluid, and swell. Histamine also causes inflammation and pain. A severe condition called anaphylaxis sometimes occurs, in which blood vessels are dilated and this lowers the blood pressure to the extent of causing death. This is how bee stings can cause death in some persons.

Asthma is another type of allergy. It may start with allergy to a type of food and then to other foodstuffs. In some cases asthma is due to chronic bronchitis, where the bronchioles become narrowed and in some cases blocked, and there is also over-secretion of mucus. The affected person finds it difficult to breathe and does so with a wheeze. Asthma can be treated by some drugs which cause the dilation of the bronchioles and make breathing easier.

Hay fever is also an allergy brought by inhalation of pollen grains, dust, animal fur, etc. It starts with the inflammation of the membranes of the nasal cavity and the lacrimal glands of the eyes. This is accompanied by sneezing and a running nose.

ORGAN TRANSPLANTS

Currently, a lot of research is being done on organ and tissue regeneration and human immune system. Surgeons can replace damaged tissues of organs using similar organs from other persons or animals e.g. pig in transplant operations. It has also been possible to transplant kidneys, liver, spleen, reproductive organs, parts of skin and limbs. A part of organs or tissues transplanted on to larger parts of a (recipient) is called a graft. Grafts from closely-related organisms within the same species are called allografts or homografts. Grafts from organisms of different species are called xenografts or heterografts. It is known that although two organisms belong to the same species, their immune systems may be so different that grafts may be rejected by the recipient. In most cases grafts involving identical twins or those from same individual are not rejected. Grafts involving identical twins are called isografts or syngeneic grafts while grafts from the same individual are called autografts. Grafts of cartilage and eye cornea are not often rejected because there is no blood supply to these tissues.

The allografts and xenografts may be rejected because the body of the host recognizes the new tissue or organ as foreign to it. The donor tissue has antigens to which the host's
leucocytes produce antibodies and the tissue may be rejected; if not, the graft will "take" or be accepted. Some transplants of hearts, kidneys, cornea of the eye or lungs and bone marrow have been carried out by using drugs that suppress the immune response of the host. A substance called interferon is also used to suppress it. In organ transplants, sophisticated machines are used to keep the organs to be transplanted and the patient alive.

WATER
The importance of water to plant and animal life has been discussed under many topics in this series of books. It is necessary to explore the sources of water as it plays an important role in the health of human beings. There are several sources of water and they include underground water, lakes, dams, rivers, rain and ice.

Underground water supply
When rain falls, most of the water seeps into the earth. The earth consists of porous and non-porous rocks. So rain water can pass through the porous rocks but not through the non-porous ones. If a porous rock rests on a non-porous rock, the rain water will flow on top of the non-porous rock. This water will eventually flow out onto the surface at a point called a spring. The spring water may flow into a stream which may join other streams to form a river. This underground water can be reached before it emerges as a spring by digging a well. When the well is deep enough to reach what is called the water table, the water will percolate into this well. See Fig. 5.16.

Underground water from deep springs and deep wells is usually pure, being free from suspended impurities, and is safe to drink. These sources should be protected from contamination, e.g. there should be no latrines, cowsheds or cattle manure heap within a distance of at least 30 metres from the spring.

A spring should be protected from contamination by surface water by building a brick concrete wall around it. The spring should be well-built and livestock should not be allowed to drink water from it. If possible, there should be a spout to allow water to flow downwards easily. The water can be directed through a pipe into a tank from which the water for domestic use can be obtained.

Shallow wells or water holes
Water which collects in a shallow well is contaminated because it is not sufficiently filtered. The layers of porous soil or rock that

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**Fig. 5.16:** Sources of underground water: spring, shallow well and deep well.
impervious. In deep wells, the water-bearing layer is sandwiched between two non-porous layers, but this is not the case with a shallow well. Thus water from deep wells is purer than that from shallow wells.

Wells should be surrounded by a concrete wall and covered by a tight-fitting lid. The lid should be slanting outwards so that dirty water split near the well does not flow into the well. Clean buckets or containers should be used to collect water from the wells.

Rain water
Rain water is the cleanest if it is collected directly. However, several factors may make this water unsuitable for drinking. The common method of obtaining this water is by collecting the run-off from the roofs and storing it in large underground or surface tanks. The roofs may not be clean due to bird droppings, dust and rotting leaves. Paint from roofs can be a source of metal poisoning. Similarly, concrete roofs can be a source of lead poisoning, while asbestos roofs can be a source of asbestos poisoning. The roof gutters also collect a lot of dust and leaves which rot and provide an environment for bacteria, fungi and mosses.

To collect uncontaminated rain water, the gutters should be thoroughly cleaned. Run-off water from the first rains should not be collected since it washes the roof and the gutters. Run-off water from asbestos and tile roofs or roofs with lead paints should not be drunk.

In urban centres with industries, the rain water dissolves some gases as it passes through the air. The most soluble gases such as sulphur dioxide, ammonia, hydrogen sulphide and chlorine contaminate rain water. This contaminated water then causes erosion of the roofs and so increases the amount of soluble metal compounds in the run-off water.

Lakes and rivers
Untreated lake or river water forms the main source of domestic water in the rural areas. Lake water is stagnant except for the churning caused by waves. Rivers may be contaminated by improper sanitation and industrial effluents. Wild animals and even domestic animals may drink from the same rivers. Their faeces and urine contaminate the river water. River and lake water is further contaminated by people who may bathe in them. The water from the rivers and lakes must therefore be treated before use.
Pools, ponds and dams
Rock pools and roadside pools are used as a source of water in some areas. Pools may form in depressions left after excavation or quarrying. Clay dust collects at the bottom of the pools and forms an impervious layer allowing water to collect. The water in these pools is contaminated and is not fit for drinking. The frogs, fish and micro-organisms may be too many, while parasitic worms may also be present.

Dams are artificially built water reservoirs. Like ponds, the water is stagnant and may be infested with parasitic worms, micro-organisms and other parasites. Pools, ponds and dams can therefore be a source of waterborne diseases.

The water from dams, rivers, springs and boreholes is often treated before use. Some of the reservoirs occurring in farming areas may be contaminated with dissolved fertilisers. Fertilisers cause water weeds to grow faster and therefore it becomes necessary to remove or kill these weeds. The water is purified in water treatment plants. It is initially filtered through fine wire mesh to remove any large objects in suspension. The water is then led into settlement tanks where it is left to stand for some days so that colloidal particles may settle to the bottom. Filtration then follows and it is done in two ways:

(i) In the rapid filtration process, floculants are added and the resultant precipitate traps all the bacteria, algae and other tiny particles in the water. This is done by adding calcium bicarbonate. If the water is hard, lime is added, followed by alluminium sulphate. These chemicals produce a precipitate:

\[
\text{Al}_2(\text{SO}_4)_3(\text{aq}) + 3\text{Ca}(\text{HCO}_3)_2(\text{aq}) \rightarrow 3\text{CaSO}_4(\text{aq}) + 2\text{Al(OH)}_3(\text{s}) + 6\text{CO}_2(\text{g}).
\]

WATER SUPPLIES TO URBAN AREAS
Water supplies to large towns or large communities may be obtained from lakes, rivers or underground reservoirs e.g. Nakuru is supplied with water from boreholes and springs; while Mombasa gets nearly all its water supply from Mzima Springs. Water can also be obtained from artificial lakes or dams built in river valleys.
This material is then filtered through sand-beds about one metre deep. This removes the precipitate and also holds back bacteria, cysts, eggs and other potentially infectious agents.

(iii) The “slow filtration” process also uses sand-beds about one metre deep. Filtration depends on the fact that growth of bacteria produces a gelatinous material which serves as a filter that removes copper ions from the copper sulphate that had been added earlier to prevent algal growth. Water which is hard is then softened as described earlier and may be chlorinated before being distributed for use.

POLLUTION AND HUMAN HEALTH

There are many toxic substances which can pollute the biosphere. Many of these toxic substances are man-made and are of recent origin. These include by-products or wastes from industries, vehicles, the use of fertilisers, insecticides, domestic wastes particularly in crowded towns and cities where waste disposal is a problem.

The earth’s atmosphere is a mixture of gases which is about 2,000 km. thick. The lower layer is about 10 km. thick and is called troposphere. This layer contains the bulk of the atmospheric gases and also tends to receive air pollution from the earth’s surface. Above this layer is the stratosphere and this contains the protective ozone layer which absorbs ultraviolet and infra-red radiation from the sun, thus protecting the life on the earth from excessive exposure to these radiation which is a source of mutations in chromosomes. Infra-red rays tend to raise the temperature of a body so the ozone layer prevents overheating of the earth’s surface.

Atmospheric pollution by gases

Carbon dioxide (CO₂)
The burning of fossil fuels like coal, oil and natural gases provide most of the energy people require for domestic, industrial and agricultural purposes; but as they burn carbon dioxide is given off. Data obtained on the amount of carbon dioxide in the air indicates that the amount is increasing. The smoke (soot, carbon dioxide, carbon monoxide) and fog form a type of pollutant called smog. The smog accumulates in the atmosphere close to the ground and this prevents layers of warm air from escaping. Consequently there results a rise in temperature called “green house” effect. The overall effect could bring about melting of the polar icecaps thus raising the level of oceans. This will result in flooding of lowland areas. The other effect of this pollutant is intense eye irritation, headaches and respiratory difficulties.

Carbon monoxide (CO)
Carbon monoxide is produced when coal or charcoal is burnt in a limited amount of oxygen. Also a lot of carbon monoxide is produced from the exhaust fumes of motor vehicles or internal combustion engines of various types. The haemoglobin in the animal blood has higher affinity for carbon monoxide than for oxygen. This means that when an animal breathes in air containing carbon monoxide and oxygen, the haemoglobin will pick up carbon monoxide more readily than oxygen.

Most people suffer from oxygen deficiency if the level of carbon monoxide reaches five per cent in their blood. Cigarette smokers can have up to ten per cent carbon monoxide in their blood.

Sulphur dioxide (SO₂)
Sulphur dioxide is also released into the air when fossil fuels are burnt. The normal concentration of sulphur dioxide in the atmosphere is between 0.3 and 1.0 μg/m³ but in areas near heavy industries the concentration can rise up to 3000 μg/m³.

Sulphur dioxide can be oxidised to sulphate ions in the air. This is precipitated in rain water and so gets added to the soil from which it can be absorbed by plants. Sulphur is an
lead tanks and pipes were used to supply drinking water. The lead water pipes contribute considerably to the intake of lead by people.

Lead in food (tinned food poisoning)
The use of solders, which are made of lead, in sealing canned foods makes the concentration of lead in tinned food high. This can lead to tinned food poisoning.

Lead accumulation in man
Whether inhaled or ingested, lead is absorbed into the blood and accumulates in the liver, kidneys and bones. About 90 per cent of lead in the body accumulates in the bones and teeth. There is evidence to suggest that the mental development of children in urban areas may be affected by the lead they breathe. Tobacco smokers take in more lead than non-smokers because nicotine is thought to stimulate the absorption of lead by the lungs.

Mercury
Mercury is used extensively as a floating electrode in the production of chlorine and caustic soda from brine. It is also used as a catalyst in the manufacture of vinyl plastics. Organic mercury fungicides are used to preserve wood pulp and as seed dressings to ensure good germination.

Mercury in the air
When coal and oil are burned, mercury is released into the air. Ore refining is another source of air pollution by mercury. Mercury also evaporates from the earth's crust. High concentrations of atmospheric mercury detected by "sniffer" aircraft are valuable indicators of where ores of mercury can be found.

Mercury in water
Rain picks up mercury as it falls through the air. Waste water from paper mills and factories of vinyl plastics also contain mercury. It accumulates in the mud at the bottom of rivers and lakes. These are converted to methyl mercury by methane-producing bacteria. Methyl mercury is volatile and very
toxic. It is absorbed by aquatic organisms which may form part of the food web involving man.

**Mercury in food**
Spray and seed-dressings containing mercury have been used a great deal to prevent and to control many plant diseases caused by pathogenic fungi. Mercury is retained in the upper layers of well-drained soils. From here it is absorbed by the roots of the plants.

Mercury in sprays is absorbed through leaves and translocated to the fruit and other edible parts of plants. For example, mercury poisoning has been known to occur in wood-pigeons that have eaten seeds coated with mercury.

**Mercury in man**
Mercury poisoning results in blindness and paralysis of sensation and even death. Post-mortem examinations of such persons reveal high concentrations of mercury in the kidneys, liver and brain.

**Mercury in cosmetics**
A number of skin-lightening cosmetics have compounds of mercury in them. These interfere with the normal chemical pathway in the formation of the melanin in the skin. Also if there is an accumulation of mercury in the liver, kidneys and brain, complications like paralysis or blindness may result.

**Copper**
Copper enters streams and rivers in drainage water from copper mines and in the liquid copper-plating works. It is a very toxic metal. Fresh water plants and fish are killed by less than 1 ppm of copper. Fish absorb it through their gills. The rate at which water passes over the gills determines the rate of absorption of copper. In water containing a low concentration of dissolved oxygen, gill ventilation is rapid. In such conditions fish are quickly killed by copper pollution in the water.

Pollution of soil by copper occurs when copper-containing fungicides are used for spraying plants. If the fruits of these plants are eaten by man the copper enters and accumulates in his body.

**Cadmium**
Cadmium, zinc and copper occur together generally. In areas where metal melting or flame-cutting of metals is carried out, the atmosphere has fumes of cadmium oxide. The inhalation of these fumes leads to accumulation of cadmium in the lungs and kidneys. In the kidneys, it causes renal damage and high blood pressure. It also causes decalcification of bones, a process that produces severe pain.

Emphysema is a disease of the lungs arising from inhaling fumes of cadmium oxide for a very long time, (between 20 and 40 years). It usually affects people who are 50 years and above, and whose main occupation is welding and flame-cutting of scrap metals. It is also due to inhalation of carbon in the form of coal-dust amongst workers and those who use coal for cooking. The same can be said of charcoal-dust which is mainly carbon. This lung disease is characterized by ulcers (lesions) in the lungs. The lung cells die and this results in the formation of fibrous tissue. The worst effect of cadmium fumes or coal dust is the increase in size of alveoli due to either dilation or destruction of the adjoining air sacs. Bronchioles are also destroyed. The final consequences of this is the reduction of surface area available for gaseous exchange, causing respiratory difficulties.

**Agricultural sources of pollution (herbicides)**
Herbicides make up about 40 per cent of the world's production of pesticides. They are used to control and eliminate weeds that grow amongst crops, pastures, etc. Herbicides are also used in forestry to kill weeds. They are generally biodegradable and are soon broken down into harmless products by soil bacteria. Several widely used herbicides are derivatives of trinitrophenol, e.g. trichlorophenoloxycetic acid.

In the manufacture of trinitrophenol, an impurity called dioxin is formed. Dioxin is harmful to humans, one gram can kill up to 3000 people! It is known to cause tumors and
cancers. It also causes a number of defects in the foetuses of pregnant animals, such as cleft palate, kidney malfunction, enlarged liver and internal haemorrhage. Miscarriages can be caused by dioxin.

**Fungicides**

Compounds of mercury and copper are the most dangerous pollutant components of fungicides.

**Insecticides**

These are chemicals which are used to kill harmful insects. Before 1940 the insecticides used were natural products such as pyrethrin and nicotine. Synthetic insecticides such as organochlorine and organophosphorus compounds, have also been produced.

Like pyrethrin and nicotine, organophosphorus insecticides are biodegradable, i.e. are quickly broken down into harmless products in the environment. However, organochlorine insecticides persist for many years in the environment and their persistence has been a source of pollution.

Other organochlorine insecticides include aldrin, DDT, dieldrin, heptachlor and lindane. Because they are insoluble in water, the organochlorine compounds remain in fatty tissues, instead of being excreted. In this way they accumulate at each trophic level of the food web. It is thought that their high concentration causes inactivation of the enzyme cholinesterase, thus interfering with nervous transmission across the synapses.

**Noise Pollution**

Pollution is not only an increase in harmful chemical substances in the environment but also of other harmful factors such as noise.

Noise can be measured by a sound meter and its unit of measure is called the decibel (db). The lowest sound that the human ear can detect (zero decibel) is called the threshold of hearing. Sound of 120 db is on the threshold of pain. Sounds louder than this actually hurt the ears and can cause headache. If the noise goes on continuously for long periods of time, the sensory cells in the inner ear can be damaged, causing permanent deafness. People who work close to noisy machinery in factories and mills are at high risk, and are advised to wear ear-plugs. Due to the dangers of noise pollution, loud-noised aeroplanes have been banned in European airports, while the Concorde is not allowed to fly a distance below 1000 m above the ground.

**Radioactivity**

The radiation which is most dangerous to man is ionizing radiation of which there are three types:

1. Natural radioactive particles like $\alpha$ (alpha), $\beta$ (beta) and $\gamma$ (gamma) rays.
2. X-ray machines which produce high-frequency electro-magnetic radiation.
3. Nuclear radiation composed of neutrons which are fired from the nuclei of atoms in nuclear reactors. Leakage from nuclear reactors like the Chernobyl disaster in USSR in 1986, and the crashing of a USSR nuclear plane in North America a few years ago can be cited as some of the sources of radioactivity hazards posed to man and nature.

People exposed to high doses of radiactive radiation have their tissues and cells damaged due to the absorption of radiation energy. Sometimes the cells get destroyed, leading to death. Other long-term effects of radiation include cancer, leukaemia (cancer of the blood) and gene mutations.

**Precautions for human beings**

The alpha ($\alpha$) and beta ($\beta$) rays are only dangerous when inside the body. These do not, however, penetrate deep into the body and therefore can be of little harm outside the body. Gamma ($\gamma$) rays are more penetrative and therefore more dangerous.

To prevent radioactive materials from getting into our bodies any food contaminated with radioactive particles should not be taken, while direct breathing in of radioactive particles should be avoided. Smoking should be prohibited while handling radioactive materials. Active preventive methods include the wearing of disposable gloves, mouth and
nose masks and protective clothing for the body. Any person handling radioactive materials should use remote-controlled tools and work behind a shielding wall of thick concrete or lead. In hospitals the X-rays used in radiography are carefully controlled. Also the X-rays are directed to only one particular part of the body. This ensures that the whole body is not unnecessarily exposed to X-rays. The number of X-ray exposures a patient is subjected to should also be limited.

People who reside near nuclear stations, at least within a radius of 80 kilometres, are exposed to constant potential danger of radioactive "dust" escaping from the nuclear reactors. However, the buildings in which the reactors are housed draw in air and this ensures that radioactive particles do not escape. Occasionally accidents occur in these stations such as the 1986 Chernobyl accident in USSR. In this accident, leakage in the nuclear reactor provoked an explosion resulting in the whole station burning and scattering radioactive particles to within several kilometres around the station and into neighbouring countries. The precautions then taken were to evacuate the whole town while food and water were carefully checked. Up to 1988, radioactive material was still being detected in powdered milk produced in neighbouring countries. Fruits, vegetables, meat, eggs, etc. produced near the station could not be eaten or exported.

Another nuclear accident involved the crashing of a nuclear-powered Russian satellite in North America. Experts were quickly sent to collect and dump the debris deep under sea and in the desert. Countries like Kenya have already effected protection laws regarding radioactive materials. There are also international agreements or conventions which bar countries from using nuclear weapons against enemy countries during wars.

FIRST AID
First aid is the skilled application of accepted principles of treatment in the occurrence of injury or in the case of sudden illness using appropriate facilities or materials available at the time. It involves giving of approved assistance of aid to casualty patients until they are placed in the care of qualified medical personnel.

If the victim has stopped breathing for whatever reason, artificial respiration must be started at once, before any other treatment is given, and should be continued until breathing is restored.

In the case of shock, the patient should be made to lie down to relax, and should be covered with a light blanket or some clothing. No drink or food should be taken if there are signs of internal injury. (The hands of those giving first aid should be washed clean before and after treating wounds, burns or eye injuries). The patient should be comforted by word and deed. Improvisations such as splints, stretchers, etc. should be made where necessary and possible. First-aid should be given quickly, gently and quietly, avoiding panic. A crowd around an injured person not only hinders the first- aider but also worries the patient, and therefore, should be told to leave. Besides, the patient generally needs plenty of air. The first- aider should show self-confidence so that the patient develops confidence in him. The information about the accident and the first-aid given should then be passed on to the hospital personnel or medical officer.

Cuts, minor wounds and scratches
All wounds and scratches should be covered with sterilised dressing after cleaning the wound and the area around it using antiseptic lotion. Foreign bodies such as fragments of glass, gravel, etc. should be removed gently.

Wounds with severe bleeding
The bleeding should be stopped at once by applying a firm bandage. In severe cases a bandage should be tied near the wound and then tightened by twisting a rod inserted under it to form what is called a tourniquet. If a tourniquet is used it should be loosened momentarily every 15 minutes. The casualty should be taken as soon as possible to a nearby health centre or hospital for further attention. If the bleeding still does not cease, pressure should
Drowning
Drowning occurs when one is unable to breathe while in water. Drowning accidents can happen even amongst expert swimmers; so it is advisable not to go swimming alone. There are two types of drowning: dry and wet drowning. Dry drowning is the case of the water reaching the lungs. In dry drowning recovery through artificial respiration is rapid.

In the case of wet drowning, the water acts as an irritant and causes the lungs to produce froth which oozes out of the mouth and the lungs. The froth is sometimes mixed with blood from broken alveolar blood vessels. This type of drowning can cause a condition called asoxia, which leads to brain damage.

Sea water has 3.5% salt concentration and is hypertonic to the body fluids. In sea-water wet drowning, water passes from the pulmonary blood vessels into the lung alveoli causing a lot of froth formation in the lungs. In fresh-water drowning, water is absorbed into the pulmonary blood vessels and this causes 50 per cent haemodilution or blood dilution. This then results in the bursting of erythrocytes or haemolysis.

Snake bites
A bite by a poisonous snake leaves two wound marks which are a short distance apart; these are wounds left by the fangs, and through which snakes inject poison into the body of a victim. There are two types of poisons produced by snakes. The poison produced by the cobra-group affects the nervous system. Its paralysing effects are slow. Poison from the viper-group of snakes affects the area near the bite. Pain is partly due to blood clotting in the blood vessels. The snake should be identified, or described to the doctor who can then determine the type of treatment. The treatment must be immediate.

Treatment
First aid should be administered immediately. The victim should be kept as still as possible so that the poison does not spread quickly in the body. If pieces of broken fangs have remained in the wound, they should be removed as quickly as possible. Usually the part just above the wound should be tied with a constrictive or tight bandage to stop the flow of blood in the veins from reaching the heart. This bandage must not be very tight otherwise it will stop blood flow in the arteries. A person with a healthy mouth and gums free from ulcers should suck the blood out of the wound so as to extract the poison. This should then be spat out. One should never attempt to suck the blood out unless one is sure that one's gums are healthy. Another possibility is to make several cuts around the bitten part to allow free out-flow of blood and poison. The wound can then be washed with antiseptics like potassium permanganate solution. It is advisable to keep anti-snakebite ointment at hand for quick treatment of victims.

Apart from snakes there are other organisms that can inflict poisonous bite or sting; these include: scorpions, spiders, centipedes and bees.

Fig. 5.17: Diagram showing use of a constrictive bandage on the leg.
FIRST AID FOR SIMPLE FRACTURES

A simple bone fracture is one in which a bone is broken but there is no external wound on the flesh due to it. A compound fracture is one in which the bone is broken and so the flesh is wounded by it. The third type of fracture is one in which the bone is broken and injury is caused to internal organs.

In either simple or compound fracture the injured person should not be moved unnecessarily. This is because broken bone-ends rub against each other and this can be extremely painful. Furthermore, additional damage may be made to internal structures such as nerves, blood vessels and tendons. The limb or the bone which is fractured should be immobilised. If the bone is protruding or sticking through the skin it should not be forced back beneath the skin, but should be treated by qualified medical personnel.

When the injured is moved to hospital, as in the case of those involved in motor accidents, the injured part or limb should be bandaged on to a splint or plank, to keep it immobile. The patient should be carried carefully on a stretcher or in a vehicle to a hospital.

If bones such as the collar bone (clavicle), the spine or the hip are fractured, extra care should be taken and the services of a qualified doctor should be sought immediately.

metabolic processes thus altering normal function of tissues or organs. Most poisonous substances interfere with normal nerve transmission in the body. There are many different types of substances that bring about poisoning but only some of them will be dealt with here.

Acetyl salicylic acid (aspirin and soluble aspirin)

When taken in excessive doses, aspirin irritates the lining of the stomach and stimulates the vomiting centre of the brain, so causing nausea with or without vomiting, epigastric pain, dizziness, mental confusion, deafness, visual disturbances, profuse perspiration, rapid and feeble pulse, laboured breathing (early), respiratory failure (later), sleepiness and coma.

Treatment

Give a large quantity of water to drink as soon as the patient’s condition permits, so that the urinary bladder is emptied hourly. Fluid intake and output should be accurately recorded. The patient should be taken to the hospital as soon as possible for medical treatment.

Acids and inorganic corrosives

These irritate the lining of the alimentary canal and provoke vomiting and bring about dehydration. Hydrochloric, nitric and sulphuric (oil of vitriol) acids cause poisoning. They also cause burning of lips, mouth and tongue pain in the digestive tract, intense thirst, nausea and vomiting, rapid and feeble

![Diagram of a fractured leg with splints tied around it.](image_url)
pulse, shallow but difficult respiration and
couvulsions.

Treatment
Usually a patient is given milk of magnesia or
lime water to drink, followed by milk or egg
albumen, or olive oil or barley water. Mor-
phine or alkaline carbonate (chalk, magnesia carbonate, sodium carbonate,
etc.) may be given in emergency cases only
i.e., if poisoning is by concentrated acids,
since they liberate carbon dioxide which may
cause gastric distension and perhaps
perforation.

Alkalis (caustic)
Poisonous alkalies include caustic potash,
caustic soda, soap dye, strong ammonia, etc.

Symptoms
Similar effects as those caused by acids: pain
in the mouth, throat and abdomen, swollen
tips and tongue, vomiting, diarrhoea, cold and
clammy skin and weak pulse, shock.

Treatment
The patient could be made to drink dilute
vinegar, lemon juice or solutions of citric or
tartaric acid to neutralise the alkali. This may
be followed by either milk, olive oil or egg
albumen.

Bleaching solutions
These may cause poisoning if ingested. Com-
mon poisonous bleaching solutions include
sodium hypochlorite solution and
hypochlorous acid.

Symptoms
They include severe pulmonary irritation with
corrosion of the mucous layers so causing
coughing and choking, followed by pharynx
and larynx oedema. Nausea and vomiting may
also occur.

Treatment
If the bleaching solution gets onto the skin it
should be washed off with plenty of water.
If swallowed, the person should be given a
solution of sodium bicarbonate to drink,
followed by a mixed solution of sodium bicar-
bonate and sodium sulphate, a treatment re-
ed gastric lavage.

Boric acid
Has similar effects in the body as those of
hydrochloric acid.

Symptoms
In acute poisoning by boric acid the symptoms
develop slowly beginning about eight hours
after ingestion. They include nausea and
vomiting, diarrhoea, convulsions, peeling off
of the skin, increasing shock, low body
temperature and cold sweat, and finally col-
lapse of the patient.

Note that absorption of boric acid through
continual use as an ointment, lotion or
powder particularly by infants can produce
slight but cumulative effects.
The cleansing of the nipples of nursing
mothers with solution of boric acid is another
source of entry and so this should be avoid-
ed. The proportion contained in dusting
powders should not exceed five per cent.

Treatment
In acute cases where there is difficulty in
breathing, oxygen is given and artificial
respiration is performed. The patient should
also be kept warm and quiet, and should be
given hot coffee or milk.

Carbolic acid
Symptoms of carbolic acid poisoning include
whitening and drying of lips, burning pain
from mouth down to the stomach. Other
symptoms include contracted pupils, cold and
clammy skin, low body temperature, feeble
pulse, contracted and rigid abdomen, urine
turns black when allowed to stand for
sometime.

Treatment
Give a copious quantity of water to which lime
water is added and later milk or egg albumen.
Artificial respiration is performed and oxygen
given when difficulty in respiration occurs.
tion rate. Severe headache, confusion, convulsion and loss of consciousness may result. Deep and rapid respiration with a cessation of blood circulation may occur.

**Treatment**
Gastric lavage with sodium bicarbonate solution should be given to the victim.

**Hydrocyanic acid poisoning**
This interferes with nerve impulse transmission especially at the synaptic cleft. This results in rapid and vigorous respiration which later becomes slow and difficult. The patient may foam at the mouth.

**Treatment**
Artificial respiration may be given, and the patient taken to a medical centre.

**Iodine poisoning**
The victim feels burning pain in the throat and abdomen. Vomiting may occur and the victim may faint.

**Treatment**
The patient is given starch solution e.g. rice and barley water, or sodium bicarbonate.

**Kerosene, turpentine or petrol poisoning**
This affects the nervous system and irritates the lining of the alimentary canal. The victim becomes restless with unco-ordinated movements. Vomiting and diarrhoea can result. Drowsiness and convulsions may occur.

**Treatment**
Give artificial respiration if necessary. In severe cases take the patient to a medical centre or hospital.

**Mercury compounds**
The effects are similar to those of cyanide poisoning but mercury also affects the nephrons of the kidney. The casualty feels burning pain in the mouth, throat and stomach. The tongue may become white and swollen. Acute kidney inflammation may result and scaly or suppressed passing of urine may be experienced.

**Treatment**
Large quantities of eggs and milk should be given as well as milk of magnesia. Take the patient to a medical centre.

**Silver nitrate poisoning**
The effects are similar to those of cyanide poisoning; the casualty feels burning pain in the throat and abdomen. Vomiting of whitish flaky matter, which blackens on exposure to light, may occur. Slow respiration and dizziness may also result.

**Treatment**
Give 30 gm of sodium chloride in a glass of water and then give plenty of milk and raw eggs to swallow.

**Simple artificial respiration**
Artificial respiration is usually administered to people who are unable to breathe properly. This artificial respiration is sometimes referred to as "Exhaled Air Resuscitation" or "Kiss of Life." Artificial respiration becomes necessary in the following circumstances:

1. Choking.
2. Suffocation.
3. Drowning.
4. Accidents which lead to shock.

Failure of respiration in man is followed two or three minutes later by heart failure. Artificial respiration should therefore take precedence over all other first aid measures under the circumstances listed above, and should be commenced immediately. However repulsive the method of administering artificial respiration may appear to be, the desire to help and save life should take priority. If the air passages are blocked with debris, or food substances, remove them using a handkerchief. This must be done as quickly as possible. Sometimes removal of these substances alone may stimulate breathing.

When the victim is on his back and unconscious, the tongue will fall back and block the air passage. So the head should be tilted back as far as it can go and the passage will open. In other cases it may be necessary to
Carbon monoxide
This gas competes with oxygen for the active site on the haemoglobin molecule. It occurs in coal gas, exhaust fumes, etc.

**Symptoms**
Acute poisoning is indicated by fainting, headache, nausea, dizziness, throbbing of the heart and eventually, coma. There may be convulsions and loss of control in passing of urine and faeces.

**Treatment**
Subject patient to plenty of fresh air. Ensure clear air passage through mouth by pulling tongue forward. If respiration has failed, give artificial respiration immediately using mouth to mouth, or mouth to nose method. Keep patient warm and quiet. Take patient to hospital as soon as possible.

Carbon tetrachloride
This chemical interferes with the transmission of the nerve impulses.

**Symptoms**
When inhaled, carbon tetrachloride has effects similar to, but not as strong as those of chloroform, and may produce delayed poisoning. There usually occurs headache, mental confusion, dizziness, diarrhoea, loss of consciousness, respiratory or cardiac failure.

In mild cases of poisoning nausea, dizziness, headache, vomiting and feeble pulse may occur. In more severe cases there may be diarrhoea, mental confusion, nervousness, or loss of memory. Respiration may be laboured. Carbon tetrachloride when used as a fire extinguisher in confined spaces for example, may lead to acute poisoning if the phosphogene gas released by the combustion is inhaled.

**Treatment**
If poisoning by inhalation of vapour occurs, move the patient to fresh air. Give artificial respiration if necessary. Contaminated clothing should be removed. Treatment of poisoning through ingestion is by gastric lavage, promoting diuresis by giving patient plenty of fluids to drink. If the condition is serious take the patient to hospital immediately.

Cocaine poisoning
If ingested, cocaine stimulates the body, causing restlessness. The common signs include headache, sweating, dry throat, dilated pupils, rapid pulse, laboured respiration, drop in blood pressure and convulsions.

**Treatment**
Give artificial respiration. Give a lot of fluid to drink. Take the patient to a medical centre.

Copper salt poisoning
This interferes with nerve impulse transmission and osmo-regulation. Copper poisoning results in salivation and vomiting of a bluish green substance. The patient might have diarrhoea, sometimes with blood occurring in the faeces. Headache, rapid pulse rate and high respiration rate occur. This might lead to convulsions and coma, if a heavy dose was taken.

**Treatment**
Milk and egg can be given in large quantities to the casualty. Take the casualty to hospital as soon as possible.

Ethyl alcohol poisoning
This interferes with nerve impulse transmission and dehydrates the body. In the case of acute poisoning, there occurs dilation of pupils, dizziness, slow respiration and coma.

**Treatment**
Artificial respiration is to be given followed by gastric lavage. In acute cases take the patient to a medical centre.

Iron salt poisoning
The effects are similar to those caused by copper salts. The victim feels cold and starts vomiting. The victim feels drowsy and restless. There may be increased respira-
tion rate. Severe headache, confusion, convulsion and loss of consciousness may result. Deep and rapid respiration with a cessation of blood circulation may occur.

**Treatment**
Gastric lavage with sodium bicarbonate solution should be given to the victim.

**Hydrocyanic acid poisoning**
This interferes with nerve impulse transmission especially at the synaptic cleft. This results in rapid and vigorous respiration which later becomes slow and difficult. The patient may foam at the mouth.

**Treatment**
Artificial respiration may be given, and the patient taken to a medical centre.

**Iodine poisoning**
The victim feels burning pain in the throat and abdomen. Vomiting may occur and the victim may faint.

**Treatment**
The patient is given starch solution e.g. rice and barley water, or sodium bicarbonate.

**Kerosene, turpentine or petrol poisoning**
This affects the nervous system and irritates the lining of the alimentary canal. The victim becomes restless with unco-ordinated movements. Vomiting and diarrhoea can result. Drowsiness and convulsions may occur.

**Treatment**
Give artificial respiration if necessary. In severe cases take the patient to a medical centre or hospital.

**Mercury compounds**
The effects are similar to those of cyanide poisoning but mercury also affects the nephrons of the kidney. The casualty feels burning pain in the mouth, throat and stomach. The tongue and lips may become white and swollen. Acute kidney inflammation may result and scanty or suppressed passing of urine may be experienced.

**Treatment**
Large quantities of eggs and milk should be given as well as milk of magnesia. Take the patient to a medical centre.

**Silver nitrate poisoning**
The effects are similar to those of cyanide poisoning; the casualty feels burning pain in the throat and abdomen. Vomiting of whitish flaky matter, which blackens on exposure to light, may occur. Slow respiration and dizziness may also result.

**Treatment**
Give 30 gm of sodium chloride in a glass of water and then give plenty of milk and raw eggs to swallow.

**Simple artificial respiration**
Artificial respiration is usually administered to people who are unable to breathe properly. This artificial respiration is sometimes referred to as “Exhaled Air Resuscitation” or “Kiss of Life.” Artificial respiration becomes necessary in the following circumstances:

1. Choking.
2. Suffocation.
3. Drowning.
4. Accidents which lead to shock.

Failure of respiration in man is followed two or three minutes later by heart failure. Artificial respiration should therefore take precedence over all other first aid measures under the circumstances listed above, and should be commenced immediately. However repulsive the method of administering artificial respiration may appear to be, the desire to help and save life should take priority. If the air passages are blocked with debris, or food substances, remove them using a handkerchief. This must be done as quickly as possible. Sometimes removal of these substances alone may stimulate breathing.

When the victim is on his back and unconscious, the tongue will fall back and block the air passage. So the head should be tilted back as far as it can go and the passage will open. In other cases it may be necessary to
be applied at appropriate pressure points e.g. bronchial pressure points or femoral pressure points.

Internal bleeding
The causes of internal bleeding are many; they include broken bones, severe blows, bullet wounds, diseases leading to bursting of blood vessels, etc. Signs indicating internal bleeding include fainting, rapid loss of strength, oozing of blood from the ear canal, nose, eye, coughing or vomiting of blood, urine containing blood.

In case of severe internal injuries the patient should be made to lie still and the legs raised. The clothes should be loosened and the patient exposed to plenty of fresh air. Some cold water should be poured on the face to reduce the temperature and the flow of blood into the head. If the patient has collapsed, the limbs should be raised. The pulse rate should be recorded at intervals of 10-15 minutes.

Blood loss due to internal bleeding may cause one or more of the following:
(i) Face and limbs becoming pale.
(ii) Pulse becomes weaker.
(iii) Restlessness and thirst.
(iv) Breathing becomes shallow, accompanied by gasping for air.

The patient should be given expert medical attention as soon as possible.

Bleeding from nose
The patient should be made to sit in front of an open window with the head forward and down so that no blood is swallowed. The mouth should be open. The clothes around the neck and chest should then be loosened. A wet cloth or ice should be placed on the nose and on the back of the neck. The hands are raised above the head, and the feet placed in warm water. If bleeding still does not stop, the patient should be taken to the nearest health centre or hospital for medical treatment.

Bleeding from ear canal
The ear canal should not be plugged. Some dry absorbent material such as cotton wool or tissue paper should be applied to the ear and secured in place with a bandage round the head. The patient should be taken to a health centre immediately.

Burns and scalds
In the case of slight burns, the clothing around the burns should be removed unless it is sticking onto the skin. The burns should be cleaned with mild antiseptic solution or baking soda solution and then covered with a clean dressing. If the burns are severe the clothing should not be removed; if the burns are exposed, the area should be covered with clean dressing. Clean sheets are useful for wrapping large burned areas. Don't burst the blisters.

Acid burns
The affected area should be washed with alkaline lotion e.g. soda water, lime water, or just flooded with plenty of water. Use of antiseptics and the bursting of blisters should be avoided.

Alkali burns
The affected area should be washed with dilute acid solution, such as dilute vinegar, and then sprinkled with boric acid. If these are not available flood the burned area with plenty of water. Antiseptics should not be used, and blisters should not be broken open.

Eye injuries
If there is a foreign object in the eye and it cannot be removed easily two or three eye-drops should be applied and the eye covered with an eye pad and bandaged firmly so as to keep the eye shut and still. The casualty should be taken to a doctor immediately. An eye injured by a blow should be covered with a pad. The casualty should be taken at once for medical treatment.

Chemicals in the eye
The eye should be washed with clean cold water for at least 15 minutes. The casualty should try to blink under water. The application of eye-drops should be avoided. The victim should then be taken to the nearest hospital for treatment.
pull the tongue forward in order to keep the air passage open. Having prepared the victim thus, kneel down near the head of the victim. If the victim had not taken poison, the rescuer should take a deep breath and then apply his mouth to the mouth of the victim. It may be necessary to close the victim's nose. Blow into his mouth to inflate the lungs. Watch the chest of the victim as it empties the air. Apply about 12 inflations per minute until the victim starts breathing by himself. The mouth-to-nose inflation method is very efficient. If the nostrils or nasal passages are not blocked, then apply the mouth on the nose of the victim and blow down the nostrils. In some cases it might take very long — as long as an hour before the victim recovers. Therefore, more than one person should assist in giving artificial respiration before the patient reaches the hospital. This artificial resuscitation does not require any special skill.

DIARRHOEA
Diarrhoea is a condition in which the rectum releases semi-liquid faecal material very often. This happens when the ileum and colon are infected and the indigestible food residue does not stay in the colon long enough to allow reabsorption of water. The peristaltic movement of the intestines are very fast and more water is withdrawn from the body, making the residue more watery. This leads to dehydration and even death. Diarrhoea is mostly brought about by food poisoning by bacteria called Clostridium. It is therefore important that personal hygiene is maintained e.g. washing of mothers' breast before feeding babies, cleaning of feeding bottles, utensils, cutlery and hands. Also it is advisable to frequently cut down finger nails.

Preparation of the food is also important if diarrhoea is to be prevented from infecting people. Some of the food sold by either street hawkers or backstreet hotels may be heavily contaminated with food poisoning bacteria. The foods include sausages, meat pies, cakes, buns, sausages, stew, etc. Unprocessed milk or porridge which is usually served cold to the babies may cause diarrhoea in children.

The food should not be left at room temperature for a long time before it is served. This is what causes most food poisoning in hotels, homes and schools. A few minutes after eating heavily contaminated food there follows a set of sudden abdominal pain and diarrhoea accompanied by vomiting and sweating because the body is expelling poisonous food materials.

Prevention and Care
Hygienic ways of preparing food and use of clean utensils or containers has already been mentioned above as a preventative measure. A dehydrated child becomes weak and exhausted dies to excessive loss of water and salts, and may enter into a state of shock and die. It is advisable to give such a child oral rehydration solution before taking it to a hospital where the child will be given a drip of salt and sugar solution to replace the liquid lost by the body.

Plate 12: Photograph of a dehydrated child with diarrhoea having a drip (Reproduced from page 3, author).
To prepare oral rehydration solution, a pinch of sodium chloride (table salt) and two teaspoonsful of sugar (preferably glucose) are mixed together in a cupful or glassful of warm water. When cool, the solution is given to the sick child to drink, a little at a time.

SUGGESTED ACTIVITIES
Most of the activities suggested here have been described in the Teachers’ Guide and reference should be made to Pupils’ Books 1, 2 and 3.
1. Test for carbohydrates.
2. Test for fats.
3. Test for vitamin C.
4. Food preservation methods.
5. Examination of preserved animal parasites.
6. Examination of prepared slides of parasites.
7. Construction of a water filter.
8. Visit to a sewage treatment plant.
10. Common emergencies that require first aid before a doctor arrives or before a patient is transferred to a medical clinic or hospital.

EXERCISES
1. Which diseases could be prevented by:
   (a) Personal hygiene?
   (b) Efficient sewage disposal?
   (c) Purification of drinking water?

   Explain your answers in each case.

2. It is possible to contract amoebic dysentery as a result of close contact with an infected person. Similar contact with a malaria victim cannot produce infection. Explain why the transmission of these two diseases is so different.

3. Describe the causes and symptoms of:
   Kwashiorkor.
   Marasmus.
   Pellagra.
   Rickets.

   How would such diseases be treated and how can they be avoided?

4. Name the deficiency symptoms resulting from lack of the following vitamins:
   A — (Retinsol).
   B — (Complex).
   C — (Ascorbic acid).
   D — (Calciferal).
   E — (Tocopherol).
   K — (Quinone).

5. Give an account of the role of taboos, religious and customary beliefs that influence the diet of persons.
6. (a) List three common diseases caused by each of the followings:
   Virus.
   Bacteria.
   Protozoa.
   Parasitic worms.

   (b) State how each of the diseases listed above can be avoided.

7. Compare and contrast the life cycles of the following:
   Schistosoma
   Plasmodium
   Ascaris (round worms)
   Hook-worms.

8. Outline the methods one would use to minimise possible infections in the home.

9. Describe a balanced diet.

10. Discuss the role of vitamins and mineral salts in a balanced diet.

11. What factors contribute to the spread of malaria? State briefly what methods are being used to control this disease and state their limitations and effectiveness.

12. Describe the various methods used to reduce the incidence of vector-borne diseases.

13. Comment on the quantity of calcium needed by pregnant women.

14. Why does a girl require more iron in the diet than a boy at the ages of 13-14 years?

15. Why does a pregnant woman require about 15 gms more of protein per day than a very active man?
Appendix K

Analysis of the Specific Objectives of the Human Health Topic

The following tables show the different curriculum emphases in the biology and biological sciences objectives (Kenya National Examinations Council, 1990, pp. 139-144). Note that some items overlap. That is, they occur under two emphases. This should be a reflection of the point made by Roberts (1982), that curriculum emphases are "not mutually exclusive".

22.1 Specific Objectives

| CURRICULUM EMPHASIS | (a) discuss the meaning of good health and factors affecting it and prerequisites of good health  
|                     | *(c) discuss deficiency diseases in humans  
|                     | *(d) evaluate various weekly diets presented by pupils  
|                     | (e) identify the symptoms of different types of human diseases and methods of transmission and control  
|                     | (h) discuss the effects of pollution on human health in rural and urban situations  
|                     | (i) demonstrate knowledge of first aid techniques  
| The "Every-day Coping" |  
| The "Structure of Science" |  
| The Science, Technology and Decisions" |  
| The "Scientific Skill Development" |  
| The "Correct Explanations" | *(c) discuss deficiency diseases in humans  
|                            | (f) describe the life cycles of pathogenic protozoan and helminth parasites e.g. *Plasmodium, Ascaris, Schistosoma*  
|                            | (g) explain immunity and describe immune responses  
| The "Self As Explainer" | *(d) evaluate various weekly diets presented by pupils  
| The "Solid "Foundations" |  

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### 22.2 Eating Habits and Health

<table>
<thead>
<tr>
<th>CURRICULUM EMPHASIS</th>
<th>*(a) balanced diet and energy requirements (Refer to topic 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The &quot;Every-day Coping&quot;</td>
<td>(c) effects of some eating habits on health</td>
</tr>
<tr>
<td></td>
<td>(d) discuss cultural relations in relation to eating a balanced diet</td>
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<tr>
<td>The &quot;Structure of Science&quot;</td>
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<tr>
<td>The Science, Technology and Decisions&quot;</td>
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<tr>
<td>The &quot;Scientific Skill Development&quot;</td>
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</tr>
<tr>
<td>The &quot;Correct Explanations&quot;</td>
<td>*(b) Deficiency diseases e.g Marasmus and Kwashiokor (Refer to topic 7)</td>
</tr>
<tr>
<td>The &quot;Structure of Science&quot;</td>
<td></td>
</tr>
<tr>
<td>The &quot;Solid Foundations&quot;</td>
<td>*(a) balanced diet and energy requirements (Refer to topic 8)</td>
</tr>
<tr>
<td></td>
<td>*(b) Deficiency diseases e.g Marasmus and Kwashiokor (Refer to topic 7)</td>
</tr>
</tbody>
</table>
### 22.3 Micro-organisms, Viruses and their Economic Importance

<table>
<thead>
<tr>
<th>CURRICULUM EMPHASIS</th>
<th>22.31 Specific Objectives - The learner should be able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The “Every-day Coping”</td>
<td>(a) differentiate between micro-organisms and viruses</td>
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<td></td>
<td>(c)* carry out experiments to show the occurrence and conditions necessary for growth and dissemination of micro-organism</td>
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<tr>
<td></td>
<td>(d) explain the economic importance of micro-organisms in food storage and spoilage</td>
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<td></td>
<td>(g)* relate the economic importance of these diseases to human health (also reference to Agriculture syllabus)</td>
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<tr>
<td></td>
<td>(i)* name and discuss the role of micro-organisms in:</td>
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<td></td>
<td>(i) carbon cycle</td>
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<td></td>
<td>(ii) nitrogen cycle</td>
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<td></td>
<td>(iii) food processing</td>
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<tr>
<td>The “Structure of Science”</td>
<td></td>
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<tr>
<td>The Science, Technology and Decisions“</td>
<td>(c)* carry out experiments to show the occurrence and conditions necessary for growth and dissemination of micro-organism</td>
</tr>
<tr>
<td>The “Scientific Skill Development“</td>
<td>(b) describe the simple structure of a named bacterium and virus</td>
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<td></td>
<td>(f) describe the common plant and animal diseases caused by viruses and micro-organisms</td>
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<tr>
<td></td>
<td>(h) describe the methods used to control diseases caused by viruses and micro-organisms e.g fungi, bacteria and protozoa</td>
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<tr>
<td></td>
<td>(i)* name and discuss the role of micro-organisms in:</td>
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<td>The “Self As Explainer”</td>
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<td>The “Solid Foundations“</td>
<td>(g)* relate the economic importance of these diseases to human health (also reference to Agriculture syllabus)</td>
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<td>CURRICULUM EMPHASIS</td>
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<tr>
<td>The &quot;Every-day Coping&quot;</td>
<td>*(b) viral diseases e.g small pox, chicken pox, tobacco mosaic (c) control of viral diseases (d) economic importance of viruses</td>
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<tr>
<td>The &quot;Structure of Science&quot;</td>
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<tr>
<td>The Science, Technology and Decisions&quot;</td>
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<tr>
<td>The &quot;Scientific Skill Development&quot;</td>
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<tr>
<td>The &quot;Correct Explanations&quot;</td>
<td>(a) structure of a virus *(b) viral diseases e.g small pox, chicken pox, tobacco mosaic</td>
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<tr>
<td>The &quot;Self As Explainer&quot;</td>
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<tr>
<td>The &quot;Solid Foundation&quot;</td>
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</table>
### CURRICULUM EMPHASIS

#### The "Every-day Coping"
- (a) Identification of various types of bacteria: rods, spiral, cocci
- (c) Conditions necessary for growth of bacteria
- (d) The importance of useful bacteria in nature
- (e) Common diseases caused by named bacteria, protozoa and methods of control
- (h) Economic importance of bacteria and fungi

#### The "Structure of Science"

#### The Science, Technology and Decisions"

#### The "Scientific Skill Development"

#### The "Correct Explanations"
- (b) Structure of yeast and *E. Coli*
- *(f) The nitrogen and carbon cycles (Ref. to topic 7.0)*

#### The "Self As Explainer"

#### The "Solid Foundations"
- *(f) The nitrogen and carbon cycles (Ref. to topic 7.0)*
## 22.4 Practical Activities

<table>
<thead>
<tr>
<th>CURRICULUM EMPHASIS</th>
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<tbody>
<tr>
<td><strong>The “Every-day Coping”</strong></td>
<td>*22.42 Carry out experiments on budding and fermentation using yeast</td>
</tr>
<tr>
<td></td>
<td>*22.43 Carry out experiments to show:</td>
</tr>
<tr>
<td></td>
<td>(a) Universal occurrence of bacteria and fungi</td>
</tr>
<tr>
<td></td>
<td>(b) Environmental conditions affecting bacterial and fungal growth. (Care should be taken not to examine micro-organisms in open petri-dishes.) Count bacterial and fungal colonies under various temperature conditions</td>
</tr>
<tr>
<td></td>
<td>*22.44 Carry out microscopic examination of:</td>
</tr>
<tr>
<td></td>
<td>(a) bacteria in fermented milk</td>
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<tr>
<td></td>
<td>(b) micro-organisms in various samples of farm manure</td>
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<tr>
<td></td>
<td>* -&gt; List some of the antibiotics and the disease against which they are used. NOTE:</td>
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<td></td>
<td>Dangers of under-dose should be discussed.</td>
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<td></td>
<td>22.46 Carry out experiments to show the antibiotic nature of some fungi by planting Penicillium ssp. On petri dishes containing other micro-organisms</td>
</tr>
<tr>
<td><strong>The “Correct Explanations”</strong></td>
<td>22.41 Examine prepared slides of malaria parasites, Trypanosoma or ringworms</td>
</tr>
<tr>
<td></td>
<td>* -&gt; List some of the antibiotics and the disease against which they are used. NOTE:</td>
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<td><strong>The “Self As Explainer”</strong></td>
<td>22.45 Evaluate modern and traditional methods of curing fungal infections like Athlete’s foot, ringworms, oral and urino-genital fungal infections</td>
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<tr>
<td><strong>The “Solid Foundations”</strong></td>
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### 22.5 Human Diseases

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<tr>
<td>The &quot;Every-day Coping&quot;</td>
<td>*Discuss at least one example from each of the following categories:</td>
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<tr>
<td></td>
<td>(a) Bacterial diseases e.g. cholera, typhoid</td>
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<td>(b) Viral diseases - e.g. measles</td>
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<tr>
<td></td>
<td>(c) Protozoa diseases - e.g. malaria, amoebic dysentery</td>
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<td></td>
<td>(d) Diseases caused by nematodes e.g Roundworm / Ascaris (hookworm)</td>
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<tr>
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### 22.6 Respiratory Diseases

<table>
<thead>
<tr>
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</table>
| The “Every-day Coping” | (b) Discuss the causes, symptoms and prevention of respiratory diseases  
*(c) State the common diseases of the circulatory and lymphatic systems and suggest possible methods of control/prevention  
*(d) Diseases and defects of the heart (coronary thrombosis), (varicose veins) and arteries, how to control them  
*(e) Diseases of the blood e.g hemophilia, anaemia, leukemia, septicaemia, sickle cell anaemia. (Refer to topic 19)  
*(g) Common kidney and liver diseases, their symptoms and possible methods of prevention/control  
*(h) Common dental disease, their causes and treatment |
| The “Structure of Science” |  |
| The Science, Technology and Decisions” |  |
| The “Scientific Skill Development” |  |
| The “Correct Explanations” | (a) Asthma, bronchitis, pulmonary tuberculosis, pneumonia and whooping cough  
*(c) State the common diseases of the circulatory and lymphatic systems and suggest possible methods of control/prevention  
*(d) Diseases and defects of the heart (coronary thrombosis), (varicose veins) and arteries, how to control them  
*(e) Diseases of the blood e.g hemophilia, anaemia, leukemia, septicaemia, sickle cell anaemia. (Refer to topic 19)  
*(g) Common kidney and liver diseases, their symptoms and possible methods of prevention/control  
*(h) Common dental disease, their causes and treatment |
| The “Self As Explainer” |  |
| The “Solid Foundations” |  |
### 22.7 Sexually Transmitted Diseases (STD)

<table>
<thead>
<tr>
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## 22.8 Symptoms and Methods of Transmission of STDs

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### 22.9 Immune Response

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(b) Artificial immunity  
(c) Allergic reactions  
(d) Organ transplants and associated problems  
(e) The role of vaccinations and the vaccination time table in children against diseases like typhoid, poliomyelitis, whooping cough etc. |
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## 22.11 Sewage and Refuse Disposal in Rural and Urban Situations

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<td>*(b) Methods of disposing sewage and refuse at home, in small and large communities</td>
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<td>*(c) Sewage treatment plants and pit latrines</td>
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### 22.12 Effect of Pollution and Human Health

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<td>&gt; Simple treatment of the following: cuts, burns, snake bites, nose bleeding, drowning in water, intake of poisoning substances, simple fractures, artificial respiration and diarrhoea.</td>
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<td>22.142 A guided visit to a local market, sewage treatment plant and a slaughter house (abattoir) etc.</td>
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<td>22.143 Demonstrate basic skills in simple treatment of cuts, burns, snake bite, nose bleeding, drowning in water, intake of poisonous substances especially food poisoning, simple fractures and artificial respiration</td>
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<td>22.144 Carry out observation of some of the following diseases: kwashiorkor, Marasmus, malaria (details of paroxisms due to individual Plasmodium species is not required.</td>
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<td>22.145 Demonstrate techniques of preserving food (both traditional and modern) e.g. vegetable drying, smoking, freezing</td>
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<td>22.146 Construct a simple water filter</td>
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<td>22.147 Carry out an antigen/antibody immune response by injecting a male frog with urine samples from a pregnant human female</td>
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| The "Correct Explanations" | 22.148 Effort should be made to invite speakers like public health officers  
22.149 Films can be borrowed from United Nations Environment Programme (UNEP), National Christian Council of Kenya (NCCK), International Planned Parenthood Federation (IPPF), World Health Organization (WHO), African Medical and Research Foundation (AMREF), Kenya Institute of Education (KIE) |
| The "Self As Explainer" |                                                                                                         |
| The "Solid Foundations" |                                                                                                         |