CHAPTER ONE

ORIENTATIVE INTRODUCTION

1.1 INTRODUCTION

"Humanity now exceeds the planet's capacity to sustain its consumption of renewable resources…"

(Loh 2002:2)

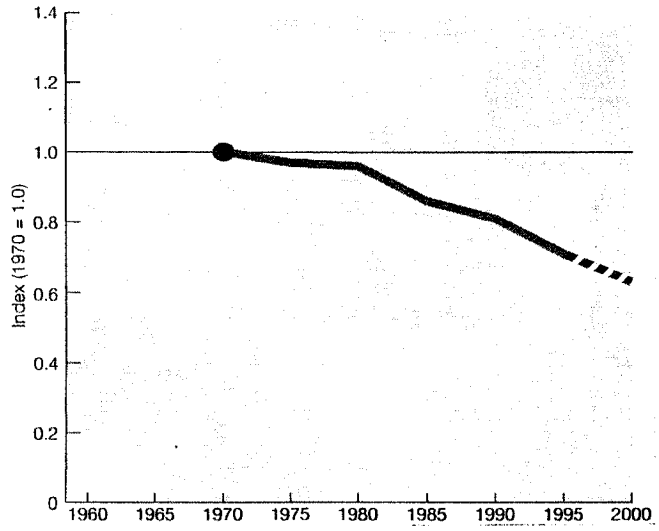
At the Earth Summit in Rio de Janeiro in June 1992, world leaders pledged to work together and adopt Agenda 21 – an action plan for sustainable development into the 21st century (Smallhorne 2002:14). Hence sustainable development was "welcomed as, and remains a concept to which politicians and economists in developed and developing countries alike lend unanimous support" (Potter 1997:147). South Africa's support for Agenda 21 initiatives clearly illustrates itself in numerous policy documents: the RDP document (1994); the White Paper on Education and Training (1995); the White Paper on Environmental Management Policy for South Africa (1998) and Local Agenda 21 (Urquhart and Atkinson 2000).

Although the years after the summit in Rio have seen improvements in the quality of life for people in many parts of the world (Kassas 1997:66; Martin 2002:2; Loh 2002:2; Johannesburg World Summit 2002), the goal of sustainable development remains elusive as indicated in the latest Living Planet Report of 9th July 2002 (Martin 2002:2) and in articles titled *Rio Plus Ten* (Smallhorne 2002:16) and *SA's Chance to Reverse the Slide to Disaster* (Yeld 2002:9).

According to the Living Planet Report humanity has started to live on planetary "overdraft" (Figure 1) meaning that the Earth will not be able to sustain human life as we currently live it (Loh 2002:3). The decline in the standards of living and development will start to

plunge rapidly throughout the world by 2030 unless government, business and industry and each one of us start to act now and totally embrace a path to sustainability. Concerted efforts of implementing declarations of the Rio and the Johannesburg World Summit on Sustainable Development are opportunities to start reversing negative trends (Loh 2002:3).

Figure 1:
LIVING PLANET INDEX,
1970–2000



(Source: Loh 2002:2)

To move from a "situation of wasteful consumption and pollution to one of conservation and from one of privilege and protectionism to one of fair and equitable chances to all" (Fien 1993:7) makes education among other options crucial to ensure that non-renewable and renewable resources will be sustained and ecological deficits eliminated (Johannesburg World Summit 2002; Loh 2002:20). Teachers at all levels thus face a compelling responsibility to foster the process of understanding transformation towards a path to sustainability (Fien 1993:7; Loh 2002:20; Johannesburg World Summit 2002).

A major step to ensure the success of this transformation in South Africa is Curriculum 2005 (C2005) with an outcomes based approach and the vision mentioned in the White Paper of Education and Training (1995:18) that "environmental education involving an interdisciplinary, integrated and active approach to

learning, must be a vital element of all levels and programmes of the education and training system, in order to create environmentally literate and active citizens and ensure that all South Africans, present and future, enjoy a decent quality of life through the sustainable use of resources". Inherent in such a vision is the translation of local needs and peoples' knowledge including indigenous knowledge (IK) into learning programmes for all phases and across all learning areas (EECI 1993:3).

Including IK in formal education stems from the premise that it is a valuable source of information (von Liebenstein 2000:2). Since time immemorial, people have built stores of knowledge and have developed IK systems (IKS) to help solve problems they encounter in their innumerable interactions with the natural milieu. Evolving sustainable systems to manage the environment and strategies to cope with fluctuating environments are common occurrences in communities whose livelihood depends on resources in their immediate environment (Lalonde and Morin-Labatut 1993:4;von Liebenstein 2000:2). Furthermore, studies over the past years have shown that in many cases IKS have sophisticated arrays of information, understandings and interpretations that enabled people to survive (Atte 1992:2; von Liebenstein 2000:2). Unfortunately prior to 1992, IK had been dismissed as unsystematic and insignificant (von Liebenstein 2000:2; Prakash 2000:1). However, the 1992 Rio Earth Summit and the UNESCO-ICSU World Conference on Science in Budapest, Hungry in 1999, catapulted IK to the forefront in the development discourse (Prakash 2000:1) and in scientific education and research (von Liebenstein 2000:2) respectively. Policymakers worldwide thus began to highlight the critical role of IK in the development process and in formal education.

Despite the fact that several governments and organizations have placed IK on their agendas, the day-to-day practice of science education in many countries fails to adequately reflect or excludes

this body of knowledge in their science curricula (Nuffic 2002:2; Hoppers 2002:5; Hountondji 2002:35; Ntuli 2002:64). South Africa is no exception (Hoppers 2002:5; Ntuli 2002:64). As a consequence the immense legacy of IK in South Africa is under-used and the call of the UNESCO-ICSU World Conference on Science in Budapest, Hungry in 1999 for a drastic change in the attitude, methods and approach in the scientific field and to the problems to development, remains relegated to the backwaters. Thus the quality of life for a great majority of people in Africa continues to worsen (Hoppers 2002: 3). Accompanying this is the decline in environmental quality (Loh 2002:2-3; Annan cited in Smallhorne 2002:14).

The preceding scenario shows that, to be sustainable, humanity's consumption of renewable and non-renewable natural sources must stay within the limits of the Earth's biological capacity over the long term. This calls for immediate action to be taken.

The aim of this research is to take up the challenge of the "wake - up call for Planet Earth as natural resources decline " (Loh 2002:3) by building on IK in the science curriculum at schools to help eliminate the Earth's ecological deficit. The research intends to unfold to teachers how the senior phase natural science curriculum outlined in C2005 can be effectively used to address this "wake-up call" by using the relevant IK that will provide learners with the necessary knowledge, competence and values required to protect the Earth's resources and to always remember, implement and pass on to future generations these words of wisdom of Mahatma Gandhi (Premdev 2002:4).

"The Earth provides enough to satisfy every person's needs, but not every person's greed…

When we take more than we need, we are simply taking from each other,
Borrowing from the future or destroying the environment and other species

Mahatma Gandhi cited in: Premdev 2002:4

The specific context of the research is to use IK to develop learning programmes in the senior phase natural science curriculum. The themes Earth and Beyond, Life and Living, Energy and Change and Matter and Materials intend to provide focus to the use of IK in the teaching and learning of science.

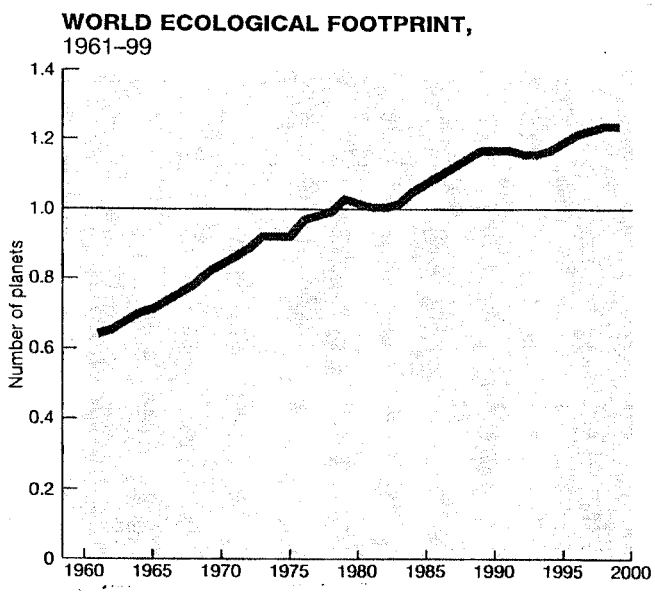
1.2 FACTORS LEADING TO THE RESEARCH

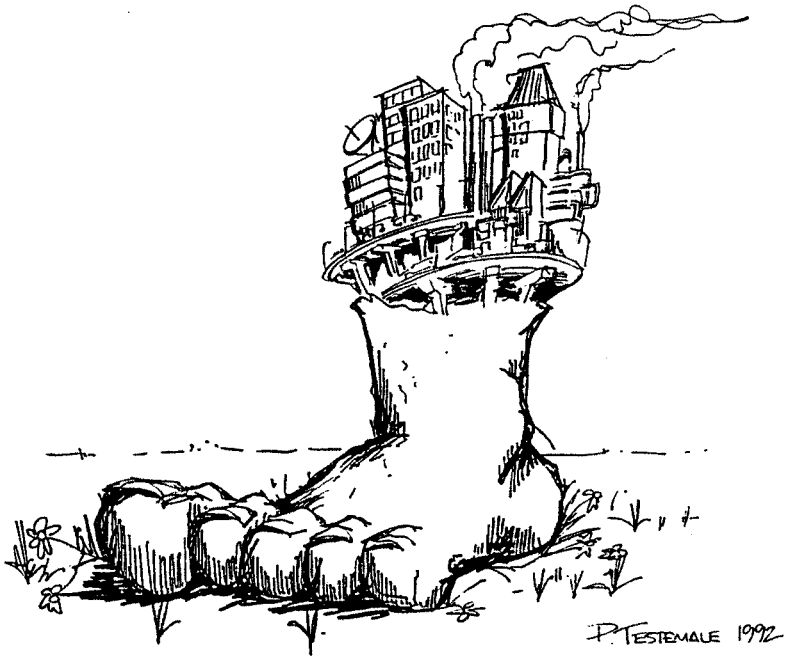
1.2.1 A LACK OF SUSTAINABILITY AND A DECLINE IN ENVIRONMENTAL QUALITY

> *"Some progress has been made in adopting measures to protect the environment… But the state of the world's environment is still fragile, and conservation measures are far from satisfactory"*
>
> Kofi Annan February 2002 cited in Smallhorne 2002:14

People have been modifying the earth's natural systems since they evolved thereby ensuring their survival; an important and an understandable goal (Kassas 1997:63; Singh 1998:1). While their efforts permitted survival, they have also been the main agent of environmental deterioration (Daily, Ehrlich and Alberti 1996:9). Activities of humans, especially in the last few decades have resulted in the earth losing its "natural habitat" except in a few areas such as ice caps, hyper-arid deserts, remote mountain peaks (Daily, Ehrlich and Alberti 1996: 19; Loh 2002:1-2). The Latest Living Planet Report of July 2002 (Loh 2002:1-29) shows that humans now use more resources and ecological services than nature can regenerate. Analyses of ecological footprints (a measure of the amount of the Earth's biological productivity that the human population, the global population, a country and an individual occupies in a given year) clearly indicate the over-use of the Earth's resources. Figures 1-8 and Table 1 from the Living Planet Report unequivocally show this over-use (Loh 2002:2-4, 27; Rees and Wackernagel 1994:371).

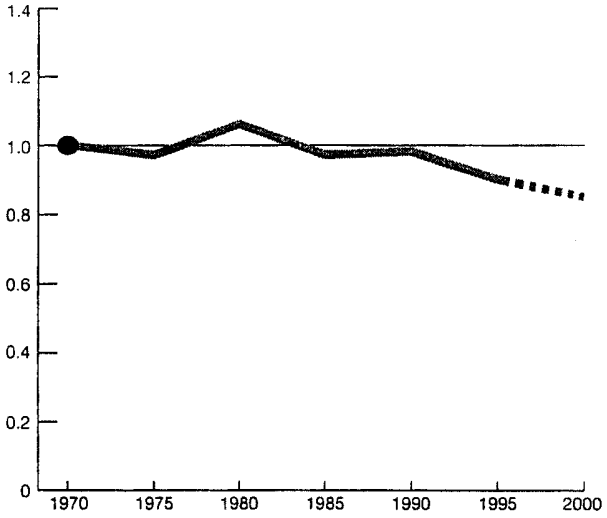
Figure 2: World Ecological Footprint, 1961-1999 and the Ecological Footprint of Many Countries





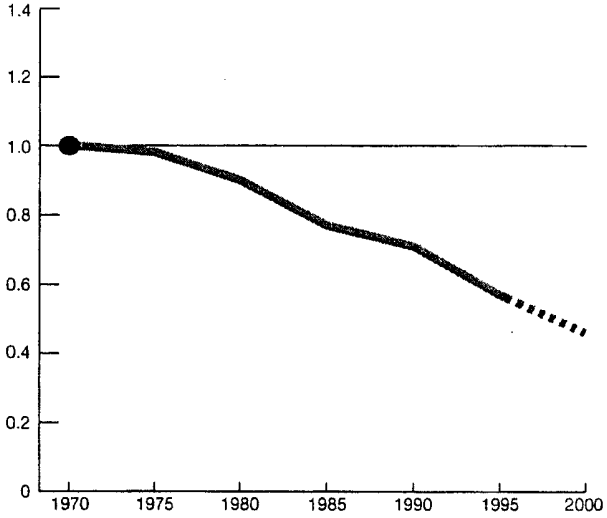
(Source: Loh 2002:2; Rees and Wackernagel 1994:371)

Figure 3:
FOREST SPECIES POPULATION INDEX, 1970–2000



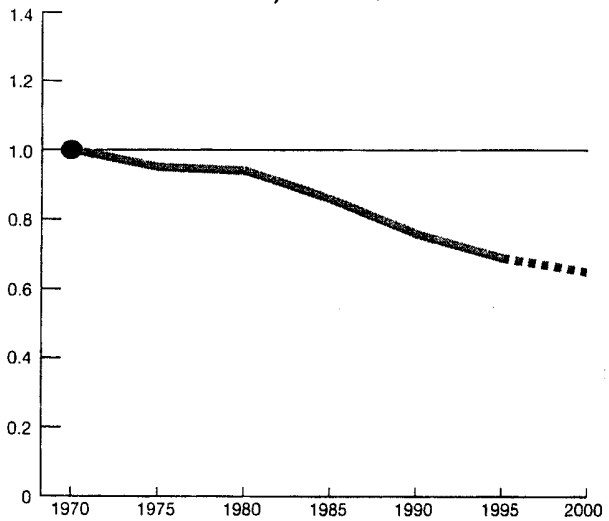
(Source: Loh 2002:3)

Figure 4:
FRESHWATER SPECIES POPULATION INDEX, 1970–2000



(Source: Loh 2002:3)

Figure 5:
MARINE SPECIES POPULATION INDEX, 1970–2000



(Source: Loh 2002:3)

Figure 6:
ECOLOGICAL FOOTPRINT PER PERSON, by country, 1999

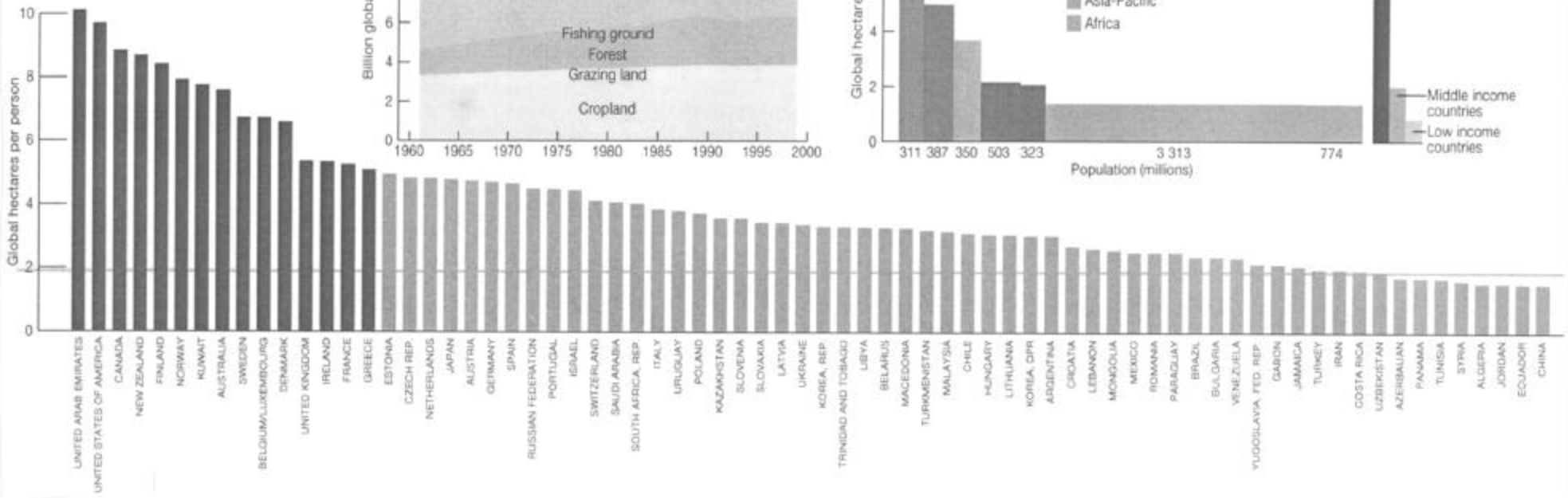


Figure 7:
WORLD ECOLOGICAL FOOTPRINT, 1961–99

Figure 8:
ECOLOGICAL FOOTPRINT, by region and income group, 1999

(Source: Loh 2002:4)

	Global population (billion)	Total ecological footprint (billion global ha)	Cropland footprint (billion global ha)	Grazing land footprint (billion global ha)	Forest footprint (ex. fuelwood) (billion global ha)	Fishing ground footprint (billion global ha)	Total energy footprint (billion global ha)	Built-up land (billion global ha)	Biocapacity (billion global ha)	World ecological footprint (number of planets)	Water* withdrawals (thousand km³/year)	Living Planet Index	Forest species population index	Freshwater species population index	Marine species population index
1960											1.99				
1961	3.08	7.47	2.89	0.41	1.03	0.31	2.51	0.32	10.90	0.69	2.04				
1962	3.14	7.62	2.90	0.43	1.04	0.33	2.60	0.32	10.91	0.70	2.09				
1963	3.20	7.81	2.91	0.44	1.06	0.35	2.74	0.33	10.92	0.72	2.15				
1964	3.27	8.04	2.92	0.45	1.10	0.36	2.88	0.33	10.93	0.74	2.20				
1965	3.34	8.24	2.92	0.46	1.12	0.39	3.01	0.34	10.94	0.75	2.26				
1966	3.41	8.47	2.93	0.47	1.15	0.41	3.16	0.35	10.95	0.77	2.32				
1967	3.48	8.65	2.93	0.49	1.17	0.45	3.25	0.36	10.97	0.79	2.38				
1968	3.55	8.92	2.96	0.51	1.18	0.50	3.41	0.36	10.98	0.81	2.44				
1969	3.62	9.19	2.98	0.52	1.20	0.52	3.60	0.37	11.00	0.84	2.51				
1970	3.70	9.50	2.99	0.52	1.23	0.54	3.84	0.38	11.00	0.86	2.57	1.00	1.00	1.00	1.00
1971	3.77	9.70	2.98	0.52	1.25	0.56	3.99	0.39	11.01	0.88	2.63				
1972	3.85	9.94	2.99	0.53	1.26	0.62	4.15	0.39	11.02	0.90	2.69				
1973	3.92	10.24	3.00	0.53	1.30	0.63	4.38	0.40	11.04	0.93	2.75				
1974	4.00	10.32	3.01	0.55	1.31	0.63	4.40	0.41	11.05	0.93	2.81				
1975	4.07	10.32	3.02	0.57	1.28	0.64	4.40	0.42	11.06	0.93	2.87	0.97	0.97	0.98	0.95
1976	4.15	10.66	3.03	0.60	1.33	0.64	4.65	0.42	11.05	0.97	2.93				
1977	4.22	10.82	3.04	0.60	1.34	0.62	4.79	0.43	11.05	0.98	3.00				
1978	4.29	10.96	3.05	0.61	1.38	0.62	4.86	0.44	11.06	0.99	3.06				
1979	4.37	11.28	3.07	0.60	1.42	0.62	5.12	0.45	11.07	1.02	3.13				
1980	4.44	11.25	3.08	0.60	1.43	0.61	5.08	0.46	11.13	1.01	3.20	0.96	1.06	0.90	0.94
1981	4.52	11.14	3.09	0.60	1.42	0.62	4.96	0.46	11.13	1.00	3.24				
1982	4.59	11.16	3.10	0.61	1.41	0.64	4.94	0.47	11.14	1.00	3.27				
1983	4.67	11.27	3.11	0.62	1.46	0.64	4.95	0.48	11.15	1.01	3.31				
1984	4.75	11.61	3.13	0.63	1.52	0.69	5.15	0.48	11.18	1.04	3.35				
1985	4.84	11.87	3.12	0.65	1.54	0.71	5.36	0.49	11.21	1.06	3.38	0.86	0.97	0.77	0.86
1986	4.92	12.15	3.14	0.67	1.59	0.73	5.53	0.50	11.27	1.08	3.42				
1987	5.01	12.39	3.15	0.67	1.63	0.76	5.67	0.51	11.29	1.10	3.46				
1988	5.10	12.68	3.16	0.67	1.65	0.77	5.91	0.52	11.32	1.12	3.50				
1989	5.18	12.86	3.17	0.68	1.68	0.79	6.02	0.53	11.34	1.14	3.54				
1990	5.27	12.93	3.18	0.69	1.68	0.77	6.08	0.54	11.38	1.14	3.58	0.81	0.98	0.71	0.76
1991	5.35	12.93	3.17	0.69	1.59	0.75	6.19	0.55	11.37	1.14	3.62				
1992	5.43	12.84	3.15	0.68	1.55	0.75	6.16	0.55	11.38	1.13	3.65				
1993	5.51	12.84	3.15	0.69	1.54	0.73	6.17	0.55	11.40	1.13	3.69				
1994	5.59	13.03	3.16	0.70	1.56	0.75	6.30	0.56	11.40	1.14	3.72				
1995	5.67	13.26	3.16	0.70	1.58	0.79	6.46	0.57	11.39	1.16	3.76	0.71	0.90	0.57	0.69
1996	5.74	13.44	3.16	0.71	1.58	0.80	6.61	0.58	11.39	1.18	3.80				
1997	5.82	13.59	3.16	0.72	1.62	0.80	6.70	0.58	11.38	1.19	3.83				
1998	5.90	13.59	3.16	0.72	1.60	0.83	6.69	0.59	11.38	1.20	3.87				
1999	5.98	13.65	3.14	0.73	1.63	0.82	6.72	0.60	11.36	1.20	3.90				
2000											3.94	0.63	0.85	0.46	0.65

Table 1: The Living Planet Through Time (Source: Loh 2002:27)

The statistics from Figures 1-8 and from Table 1, analysed by the authors of the Living Planet Report, show that the Living Planet Index fell by 37% between 1970 and 2000 (Figure 1); the world ecological footprint grew by 80% between 1961 and 1999, to a level 20% above the Earth's biological capacity (Figure 2); the forest species population index declined 15% on average in 282 populations of species of birds, mammals and reptiles living in forest ecosystems (Figure 3); the freshwater species population index declined 54% on average in 195 species of birds, mammals, reptiles, amphibians and fish living in lakes, rivers and wetland ecosystems (Figure 4); the marine species population index declined 35% on average in 217 species of birds, mammals, reptiles and fish living in coastal and marine ecosystems (Figure 5);the ecological footprint per person for all countries with populations over 1 million grew at an average of 1.6% per year from 1961 to 1999 (Figure 7); the ecological footprints per person in high income countries was on the average over six times that of low income countries, and over three times greater than the Earth's biological capacity (Figure 8). The cropland footprint (Figure 9, 10 and 11), the grazing land footprint (Figure 12,13 and 14), the forest footprint (Figure 15,16 and 17), the fishing ground footprint (Figure 18,19 and 20) and the energy footprint (Figure 21, 22 and 23) further highlights the pressure imposed by humans on the Earth's resources.

Glaringly evident from the statistics and the information shown in Figures 1-23 and Table 1 is the fact that the diversity of environmental problems is not simply issues related to the environment. Figures 8, 11, 14, 17, 20 and 23 show that they are in the broadest sense quality of life issues. The fact that rich/developed countries account for a greater percentage of the global consumption than poor/developing countries is not new. Saxenna (1998:71) shows this data in Table 2 and Annan (cited in Smallhorne 2002:14) states in a 69 report presented at the two- week preparatory talks for the Johannesburg Earth Summit,

in New York in February 2002 that rich countries consume 56% of the global consumption while poor countries account for only 11% of consumption.

Developed countries (26% of population)				Undeveloped countries (74% of population)	
Commodity	***Unit of per capital consumption***	***Share in world consumption (%)***	***Per Capita***	***Share in world consumption (%)***	***Per Capita***
Food:					
Calorie	Kcal/day	34	3395	66	2389
Protein	g/day	38	99	62	58
Fat	g/day	53	127	47	40
Paper	kg/year	85	123	15	8
Steel	kg/year	79	455	21	43
Other Metals	kg/year	86	26	14	2
Commercial Energy	mtce/year	80	5.08	20	0.5

Table 2: Distribution of World Consumption Average for 1980-1982
(Source: Saxenna 1998:71)

Figure 9:
CROPLAND FOOTPRINT PER PERSON, by country, 1999

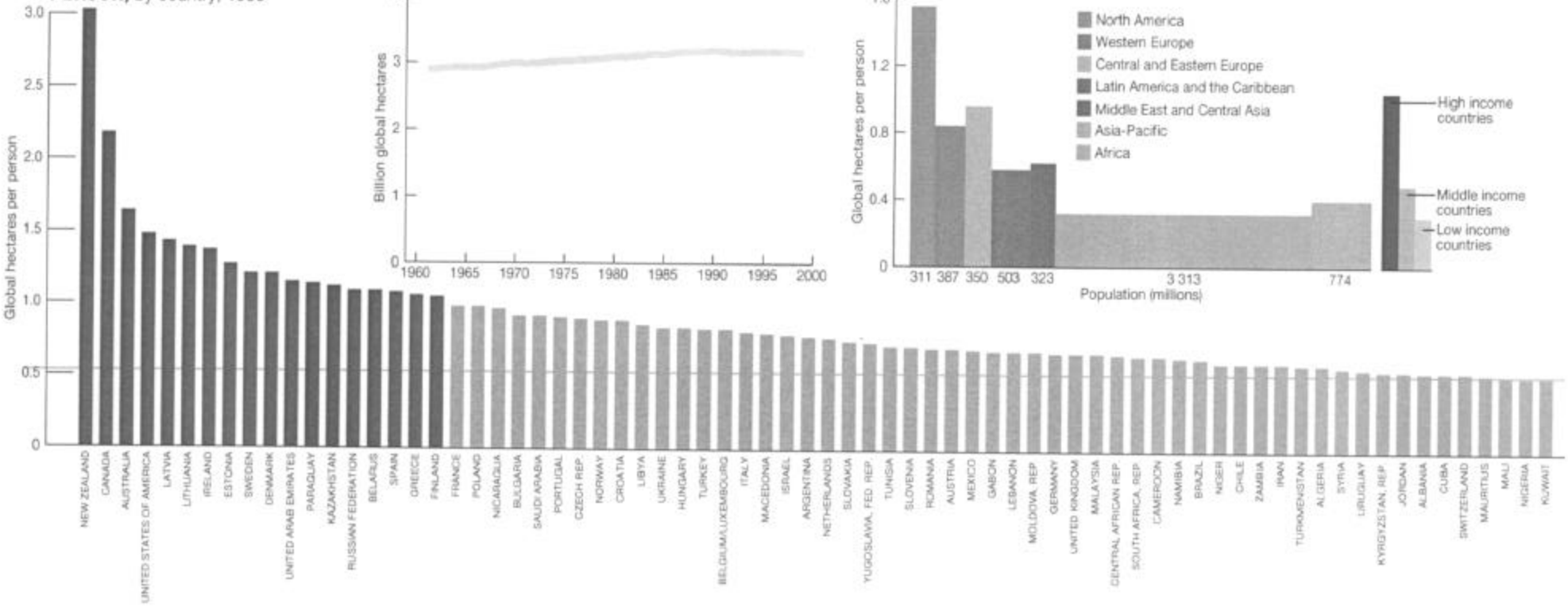


Figure 10:
WORLD CROPLAND FOOTPRINT, 1961–99

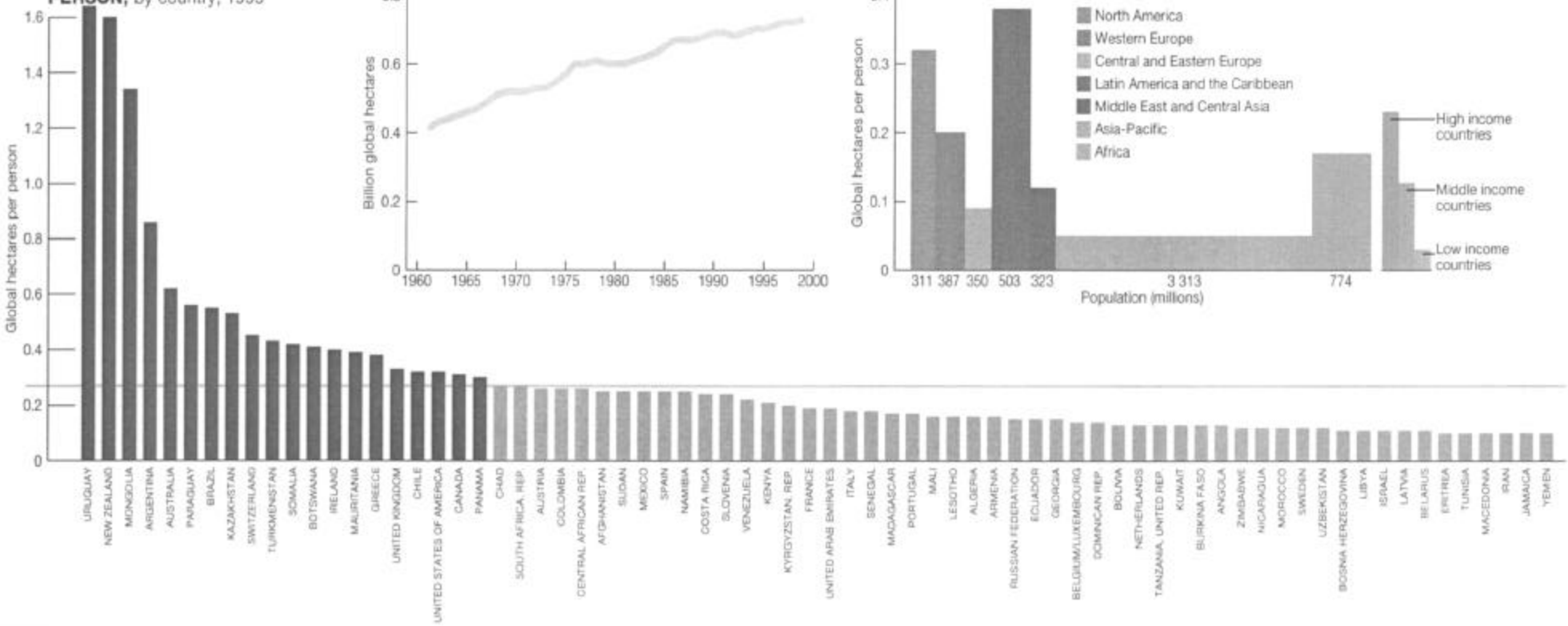
Figure 11:
CROPLAND FOOTPRINT, by region and income group, 1999

(Source: Loh 2002:6)

Note: Figure 10 shows that while the population almost doubled, The world's cropland footprint grew by less than ten percent between 1961 and 1969.

Note: Figure 11 shows that there was a 3.5 fold difference between high and low income countries, per person.

Figure 12:
GRAZING LAND FOOTPRINT PER PERSON, by country, 1999



(Source: Loh 2002:8)

Note: Figure 13 shows that humanity's demand for grazing land increased by 80% between 1961 and 1999.

Figure 13:
WORLD GRAZING LAND FOOTPRINT, 1961–99

Figure 14:
GRAZING LAND FOOTPRINT, by region and income group, 1999

Note: Figure 14 shows that there was an eight-fold disparity between the grazing land foot prints per persons of high income and low income countries in 1999.

Figure 15:
FOREST FOOTPRINT PER PERSON, by country, 1999

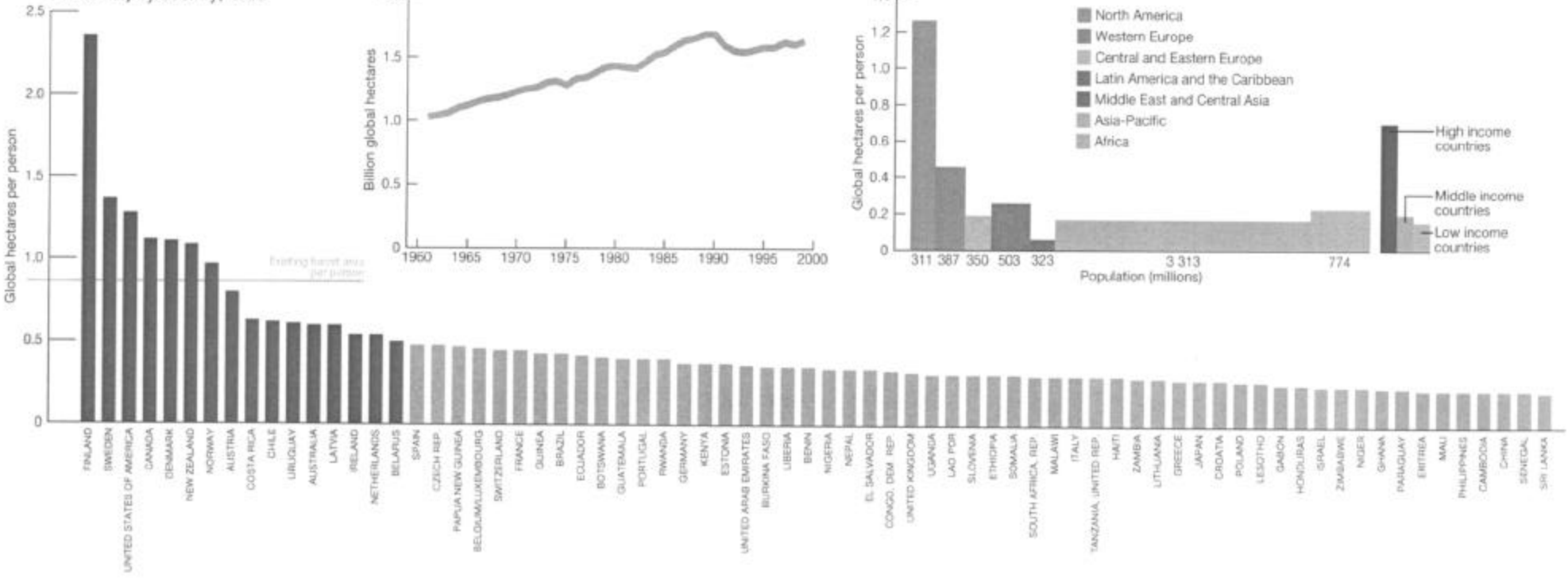


Figure 16:
WORLD FOREST FOOTPRINT, 1961–99

Figure 17:
FOREST FOOTPRINT, by region and income group, 1999

(Source: Loh 2002:10)

Note: Figure 16 shows that the world's forest footprint grew by about 50% the forest between 1961 and 1999.

Note: Figure 17 shows that there was a four-fold gap between footprints per person of high and low income countries.

Figure 18:
FISHING GROUND FOOTPRINT PER PERSON, by country, 1999

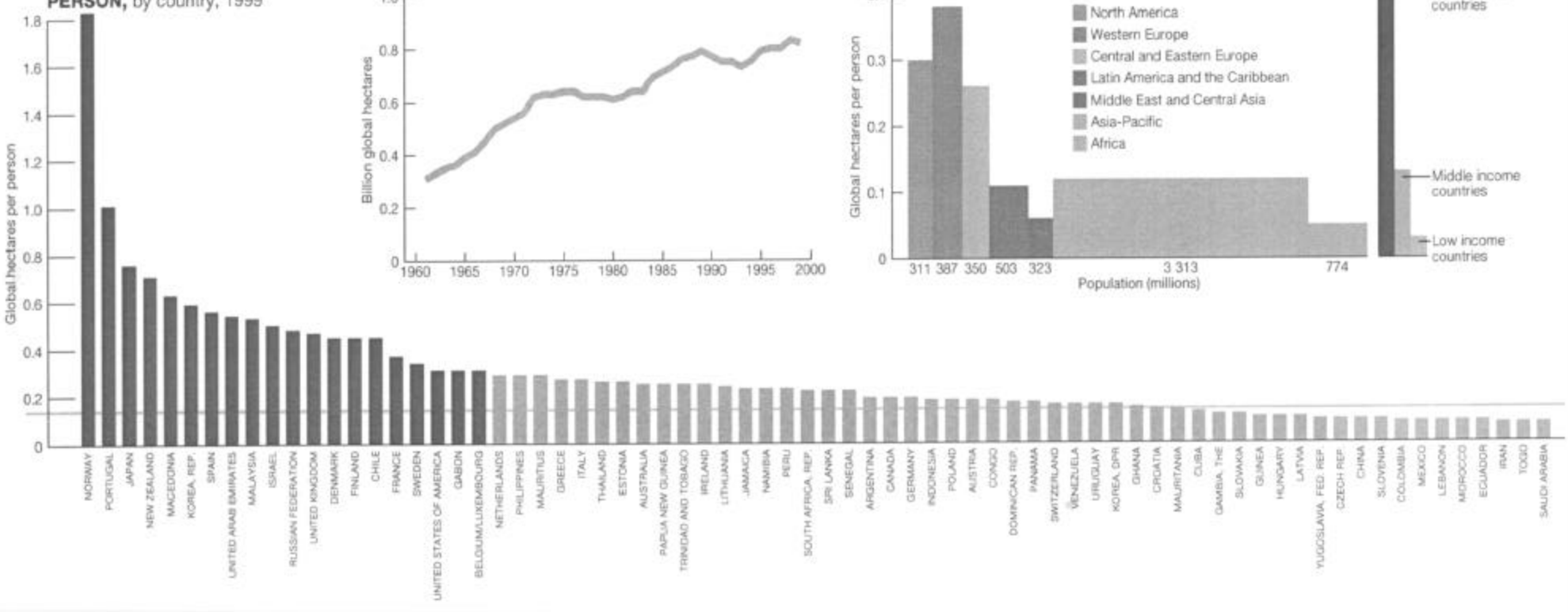


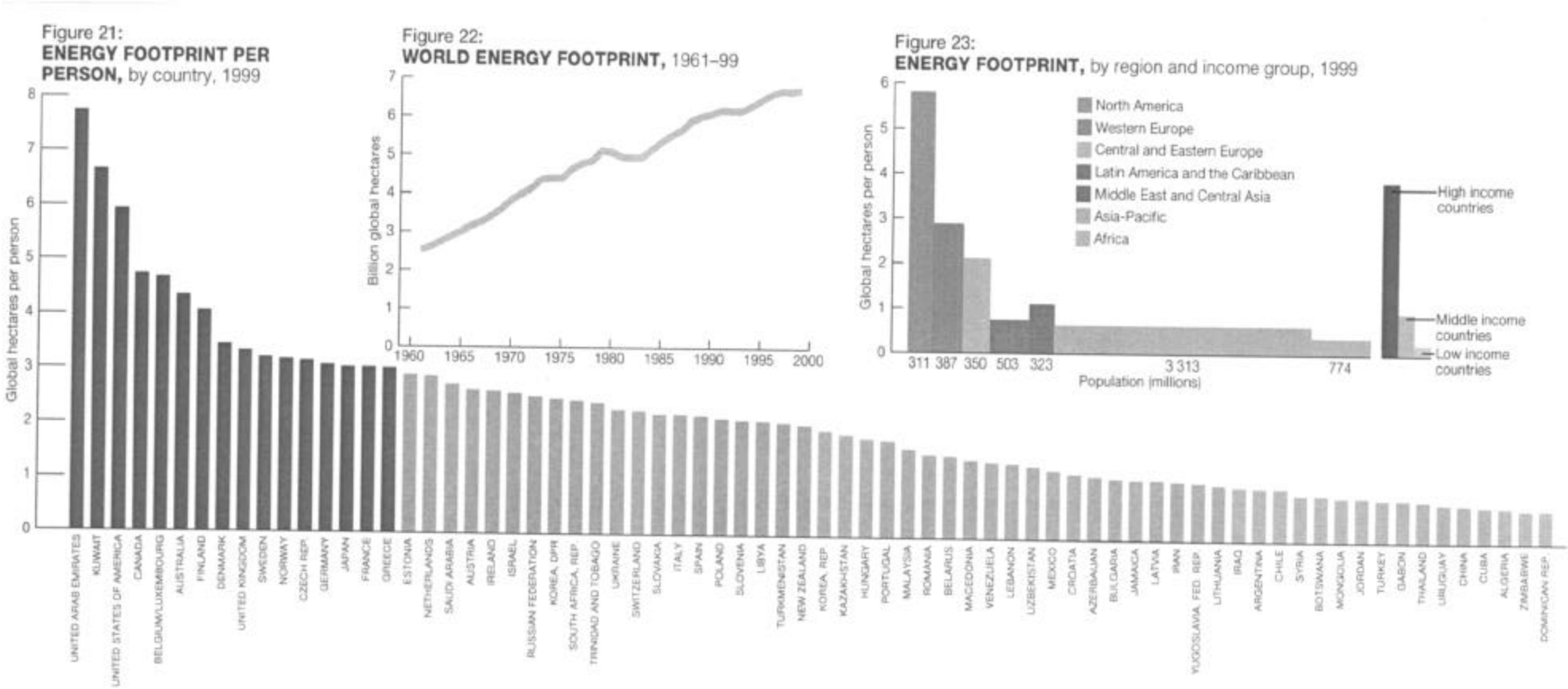
Figure 19:
WORLD FISHING GROUND FOOTPRINT, 1961–99

Figure 20:
FISHING GROUND FOOTPRINT, by region and income group, 1999

(Source: Loh 2002:12)

Note: Figure 19 shows that the global fishing ground footprint grew rapidly, and by 2.6% per year on average, between 1961 and 1999

Note: Figure 20 shows that there was a fourteen-fold difference in fish seafood consumption per person between high and low income countries.



(Source: Loh 2002:14)

Note: Figure 22 shows that the energy footprint increased at an average rate high and of more than 2.6% per year between 1961 and 1999. This was greatest the fastest growing component of the global ecological foot prints between 1961 and 1999.

Note: Figure 23 shows that there was a sixteen-fold difference between low income countries. This footprint per person shows the disparity between rich and poor.

Thus far only global problems have been highlighted and as global and local problems are inextricably linked it becomes necessary to look at the state of South Africa's environmental/poverty link if meaningful change from words into actions is to happen to help save the Earth. An extract from the 1999 National State of the Environment Report, cited in Urquhart and Atkinson (2000:27), the Poverty and Inequality Report of 1998 (Table 3), the Living Planet Report of July 2002 (Table 4) and Yeld's article (2002:14) in which he used the publication, *The Biodiversity of South Africa: Indicators, Trends and Human Impacts* published jointly by the Endangered Wildlife Trust and the Green Trust in July 2002 (Table 5) show that although the democratic government has moved swiftly in changing governance systems in South Africa to create conditions for sustainability to take effect and for more people to participate in decision making in all spheres of life, the state of the environment in South Africa is still far from satisfactory.

Extract from The 1999 National State of the Environment Report

South Africa and Global Warming

"South Africa was responsible for about 1.2% of the total global warming effect in 1990, placing it within the top ten contributing countries in the world. South Africa produces about ten tons of carbon dioxide equivalent per person per year, which is above the global average of about seven tons per person per year. This is about twice as much as other developing countries such as Mexico, Argentina, Zimbabwe and Algeria. The main gases emitted and contributing to the global warming effect from South Africa are carbon dioxide (81%), methane (13%) and nitrous oxide (6%)."

(Source: Urquhart and Atkinson 2000: 27)

SECTOR	BARRIER
Land	History of the country is one of alienation of people from the land. Resettlement policies, complicated land tenure, landlessness, overcrowding and overgrazing and unsustainable agricultural practices have contributed to land degradation.
Water	South Africa is a country of water scarcity. Water provision has been skewed in the past to white commercial, agricultural and residential use. Approximately four million black urban people lack access to clean water. Irrigation is the largest user of water.
Air	Air pollution in the county is enhanced by the atmospheric controls over the country (particularly in winter) and also by large polluting industries and residential coal burning. Health implications include respiratory problems, visual problems, indoor and outdoor pollution, particularly for the poor. In the domestic sector, evidence from rural households revealed that exposure of children to total suspended particles exceeds safety limits. Average maximum hourly levels of gaseous pollutants were found to be above health guidelines during cooking periods, sulphur dioxide was more than ten times the DoH's guidelines and carbon dioxide concentration averaged more than double the WHO standard. An important reason for this is the structure of housing designed for maximum heat retention, with few windows and no chimneys.
Energy	South Africa exhibits great inequities a with regards to energy. The developed sectors of the economy and society have enjoyed cheap commercial energy. Poor rural and urban households generally have lacked access to convenient and affordable energy. Approximately 24 million South Africans live in homes without electricity and an estimated 17 million rely exclusively on fuelwood for cooking and heating. If demand were to remain at constant levels, natural woodland cooking would be entirely denuded by 2020.
Waste	Hazardous wastes estimated to be about 1.9 million tonnes per year. Emissions to the atmosphere comprise about 147 million tonnes annually. Over 1.2 million tonnes of effluent discharged to estuarine, fresh water and marine environments annually. Many of the poor live close to waste sites thus suffer the greatest health consequences.
Mining	Mining impacts on land and water quality. Dewatering of the mines over 40 years has brought about 5000 tonnes of sodium chloride to the surface. Asbestos mining, although localised, if not mined in safe ways is an extremely hazardous substance and can cause asbestosis and lung cancer.

Table 3: Barriers to Sustainable Development
(Source: Poverty and Inequality Report 1998:97)

Footprint	SA's contributing position among 72 countries
Ecological footprint per person	28th
Cropland footprint	53rd
Grazing land footprint	22nd
Forest footprint	48th
Fishing footprint	36th
Energy footprint	25th

Table 4: SA's Footprint Position Amongst 72 Countries with Population of over 1 Million
(Source: Figures 8, 11,14,17,20 and 23)

Living Organisms	Percentage/Number affected
Renosterveld vegetation	95% destroyed
Grassland ecosystem	60 – 80% irreversibly transformed
Mangroves	90% reduced
Fynbos	45 species extinct 20% threatened with some degree of extension
Forest ecosystem (0.56% of SA's land surface)	Reduced by 40% between 1800 and 2000
Coastal Belt Forest in KwaZulu-Natal	Reduced by 65%
Thicket ecosystem of Eastern Cape and KwaZulu-Natal	99% permanently transformed 50% seriously over-grazed by 1981
Plants (23420 – 9% of world's total)	299 critically endangered 483 endangered 1519 vulnerable
Birds (694 – 7% of world's total)	5 critically endangered 11 endangered 42 vulnerable
Mammals (258 – 6% of world's total)	4 critically endangered 9 endangered 27 vulnerable
Reptiles (363 – 5% of world's total)	1 critically endangered 6 endangered 12 vulnerable
Marine Fish (2200 – 15% of world's total)	5 critically endangered 2 endangered 1 vulnerable

Table 5: Current State of Biodiversity in South Africa
(Source: Yeld 2002: 9)

From the tables (3-5) and the extract it can be seen that:

- Barriers need to be overcome and that government and ordinary people have roles to play in delivering solutions to South Africa's many problems.
- South Africa features at varying positions among the 72 countries in its contribution to global issues, many of which are unsustainable. These trends that are unsustainable need to be urgently tackled and transformed into sustainable ones.

- "South Africa has been letting its natural resources decline and with this, arguably also letting go of its best opportunity for alleviating poverty and stimulating vitally-needed economic activity"(Yeld 2002:9).

Programmes from all sectors of life are thus needed to ensure that the declarations of intent of Earth Summits, the Rio Earth Summit (1992), and Johannesburg World Summit (2002) are implemented. However, it must be stressed that the best programmes are only as good as their implementation and it is this that needs to be urgently addressed to ensure that the ecological footprint from the 21st century forward eliminates ecological deficit. This according to Annan cited in Smallhorne (2002:14) and the Living Planet Report (Loh 2002:20) depend amongst other issues on a well-educated citizenry. Promoting education to change the imprudent use of resources by humans that can irreversibly reduce the Earth's finite resource base is a must. For this to materialise, basic living conditions must be met and a functional, well-organised education system with a just and inclusive science curriculum beneficial to saving the Earth must be effectively implemented.

Learning programmes related to recycling of resources from the waste stream, protecting terrestrial, freshwater and marine ecosystems, restoring degraded ecosystems, protecting soil from erosion and degradation caused by intensive agriculture or overgrazing, preserving existing cropland for agriculture rather than urban and industrial development, protecting river basins, wetlands and watershed ecosystems to sustain freshwater and eliminating the use of toxic chemicals that degrade ecosystems functions are some of the issues that fit in very well with the natural science curriculum of C2005. Furthermore, studies have shown that relevant IK can be applicable to address environmental issues mentioned above (Maurial 1999:65; Atte 1992:1-16; McDonald Fleming 1992:69-87; Warren 1991:1-31; Warren 1992:2-3; Parrish 1999:270-275; Easton and Ronald 2000:1-4; George 1999:85; Moran 1999:1-4; Lambert 2001:1-4; van Damme 1999:85-91; Prakash 1999:163,171; Mwadime 1999:254-255; Mosha 1999:214; Quiroz 1999:310). Natural science researchers and teachers can use the educational framework and relevant IK to reduce major trade-offs between environmental sustainability, social justice and economically viability.

If IK is embraced, science teaching can help improve the fragile state of the environment and in doing so help reduce the ecological deficit. Well-planned learning programmes drawn from various sources, including peoples' IK, are thus vital to implement a path to sustainability. This is the challenge facing natural science researchers and teachers.

Forward-thinking approaches using the natural science curriculum to find ways around the environment/poverty link need to be sought to eliminate an ecological deficit and promote a path to sustainability.

1.2.2 RECLAIMING IK IN THE POST APARTHEID SOUTH AFRICAN FRAMEWORK FOR EDUCATION

"Education is an enterprise with a distant time perspective"

Husén 1992: 35

The young learners in school today or those that will enrol in the years ahead are the ones that are going to have their most productive years, decades from now, in a society and an economy that will look rather different (Husén 1992:35). In reflecting on education serving those in the decades from now, it becomes necessary for governments, curriculum developers, policy makers and teachers to adopt a futuristic perspective and work out possible scenarios for effective learning programmes in classrooms. In turn, this implies effective curriculum development and its implementation.

In working out future scenarios for education, one will have to start with a set of assumptions about societal conditions under which education in the future will have to operate. This exercise of envisaging the future is, indeed, a very hazardous one since wrong assumptions can lead governments, planners and policy makers astray. While this may be so, one assumption that research has highlighted and which is detailed in 1.2.1 above, is that the Earth cannot accommodate an infinite number of people and all the physical activities associated with this population.

Recent support for this assumption is a view held by many credible scientists, that a sixth mass extinction in the history of life on earth, this time man made, is now unfolding (Marshall 2002:11) Statistics assembled by Leakey and Lewin (1995:1) regarding the sixth mass extinction show that humankind is using almost half the energy available to sustain life on the planet and that this figure will only grow as population grow.

The African Museum of Natural History (n.d.:1) also mentions that human demand for natural resources will also increase and more and more habitats will be devastated. About 30,000 species is presently being lost per year- “a rate much faster than at any time since the last great extinction 65 million years ago that wiped out most of the dinosaurs” (The African Museum of Natural History n.d.:1)

These statistics point in no uncertain terms to the reality that the growth in global population, resource depletion rates and negative environmental quality will have to level off (Loh 2002:1-29). In turn this implies that basic needs should be met and education presently and in the future must emphasise, through its various learning programmes, the need for humans to follow a path to sustainability.

South Africa’s commitment in the education sector to address a path to sustainability is clearly outlined in The White Paper on Education and Training (1995:18) and Implementation Plans for Tirisano (2000:7). The substitution of its apartheid curriculum with C2005 with an outcome based approach and telescoping of separate subjects into eight learning areas and outcomes intends to shift South Africa from an education system where the majority of its population received substandard education to a modern, representative system founded on fundamental values of fairness and equity.

The framework of C2005, detailed in Chapter Two, unlike the curricula of the apartheid era provides teachers with more flexibility to become curriculum developers and develop learning programmes to suit the learners’ context. This major change will demand very significant changes in pedagogy and from the professional practice of teachers (Taylor 2001:113).

The learning programmes selected must benefit the learners presently and after they leave school. This inevitably spells effective participation between teachers and many stakeholders, especially community members, to drive C2005. Teachers and communities will have to make choices from amongst sets of alternatives and possibilities (Spady 1994:56). What gets selected may therefore be influenced by peoples' knowledge, including IK, and would reflect the preferences of those involved in the process. In this way the type of learning programmes the community values over other types, often based on their beliefs and assumptions for learners and society at large will be derived (Spady 1994:56). Whilst this provides ample opportunity to provide quality education leading educationalists (Jansen 1997:20; Meerkotter 2001:54; Khan 2001:88) and the Report of the Review Committee on C2005 (2000:18-21) have questioned its functionality in the present context: an educational system with excellent policies lacking the capacity to implement them. This has heralded research into the use of IK when developing learning programmes in the senior phase natural science curriculum.

1.2.3 THE DESIRE TO PREVENT THE RAPID LOSS OF IK

"…*When an elder dies in Africa, it is a library that burns…"*

Amandou Hampate Ba cited in Brock-Utne (2002:239)

"…the truth is even more tragic, however. For in the event of a library burning, other copies of the books lost may be found, and another library set up…"

"…it can be said that an elder's death is the equivalent of the burning of a unique and living manuscript. Day by day, such living manuscripts pass away …"

Brock-Utne (2002:239)

Two focussed studies conducted by the researcher for a project, titled, *Beginning local community empowerment through*

community development and environmental education (Loubser 2000) that was jointly funded by the NRF and the University of South Africa in the Province of KwaZulu-Natal in 1998 and 2000 and personal communications with the chairman of the !Xun and Khwe Communal Property Association on 7th August 2002 at the Wildebeest Kuil Rock Art Centre in Kimberley and with an intermediate science teacher from the !Xunkhwesa Combined School in Northern Cape on 8th August 2002 showed that:

- IK exists in small pockets in rural communities.
- The “bank” of IK lies with a few old people.
- The transmission of IK to the learners at school is not being adequately addressed by many of their parents and the school.

The first study was conduced with an Indian community in New Glasgow, a rural area that is located about 12 kilometres from the town of Verulam, which is about 30 kilometres from Durban. The selected area is situated North of the Umdhloti River. The Hazelmere Dam is situated in close proximity.

The pioneer Indian settlers were labourers in the sugar cane fields. Later generations were market gardeners. Vegetables and fruit were grown on smallholdings for many years. The luxurious growth maintained in this area serviced the villagers and other towns. IK associated with agriculture, handed down to the farmers by their forefathers from India was extensively used.

The population of the New Glasgow area that was once densely populated by Indian farmers is today drastically reduced. This reduction is mainly attributed to the improvement in the socio-economic conditions of the next generations. The urban life in comparison with rural life offers better facilities and higher status to their children, many of whom are professionals.

At the time of the research the population was about 100 people. About 12 tin/block buildings were scattered in the area. Many of these households consisted of only elderly people. The absence of the extended family set up, characteristic of Indian families of the past few decades was very noticeable in many of these 12 households. About 75% of this population at the time of the research were employed in other types of jobs besides agriculture. Although 75% held other jobs, all households were actively engaged in subsistence farming.

Personal communications with men in this community revealed that only a little IK of their forefathers is being implemented, mainly because of the changing environmental factors and the need to compete with large commercial farmers. Many of them also complained about the apathy of learners towards IK and farming. An old man, actively engaged in farming had this to say about the children of today:

"*Today's children do not want to farm. They are ashamed of being farmers. They don't listen when you talk to them about farming. They all want city jobs. I blame the schools and their mothers and fathers for this. In our days we learned gardening at school every day for about 1 hour in the afternoons. We dug the soil, added cow dung and compost to the soil and planted vegetables at school. After school we worked till late with our fathers in our own gardens. They taught us lots things. Schools today don't teach the children anything about farming. The teachers also don't know much. Today children are spoilt. Their parents make them sit on their heads. After school they watch TV and listen to loud music. I keep telling them that one day they will suffer because food is so expensive now. Everything is changing. The soil is not good. The food and the water taste different. The rains don't come in time. We don't have enough water and it is too hot now and many insects are damaging our crops. They laugh at me"*

(Anonymous personal communication)

The second research project was undertaken in the Hoffontal area in Bergville. Bergville is about 250 kilometres from Durban and about 45 kilometres from the Drakensberg Mountains. Hoffontal is about 45 km from Bergville. The main source of water in this area is from the Tugela River. The Woodstock Dam is in close proximity to the selected area.

The populace of Hoffontal is predominantly Zulu. Most of the men, except the elderly, spend most of the year working in the city. The Zulu women, who live very much the same way as they did for centuries, educate and feed their families in a very demanding environment. The women undertake strenuous manual labour growing crops to sustain their families. Even the tending of livestock, traditionally a male occupation, is the women's responsibility, in the absence of their men. The area has no electricity and no running water. Firewood and water have to be carried for kilometres.

The Zulus in this area still rely on nature for food and survival. IK used in the preparation of food, treatments administrated to sick animals, storage and selection of seeds, post harvest management of maize, ways of enriching the soil with kraal manure and natural pest control is still practised in this rural area. Their forefathers handed this expertise to them. This, however, is not filtering at a very rapid pace to the learners at school. Many elders expressed concern about this loss of IK. The modern way of life has a greater appeal than the traditional one. The slow rate of transmission of IK is mainly attributed to "time poverty". Personal communication via an interpreter with an elderly woman encapsulates the meaning of "time poverty ".

"We struggle to get food, clean water and firewood. The women spend longer time in the fields and have to walk for hours before they find firewood. There are few trees now. The boys cannot find grass for the cows. Collecting water these days also takes longer. The river is dirty and water has to be carried up the steep banks. By the evening all of us are very tired and we do not have time to tell our children about everything we did in our days. During the day the children are at school and at school they do not learn anything about our ways. They learn about our ways while they work with us. They have to learn this to survive. But there is not enough time these days. Everything takes longer and everything is still not enough"

(Anonymous personal communication)

Further invaluable information about IK with special reference to the present lifestyles of the !Xun and the Khwe clans was

obtained from the intermediate science teacher from the !Xunkhwesa Combined School at Barkley West. Barkley West is situated about 40 kilometres from Kimberley. The school, !Xunkchwesa Combined, is located in Schmidtsdrift which is about 100 from Kimberley. Learners that attend this school belong to two clans: the !Xun and the Khwe. Verbal communication is the main barrier amongst these learners. Obtaining responses from these learners, especially the girls, is difficult. Words are seldom uttered. The main form of communication between teacher and learners and among learners for most part of the school day is sign language. Communicating on a one to one basis at times is effective. The girls are very intimidated by the presence of the boys and are extremely reluctant to communicate to the teacher. In spite of these barriers, the teacher persevered and was able to obtain some of their IK concerning the use of a plant commonly called “Katola”. This plant is indigenous to Angola. Its sour leaves are eaten to remedy digestive problems.

Two other, undisclosed plants are used as “Vicks” and glycerine by these clans. Most of their knowledge is not disclosed to the public, thereby retaining their intellectual property. What was interesting was the disclosure that the !Xun and the Khwe IK show a gender bias. Lifestyles associated with hunting, herding, tool-making are the prerogative of the male. Females display very little or no knowledge of these lifestyles. Gathering veldkos, farming, cooking, and caring for the young are tasks associated with females. Both sexes, however, display excellent skill depicting their lifestyles through paintings. Unfortunately some lifestyles such as gathering of veldkos are becoming scarce due to the fragile state of their environment. Food purchased from shops and “decaying plant and animal matter” are common food sources today (Anonymous personal communication).

Ascertaining anything from the learners is a very serious barrier because some outsiders, unfortunately, have not been too sensitive to the intellectual rights of the clans (Anonymous personal communication). Although this persists, initiatives to preserve their IK and translate some of them into small businesses have proven successful. The !Xun and Khwe San art and crafts at the Wildebeest Kuil Rock Art Centre bears testimony to the elders' determination to perpetuate IK amongst the youth. Wildebeeste Kuil has directly created 14 new and permanent jobs for people who were previously unemployed. Dozens of other families have also gained a sizeable additional income from the production of craft to sell in the Wildebeest Kuil shop (Smith 2002).

Clearly evident from these two studies and personal communications are the following:

- The elder community members' awareness that their natural resource base is in their environment, and with its demise, some of their IK is diminishing at a rapid rate.

- The insignificant role that the school plays in transmitting some of their IK.

While the communities are changing to allow people to adapt to new influences and developments, elders by and large are concerned about the loss of IK. They feel strongly about transmitting this valuable knowledge to the present and future generations as a survival measure (Anonymous personal communication).

The research studies and personal communications show that culture and tradition continue to have a strong hold on these rural communities and even the liberated individuals find themselves hard pressed to show a total disregard for their

heritage. Against this backdrop, the framework of the senior phase natural science curriculum in C2005 offers teachers opportunities, with the help of the elder members of a community and other appropriate, professionals such as environmental officers, heritage and conservation workers to incorporate IK into their learning programmes.

Tapping into traditional wisdom and transmitting some of this IK through the senior phase natural science curriculum will involve drawing up and implementing learning programmes through a partnership between community members, science teachers and other professionals. The community brings knowledge of significance, meanings of the actions and a wealth of knowledge as to how these actions helped them survive and protect their resources. The professionals bring broad experiences of practices that have worked effectively in other places and complex technical scientific skills that can help conserve their IK. The science teacher creates the forum to transmit the invaluable knowledge. To get this to work in practice is however a challenging, fine balance act in which issues and concerns of all parties involved are made explicit and compromises reached and effected. The senior phase natural science curriculum, offers in my view, this unique opportunity to empower the learners at school, and in doing so, help eliminate the Earth's ecological deficit and prevent the rapid erosion of IK. Furthermore, it will allow for the conceptualisation of a just and inclusive science education.

1.3 BACKGROUND TO THE PROBLEM

The introduction and the factors affecting this research highlight the Earth's fragile state and the call for urgent, corrective actions by everyone to avert a disaster in the making. C2005 with an outcomes based education system is seen as an effective means for addressing environmental issues using IK to pave a path to sustainability and to

provide a just and inclusive science education. Its implementation, however, has been and still is problematic to many teachers. It seems as if the current reality is far removed from the vision of the policy makers. Many teachers are struggling to implement the practicalities of the new education system. The prevalent approach to education is often still one of rote learning where the learners rely on the teacher as processor and interpreter of all knowledge. The main problem seems to be that teachers struggle to interpret the guidelines outlined in C2005, select content for learning programmes and teach towards the attainment of the predetermined outcomes of the system. Many find it extremely difficult to deviate from standard textbooks. Finding suitable topics that would amongst others relate to learners' experiences and be relevant to the learners seems to be beyond the capabilities of many teachers. There are valid reasons for this such as:

- South Africa is still recovering from the debilitating apartheid education system (Joosten 2001:94).

- Great disparities in the socio-economic context in which schooling takes place persist (Meerkotter 2001:57; Report of Review Committee 2000:73).

- 22% of teachers are un(der)qualified and 80% of these are in rural primary schools (Beard and Shindler 2001:138).

- The morale amongst many teachers is low (Bisseker 2001:15; Beard and Shindler 2001:138).

- The teacher training for implementing C2005 is insufficient (Report of the Review Committee on C2005 2000:57).

- The curricula to meet the diverse needs of the South African education system are complex. (Report of the Review Committee on C2005 2000:46).

- Insufficient time for the publication of new textbooks, learner support materials and teaching aids (Report of the Review Committee on C2005 2000: 69).

- Historically disadvantaged schools do not have the resources: reference and textbooks, stationery, paper, photocopying, facilities and other kinds of technology to implement C2005 effectively (Report of the Review Committee on C2005 2000:73).
- The programme of rationalisation and redeployment and the acceptance of the voluntary severance packages taken by many competent, experienced teachers (Nxesi 1997: 33; Report of the Review Committee on C2005 2000:26).

- The closure of colleges of education and mergers in higher education (Jansen 2001:26; Beard and Shindler 2001:144).

- The shortage of quality teachers (Maughan-Brown 2001:38; Horne 2001:40; Khan 2001:88).

To sum up, effective implementation of C2005 amongst other factors hinges upon highly competent teachers (Jansen 1997:20; Maughan-Brown 2001:36; Khan 2001:88) which South Africa desperately needs. Maughan-Brown (2001:38) puts it across aptly by stating that “there is a desperate need for this country to produce quality teachers by the thousand, not by the hundred”.

One of the learning areas where teachers are under- trained to display “sophisticated curricular, pedagogical and assessment skill” (Jansen 1997:20) is in the natural sciences. Khan (2001:88) expresses similar sentiments. He states: “The problem is that even in the private schools, it is becoming increasingly difficult to find quality science education. Teachers of science and mathematics can now command a premium,

indicating how acute the national and indeed, the international shortage of these personnel are" (Khan 2001:88).

Table 6 shows the percentage of un(der)qualified teachers in the country from a high in North West Province to a low in Gauteng and Western Cape and Table 7 shows the non-personnel monetary allocations to the poorest and least poorest 20% of learners (rand).

Province	% Un(der) qualified
Eastern Cape	26%
Free State	25%
Gauteng	11%
KwaZulu-Natal	24%
Mpumalanga	18%
North West	39%
Northern Cape	21%
Northern Province	21%
Western Cape	11%
Average	**22%**

Table 6: Percentage of Un(der) Qualified Teachers, 2000
(Source: Beard and Shindler 2001:138)

Province	Non-personnel allocations per poorest 20% of learners (rand)	Non-personnel allocations per "least" poorest 20% of learners (rand)
Eastern Cape*	223	223
Free State	193	114
Gauteng	342	40
KwaZulu-Natal	127	20
Mpumalanga	222	32
Northern Cape	396	119
Northern Province*	155	155
North West	175	25
Western Cape	187	36

Table 7: Non-Personnel Allocations to the Poorest and Least Poorest 20% of Learners (Rand)
(Source: Beard and Shindler 2001: 135)

* Note: The Eastern Cape and Northern Province did not use the resource targeting cable and thus the average expenditure was used

Seen from the number of un(der)qualified teachers from Table 6 and the disparity between provinces concerning non-personnel monetary allocations (textbooks, materials, equipment and teacher support programmes as well as capital expenditure on classroom building, water and sanitation in schools and school furniture) from Table 7, schools especially rural schools in South Africa have a serious problem: teachers do not have sound pre-service training in the natural sciences.

Personal communications with community members in the New Glasgow and Hoffantal areas, the chairman of the !Xun and Khwe Communal Property Association and the intermediate science teacher from the !Xunkhwesa Combined School also indicate that rural communities are experiencing problems with the utilization of natural resources and are living in non-sustainable ways. The elders, however, claim to have IK that could benefit science education. As a result of this claim, communities have demands for quality education and also for what they want their children to achieve. This implies that teachers are thus compelled to incorporate IK related to environmental issues in their classroom science teaching. C2005 makes provision for this. The contribution of education towards the realization of the demands of communities especially rural ones thus needs to be addressed.

1.4 THE MAIN PROBLEM

The main problem of this research is that teachers are not able to draw content from their community, to design relevant learning programmes with specific reference to the natural sciences and to follow a path of sustainability. Learners are therefore not able to achieve the prescribed learning area outcomes of the outcome based education system of C2005.

1.5 THE SUB-PROBLEMS

The following sub-problems relate to the main problem:

- Teachers are not able to visualise how they should teach IK and where it is referenced and relevant to in the natural science curriculum.

- A lack of communication between community members and science teachers as to what content should be included in learning programmes for the benefit of the community.

1.6 AIMS OF THE RESEARCH

The aims of the research study are:

- To promote effective participation in local Agenda 21 initiatives.

- To promote the use of IK in the teaching and learning of science.

- To access IK that sustains communities.

- To build capacity in natural science teachers at schools, to draw on communities' resources and services and blend IK and Western knowledge (WK), through the flexible senior phase natural science curriculum, into learning programmes to respond to the needs of the community and the learners.

- To promote, through participatory interaction, among natural science teachers from schools, other professionals, learners and community members from communities, an ethos that would reflect inclusiveness that would support a culture of teaching and learning and effective community relations and ownership.

- To empower learners to act on environmental issues and develop an environmental ethic to enable them to be part of a world wide movement to protect and maintain the Earth's natural resources.

- To enable learners to leave the education system with some knowledge, competence and values needed to follow a path to sustainability.

1.7 RESOURCES USED IN THE RESEARCH STUDY

Materials used in this study came from the sources listed below:

- Published materials (books, journal articles, reports).

- Unpublished dissertations and thesis.

- Government Policy documents.

- Papers presented at conferences and symposiums.

- Information supplied by community members.

- Information supplied by interviewees.

1.8 ASSUMPTIONS AND LIMITATIONS OF THE STUDY

1.8.1 ASSUMPTIONS

The community members and interviewees responded without bias or prejudice during interviews. In this regard, an explanation was afforded why the information was thus collected.

The interviewees are representative of all persons well-versed in IK and about science teaching in South African schools. In

selecting the interviewees, provision was made for incorporating South Africans and non-South Africans. It is assumed, therefore, that the sample used in this research is a good approximation of the total population of individuals well versed in IK.

1.8.2 LIMITATIONS

The results of this study were based on the responses of community members and the interviewees. Although the findings may be true for the teaching of natural science, they cannot be extended to other disciplines of science with any degree of confidence and conviction.

The findings of this study cannot be extended to the teaching of natural science in all schools in South Africa. How communities and teachers react to the inclusion of IK in their learning programmes varies widely in the different schools from province to province. Competence, training of teachers, methods of teaching, and methods of assessment also varies.

The recommendations made in this study are largely theoretical. Theoretical implications of recommendations to “real” situations require teachers to think in new, synergistic ways. What they do in classrooms has far-reaching implications for saving the resource base of the Earth, preventing further erosion of IK, for revising C2005, for social welfare, the country’s economy, and the quality of life within and outside the school.

1.9 THE STUDY PROGRAMME

The programme followed in this research study is as follows:

- Chapter One - Introduction; factors leading to the study; background to the problem; the main problem; sub-problems; the hypothesis; the aims of the research.

- Chapter Two - The South African Curriculum for the 21st Century: Structure and design, the advantages and disadvantages of the curriculum, and the promises and realities of the curriculum in the present educational context.
- Chapter Three – Indigenous knowledge: The definition and ways of seeing its inclusion in Revised National Curriculum Statement Grades R - 9 (Schools) Policy.

- Chapter Four – The research method: qualitative research using a semi-structured interview approach.

- Chapter Five – Main findings of the research and analysis thereof.

- Chapter Six – Summary of main findings, recommendations and implications.

CHAPTER TWO

CURRICULUM 2005 AS A REFORM STRATEGY: ITS PROMISES AND ITS REALITIES

2.1. INTRODUCTION

In South Africa, the last decade of the 20th century will probably always be associated with massive changes targeting the break down of its apartheid system and attempting to replace it with a new system that promises well-being, respect and expression for all South Africans. Central to this challenge is the transformation of the apartheid era education and training system. Why educational change is needed in South Africa has been well documented (RDP 1994:58-59; White Paper on Education and Training March 1995; Report on Review Committee on C2005 2000:1 and 8). In short, change is cited as being imperative for a dual purpose. Firstly, for ensuring that all South Africans have the knowledge, values, skills, creativity and critical thinking skills required to build democracy, development, equity, cultural pride, and social justice and secondly for establishing a system of life-long learning that will develop the knowledge, skills and competencies required to facilitate innovation, social development and economic growth in the 21st century (Ministry of Education: 2000:9).

The discussion that follows aims to look at the curriculum process, the design of the new curriculum (C2005), models that can be aligned to C2005, demands C2005 places on administrators and teachers implementing it, the place where indigenous knowledge in learning programmes can stimulate a more creative approach to teaching and

learning so that knowledge, skills, attitudes, values and outcomes can be attained and demonstrated within specific contexts, criticisms of C2005, recommendations for streamlining and strengthening C2005, the Revised National Curriculum Statement Grades R-9 (Schools) Policy and criticisms and strengths of the revised curriculum.

2.2 THE NATIONAL QUALIFICATION FRAMEWORK AND THE SOUTH AFRICAN QUALIFICATION AUTHORITY

One of the most commonly cited educational challenges of the 21st Century is the need for an education system that facilitates a process of life-long learning (White Paper on Education and Training 1995: 21). In addition, to providing life-long learning, the provision of high quality education is also demanded.

To realise these needs an integrated approach to Education and Training and a systematic approach to the development of quality assurance had to be established (DoE 1995:10-12). In 1995, the South African Qualification Authority Act was passed into law, and in 1996, the South African Qualification Authority (SAQA) was established to oversee the establishment of the National Qualification Framework (NQF). The role of SAQA is to establish standards, quality assurance systems and management information systems to support the accessibility and quality of learning within the NQF (Ministry of Education 2000: 29-39).

In looking for possible ways to develop the framework for the NQF, the Committee for Development Work on the NQF turned to the guiding principles set out in Ways of Seeing (Human Sciences Research Council 1995:11) that are shown in an adapted form in Box 1.

	The framework must:
Integration	establish the basis for an integrated approach to education and training as part of a human resources development policy aimed at integrating the theory with the practice, and the academic with the vocational.
Relevance	be, and remain responsive to national economic, social and political development needs.
Credibility	have national and international value and acceptance.
Coherence	work within a consistent framework of principles and certification which allows learners to clearly link credits into a meaningful learning or career pathway.
Flexibility	allow for multiple pathways leading to the same learning ends.
Quality	be expressed in terms of nationality agreed outcomes and performance/assessment criteria, thus facilitating both monitoring and provisioning.
Legitimacy	provide for the participation of all national stakeholders in the planning and co-ordination of standards and qualifications.
Access	provide ease of entry to appropriate levels of education and training for all prospective learners in a manner which facilitates progression.
Progression	ensure that the framework of qualifications permits individuals to move through the levels by accumulating appropriate combinations of credits.
Portability	enable learners to transfer their credits from one context to another.
Articulation	provide for learners, on successful completion on accredited prerequisites, to move between components of the delivery system.
Recognition of	through assessment, give credit to learning which has already been acquired
Prior Learning	in non-formal ways, such as through life/work experience.
Guidance of Learners	provide for counselling of learners by specially trained individuals who meet nationally recognised standards for education, training and development practitioners.
Democratic Participation	provide for the active participation of practitioners in the relevant field in the writing of unit standards and in their regular revision.

Box 1: Guiding Principles for C2005
(Source: Human Sciences Research Council 1995:11)

This committee recommended that South Africa adopt an eight level framework with three identified bands. SAQA adopted this eight level framework, with level 1 and below being grouped as the General Education and Training band, levels 2 to 4 as the Further Education and Training band and levels 5 to 8 as being the Higher Education and Training band. Level 1 also accommodates four Adult Basic Education and Training Certificates (ABET levels 1-4). Table 8 depicts the three bands of the NQF, its levels, school grades where applicable and the types of qualification and certificates envisaged in education and training.

NQF LEVEL	BAND	TYPES OF QUALIFICATIONS AND CERTIFICATES	
8	Higher Education and Training Band	Doctorates Further Research Degrees	
7		Higher Degrees Professional Qualifications	
6		First Degrees Higher Diplomas	
5		Diplomas Occupational Certificates	
FURTHER EDUCATION AND TRAINING CERTIFICATES			
4	Further Education and Training Band	Schools/College/Training Certificates Mix of units from all\ (NGOs)	
3		Schools/College/Training Certificates Mix of units from all\ (NGOs)	
2		Schools/College/Training Certificates Mix of units from all\ (NGOs)	
1= GENERAL EDUCATION AND TRAINING CERTIFICATES = 4			
	General Education and Training Band	Senior Phase	ABET Level 4
		Intermediate Phase	ABET Level 3
		Foundation Phase	ABET Level 2

		Pre-School	ABET Level 1

Table 8: The Eight Level Framework of the NQF
(Source: DoE 1997:9)

The objectives of the NQF as outlined in the SAQA Act of 1995 cited in Ministry of Education (2000:30) are to:

- Create an integrated and truly national approach to education and training.
- Facilitate access to, and mobility and progression within education, training and career paths.
- Enhance the quality of education and training.
- Accelerate the redress of past unfair discrimination in education, training and employment opportunities.
- Contribute to the full personal development of each learner and the social and economic development of the nation at large.

Attainment of the above mentioned objectives of the NQF required predetermined and accepted national outcomes to be determined and adhered to. To meet this requirement SAQA after much consultation identified the eight critical cross-field outcomes with an additional five outcomes which support development, (Box 2) upon which the development of the new curriculum had to be based.

Critical Cross-Field Outcomes
• *Identify and solve problems and make decisions using critical and creative thinking.* • *Work effectively with others as members of a team, group, organisation and community.* • *Organise and manage themselves and their activities responsibly and effectively.* • *Collect, analyse, organise and critically evaluate information.* • *Communicate effectively using visual, symbolic and/or language skills in various modes.* • *Use Science and Technology effectively and critically showing responsibility towards the environment and the health of others.* • *Demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.*
Developmental Outcomes
• *Reflect on and explore a variety of strategies to learn more effectively.*

- *Participate as responsible citizens in the life of local, national, and global communities.*
- *Be culturally and aesthetically sensitive across a range of social contexts.*
- *Explore education and career opportunities.*
- *Develop entrepreneurial opportunities*

Box 2: Critical Cross-Field and Developmental Outcomes
(Source: DoE 1997:15)

2.3 CURRICULUM PROCESS AND ITS DESIGN FEATURES

A paradigm shift to allow South Africans address the dual purpose of education (to overcome the past inequalities and to prepare for global competitiveness), implied much more than just making education accessible for all. Memorising facts becomes secondary to the ability to locate, synthesise and analyse emerging and new sources of information. Rote memorisation becomes secondary to the application of the skills of literacy and numeracy, creativity, conceptual and lateral thinking and critical engagement. Individual competencies become secondary to the ability to work in groups (Ministry of Education: 2000:27). “Skills of life” (Ministry of Education: 2000:27) become the central aspect in the new curriculum framework with the purpose of seeking to change the pedagogy of the apartheid era education and training system and in the process amongst others:

- Integrate education and training and promote life-long learning.

- Be based on outcomes rather than content.

- Equip all learners with knowledge, competencies and orientations needed to be successful after completing their formal school studies.

- Encompass a culture of human rights, multi-lingualism, multi-culturalism and sensitivity to the values of reconciliation and nation building.

- Aim at producing thinking, competent future citizens (Dreyer 2000:3).

The curriculum process began by education decision makers drawing from a variety of ideas from the international arena and “reshaping” them to fit South Africa. Curriculum writers worldwide, generally agree that the conceptualisation of a curriculum originates and draws philosophically from the same source/s that gave rise to the purpose of education (Sowell 2000:41). Against this backdrop framing the new curriculum meant aligning it with principles and sources that gave rise to the White Paper of Education and Training dated March 1995. The conceptualisation of the new curriculum was therefore informed throughout by principles derived from the White Paper on Education and Training dated March 1995 and by three sources viz. an integrated and non-disciplinary division of knowledge, learner-centred education and outcome based education (OBE).

An integrated and non-disciplinary approach aims to cut across an entire domain of knowledge to provide an integrated view of subject matter (Goodland and Su cited in Sowell 2000:58). Generally, using this approach is considered advantageous because the emphasis is on problem-solving processes and social-human skills rather than just acquiring content (Sowell 2000:58). Subject matter designs that present knowledge in a fragmented manner and out of the context of the learners’ worlds are viewed as being easily forgotten since learners’ abilities, needs, interests and past experiences are ignored. Learning content from a subject matter point of view is hence considered different from how learners learn information naturally (Sowell 2000:59). This rationale, the debates in the early 1990s around the proper relation between education and training, a specifically curricular initiative called “integrated studies in the 1980s presents, the view that schooling is a preparation for life and work and the curriculum framework which proposed seven learning areas produced in 1994 under the former government influenced the Council of Education Ministers in selecting broad areas of related knowledge called learning areas (Box 3). These learning areas underpin the aim of adopting an integrated and non-disciplinary division of knowledge in C2005.

Learning Areas
• Language, Literacy and Communication • Mathematical Literacy, Mathematics and Mathematical Sciences • Human and Social Sciences • Natural sciences • Technology • Arts and Culture • Economic and Management Sciences • Life Orientation

Box 3: The Eight Learning Areas of C2005
(Source: DoE 1997:27)

FOUNDATION PHASE			
LLC	MLMMS	Life Skills	Flexible Time
25%	25%	25%	25%

INTERMEDIATE PHASE			
LLC	MLMMS	Natural sciences and Technology	Arts and Culture and Life Skills Orientation
35%	15%	15%	15%

SENIOR PHASE *							
LLC	MLMMS	Natural sciences	Technology	HSS	EMS	Arts and Culture	Life Orientation
20%	13%	12%	10%	10%	10%	10%	10%

* Flexible Time 5%
Table 9: Guidelines for the Weighting of Learning Programmes in C2005
(Source: Report of Review Committee on C2005 2000:36)

These eight learning areas are combined in the different phases into learning programmes. There are three learning programmes in the foundation phase, five in the intermediate phase and eight in the senior phase of the General Training and Education (GET) band. “Notional time” to guide the relative weighting of learning programmes within a phase was also suggested (Table 9).

Learner centred teaching associated with progressive education and nurtured in the liberal universities and English medium private schools impacted greatly in the 1980s on People’s Education that was

presented as an alternative to “apartheid education”. Some of the encompassed principles such as an egalitarian political mission; an anti-rote learning, critical thinking thrust; a learner-centred approach to teaching; teachers as curriculum developers; group work rather than directive teaching and community participation remained crucial principles in successive versions of curriculum policy development and “competency-based” education which changed into outcome-based education in the 1990s, become central to C2005 (Report of Review Committee on C2005 2000:29; Ministry of Education: South Africa 2000:27).

OBE is a learner-centred, result-orientated design founded on the belief that all individuals can learn and achieve certain results. This approach is summed up by Spady (1992:7) when he defines “outcomes” and “based” as follows:

An *outcome* is “a culminating demonstration of the entire range of learning experiences and capabilities that underlie it, and it occurs in a performed context that directly influences what it is and how it is carried out. These defining elements clearly tell us that an outcome is not simply the name of the learning content, or the name of a concept, or the name of a competence, or grade or test score, but an actual demonstration in an authentic context”.

Based means “to define, direct, derive, determine, focus and organise what we are doing according to the substance and the nature of the learning result that we want to happen at the end of the learning process”.

In other words, in outcomes based education, curriculum developers work “back from the end” or as often cited “design down from where you want to end up” (DoE 1995:24).

Intended outputs (outcomes) as opposed to the inputs of traditional curriculum-driven education and training are its starting point. This

strategy for outcomes-based education therefore implied among others that what learners are to learn (outcomes) in each of the eight learning areas must be clearly identified (DoE 1995:17). In total 66 specific outcomes (Table 10) underpinned by SAQA's critical outcomes were developed to indicate how the critical outcomes could be achieved in each of the eight learning areas in the GET phase.

Learners are expected to achieve these specific outcomes over the period of time allocated for the GET phase. These specific outcomes will therefore need to be assessed by the teacher to determine whether the learner has achieved the critical and the specific outcomes. To facilitate this, each specific outcome has 3 or 4 assessment criteria that aim to identify the kind of evidence that must be gathered to be able to report that learners have indeed met a specific outcome (DoE 1997:13). The assessment criteria, however, do not provide sufficient details of exactly what and how much learning marks an acceptable level of achievement of the outcome (DoE 1997:13). For this reason the assessment criteria are explained and detailed in range statements and phase descriptors (DoE 1997:13). Range statements inform teachers of the contents, processes and context which the learner must engage with in order to reach an acceptable level of achievement or competencies. These range statements are in no way prescriptive. They allow for multiple learning strategies, for flexibility in the choice of specific content and process and a variety of assessment methods (DoE 1997:13). Phase descriptors were added to cater for the profile of the learners in the GET phase and they indicate the appropriate learning activities for each of the three phases (Dreyer 2000: 17).

The assessment criteria, range statements and phase descriptors thus provide broad indications of what is to be achieved (DoE 1997:14). Details about what learners should know and be able to demonstrate in order to show achievement/ competencies are, however, not stipulated. To cater for this shortcoming, performance indicators were formulated. Performance indicators describe the precise, observable signs that

indicate that the assessment criteria and range statements have been achieved (DoE 1997:15).

LEARNING AREAS				
Language. Literacy and Communication	**Mathematical Literacy and Mathematics**	**Natural Sciences**	**Technology**	**SPECIFIC OUTCOMES**
1. Make and negotiate meaning and understanding	1. Demonstrate an understanding about ways of working with numbers	1. Use process skills to investigate phenomena related to the natural sciences	1. Understand and apply the technological process to solve problems and satisfy needs and wants	
2.Show critical awareness of language use	2. Manipulate number patterns in different ways	2.Demonstrate the acquisition of knowledge and an understanding of concepts and principles in natural sciences	2. Apply a range of technological knowledge and skills ethnically and responsibility	
3. Respond to the aesthetic, cultural and social values in texts	3. Demonstrate an understanding of the historical developmental of mathematics in various social and cultural contexts	3. Apply scientific knowledge and skills to problems in innovative ways	3. Access processes and use data for technological purposes	
4. Access process and use information from a variety of sources and situations	4. Critically analyse how mathematical relationships are used in social, political and economic relations.	4. Demonstrate an understanding of how scientific knowledge and skills contribute to the management development and utilisation for natural and other resources	4. Select and evaluate products and systems	
5. Understand, know and apply language structures and conventions in context	5. Measure with competence and confidence in a variety of contexts	5. Use scientific knowledge and skills to support responsible decision-making	5. Demonstrate an understanding of how different societies create and adapt technological solutions to particular problems	
6. Use language for learning	6. Use data from various contexts to make informed judgements	6. Demonstrate knowledge and understanding of the relations between science and culture	6. Demonstrate an understanding of how technology might reflect different biases and create responsible and ethical strategies to address them	
7. Use appropriate communication strategies for specific purposes and situations	7. Describe and represent experiences with shape, space time and motion using all available senses	7. Demonstrate an understanding of the changing and contested nature of the natural sciences	7. Demonstrate an understanding of how technology might reflect different biases and create responsible and ethical strategies to address them	
	8. Analyse natural forms, cultural products and processes as representation of shape, space and time	8. Demonstrate knowledge and understanding of ethical issues, bias and inequities related to the natural sciences		
	9. Use mathematical language to communicate mathematical ideas, concepts, generalisations and though processes	9. Demonstrate an understanding of the interaction between the natural sciences, technology and socio-economic development		
	10. Use various logical processes to formulate tests and justify conjectures.			

Table 10: The Specific Outcomes of the Learning Areas (Source: Tilley cited in Le Roux and Loubser n.d.:19)

LEARNING AREAS				
Arts and Culture	**Human and Social Sciences**	**Life Orientation**	**Economic and Management Services**	**SPECIFIC OUTCOMES**
1. Apply knowledge techniques and skills to create and be critically involved in arts and culture processes and products.	1. Demonstrate a critical understanding of how South African Society has changed and developed.	1. Understand and accept themselves as unique and worthwhile human beings.	1. Engage in entrepreneurial activities.	
2. Use the creative processes of art culture to develop and apply social and interactive skills.	2. Demonstrate a critical understanding of patterns of social development.	2. Use skills and display attitudes and values that improve relationships in family, group and community.	2. Demonstrate a personal role in the economic environment.	
3. Reflect on and engage critically with arts experience and works.	3. Participate actively in promoting a just, democratic and equitable society.	3. Respect the rights of people to hold personal beliefs and values.	3. Demonstrate the principles of supply and demand and the practices of production.	
4. Demonstrate an understanding of the origins, functions and dynamic nature of culture.	4. Make sound judgements about the development, utilisation and management of resources.	4. Demonstrate the value and respect for human rights as reflects in *ubuntu* and similar philosophies.	4. Demonstrate managerial expertise and administrative proficiency.	
5. Experience and analyse the role of the mass media in popular culture and its impact on multiple forms of communication and expression in the arts.	5. Critically understand the role of technology in social development.	5. Practice acquired life and decision making skills.	5. Critically analyse economic and financial data to make decisions.	
6. Use art skills and cultural expressions to make an economic contribution to self and society.	6. Demonstrate an understanding of inter-relationships between society and the natural environment.	6. Access career and other opportunities and set foals that will enable them to make the best use of their potential and talents.	6. Evaluate different economic systems from various perspectives.	
7. Demonstrate ability to access creative art and cultural processes to develop self-esteem and promote healing.	7. Address social and environmental issues in order to promote development and social justice.	7. Demonstrate the values and attitudes necessary for a healthy and balanced lifestyle.	7. Demonstrate actions which advance sustained economic growth, reconstruction and development in South Africa.	
8. Acknowledge, understand and promote historically marginalised arts and cultural forms and practices.	8. Analyse forms and process of organisations.	8. Evaluate and participate in activities that demonstrate effective human movement and development.	8. Evaluate the inter-relationships between economic and other environments.	
		9. Use a range of skills and techniques in the human and social sciences context.		

Table 10: The Specific Outcomes of the Learning Areas (Source: Tilley cited in Le Roux and Loubser n.d.:20)

From the preceding statements, it is evident that C2005 aims to guide “what is to be done” by both teachers and learners” in an integrated way without providing structured guidelines of the nature of the content involved in the different learning programmes This is in accordance with the principle adopted by the DoE which stipulated that the curriculum should “emerge” or “evolve” and should not be designed as a finished package for teachers (Report of Review Committee on C2005 2000:31).

“What is to be done”, that is, the planning of learning programmes and the engagement between the teacher and the learners intending to learn, will vary because of relevant roleplayers’ choices. These choices invariably will often lead to different approaches. This is acceptable provided that the purposes for implementing C2005 are being addressed.

An examination and evaluation of the relationship between the curriculum (what is to be taught) and instruction (how the curriculum is delivered to learners) in different models conceived by Johnson in 1967 and Hunter and Scheirer in 1988 (cited in Sowell 2000:7-8) helps to elucidate what is expected of teachers implementing C2005.

2.4 MODELS SHOWING THE RELATIONSHIP BETWEEN THE CURRICULUM AND INSTRUCTION

Two possible relationships can exist between curriculum and instruction (Sowell 2000:6). Curriculum and instruction can be taught of as separate, but interrelated entities or not disjointed entities. Johnson’s model shown in Figure 24 (cited in Sowell 2000:6) is based on a technical approach to the curriculum process. He views reality/the world objectively and believes that it can be understood.

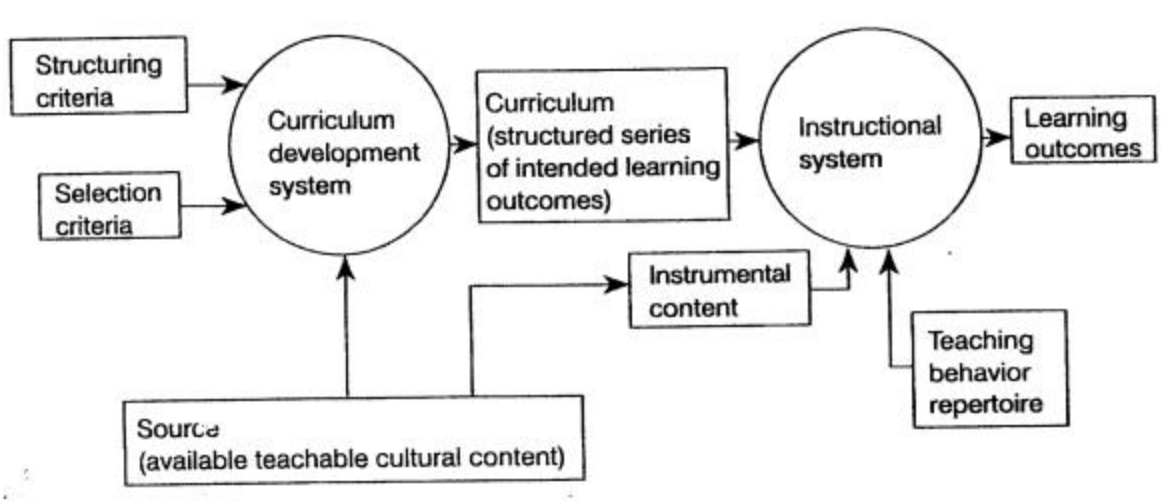


Figure 24: A Model Showing the Relationship between Curriculum and Instruction in a Technical Approach.
(Source: Sowell 2000:7)

Events, according to this interpretation, proceed in an orderly fashion. A curriculum fashioned out this way, is traditional and usually developed by a committee of people that are not responsible for implementing it in their particular teaching situations. This approach thus relies heavily on curriculum knowledge from non-teachers although knowledge from teachers is included. In this model, the curriculum and instructional functions are done by different sets of people. Curriculum developers structure the curriculum in the form of intended learning outcomes and teachers based on their repertoire of teaching strategies deliver instructions that enable learners to attain actual learning outcomes. As part of the process teachers choose additional content (instrumental content) from the available teachable content. For example, natural science teachers who provide manipulative outcomes often use science apparatus as instrumental content to help learners attain new manipulative skills. When teachers need assistance they seek assistance from departmental personnel or anyone else they choose. In this model, curriculum clearly guides instruction. Curriculum and instruction are thought of as separate, but inter-related entities. Furthermore, this type of curriculum lends itself to be used in a variety of classroom situations because it is

relatively free of concerns about the context in which it will be used (Snyder, Bolin and Zumwalt cited in Sowell 2000:8). This, however, does not mean that the curriculum is prescriptive. Teachers are expected to assume major responsibilities in school- based activities by taking into account their school-community context.

Hunter and Scheirer's model (Figure 25) cited in Sowell (2000:7) illustrates the alternative curriculum-instructional relationship, in which the entities are not readily separable. A non-technical approach to the curriculum process is advocated when using this model.

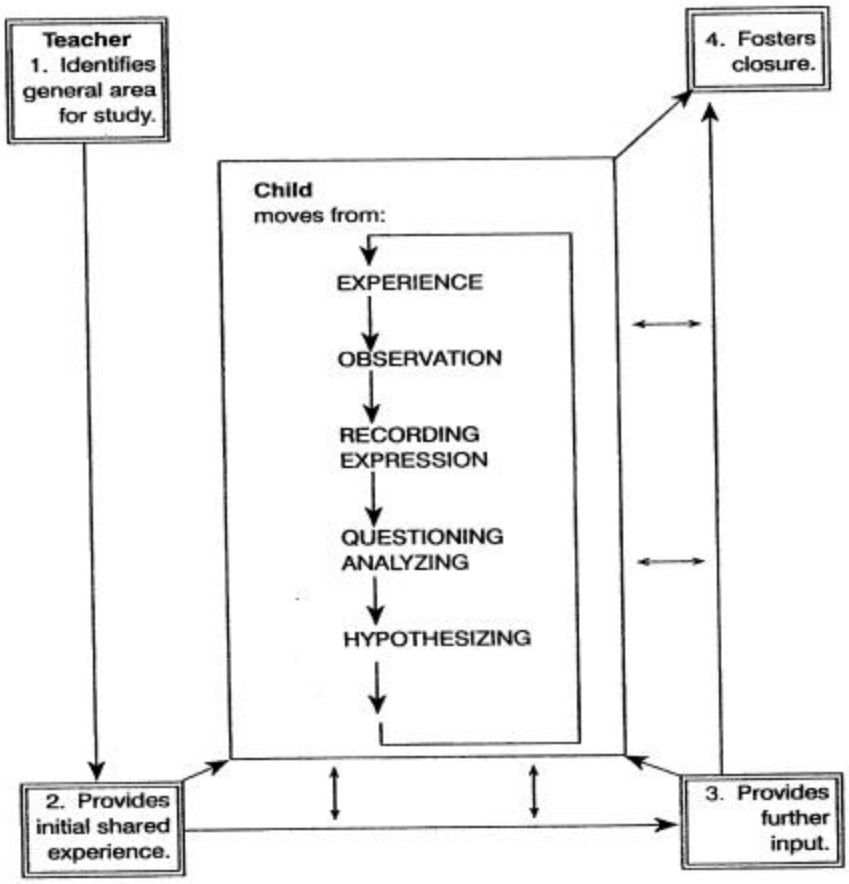


Figure 25: A Model Showing the Relationship between Curriculum and Instruction in a Non-Technical Approach
(Source: Sowell 2000:8)

Individuals preferring this approach interpret reality/the world subjectively. They believe that individual realities differ significantly and that events are not predictable. Teachers using this model interact with learners and content to develop their own realities. In this way curricula for specific contexts are planned. Teachers using this model, begin by identifying a general area of study and then guide the initial shared experience and assists learners to interact among themselves with the content. The area of study is made meaningful through a series of instructional functions such as experiences, observations, recording of results, questioning, analysing, and hypothesizing. The teacher may also provide further input and foster closure.

This approach thus relies heavily on teachers as the main source of curriculum developers because they know their learners and their teaching situations. The community at large and learners are also producers of curriculum decisions under the non-technical approach. Furthermore because teachers and learners have real choices in the learning experiences in which they engage, their decision affects materials, resources, activities, grouping and time. In this approach learners are expected to reflect on their learning processes as part of their joint efforts with teachers. This non-technical approach is often used when the major source of curriculum content is the needs and the interests of the learners or needs of society and culture. Curriculum developers do not state their intended learning outcomes at the outset because what learners will learn is not easily predicted.

Looking at the design of C2005 with its intended learning outcomes which left inputs largely unspecified and the wide range of committees involved in the development of C2005 between 1995-2000 (Table 11) clearly aligns it with Johnson's model: different sets of people being involved in curriculum and instruction. Stakeholder representation was the basis upon which C2005 was established leaving teachers to assume the major responsibility of delivering the curriculum. The curriculum process and implementing it are thought of as separate but inter-related entities.

Structure	Composition	Date	Functions
Consultative Forum on Curriculum (CFC)	Representatives of national and provincial education departments and national stakeholders in education	August 1995	To oversee process of curriculum restructuring Initiated two investigations Structures for Development of National Policy regarding curriculum A Curriculum Framework for General and Further Education and Training
National Curriculum Development Committee (NCDC)	Replaced CFC as more representative structure	March 1996	To consider public responses to above documents To reach consensus on a Life-long Learning Development Framework for South Africa
Learning Areas Committees (LACs for each LA)	Members nominated by stakeholders (30-40 on each LAC)	July 1996	To write a rationale for their LA and learning area outcomes, this reflected the critical, cross-field outcomes.
Co-ordinating Committee (one for each education Phase	Representative of education stakeholders (approximately 26 per co-ordinating committee	January 1997	To identify cross-curricular issues in the learning areas and to cluster the LAC outcomes for the development of learning programmes
Technical Committee (assisted by Reference Group)	Appointments made by nomination through the Government Gazette Reference Group three reps from each LAC and two teachers from each LA	February 1997	To develop the work of the Co-ordinating Committees towards one broad curriculum (reduce SOs, endorse ACs and RSs)
Committees	DoE officials, provincial representatives and stakeholders	Sept 1998	To develop performance indicators
Committees	DoE officials, provincial representatives and stakeholders	Nov 1998-Feb 2000	To develop expected levels of Performance.

Table 11: Composition and Functions of Structures that developed C2005 (Source: Report of the Review Committee on C2005 2000:33)

C2005 can also be aligned to some stages of the non-technical approach advocated by Hunter and Scheirer. Despite the stating of intended outcomes to be achieved, the design of the C2005 (the critical and the specific outcomes being underpinned by the needs of the learners and by the needs of society and culture, the inputs being left largely unspecified and the assessment criteria emphasizing the skills observation, recording experiences, questioning, analysing, hypothesizing as examples of the kind of evidence that needs to be gathered to be able to report that learners have met a critical and /or specific outcome) strongly

implies classroom-based curriculum decision making by teachers to suit specific contexts. Hence interacting with learners and community members to develop their learning programmes with unspecified outcomes can at times arise.

Aligning C2005 with the technical approach and stages of the non-technical approach implies that practising teachers will need to be trained to implement C2005 to attain success. This requires paying careful attention to the initiation process (Sowell 2000:141). Planning considerations including the scope and complexity of the curricular change, communication to the widest audience possible, professional development for teachers and availability of resources constitute the basis for the development of meaningful, successful learning programmes in the initiation process. The transition from the old curriculum to the new curriculum is not going to be attained by teachers attending a few workshops. It is a long- term process that is dependent on transition becoming firstly “internal” (Bridges 1991:3) and secondly “part of the belief systems of individuals” that “play itself out in their behaviour” (Peel and McCary 1997:698). Only once this happens can practising teachers begin true implementation of C2005.

2.5 GENERALIZED PROCEDURE FOR THE DEVELOPMENT OF LEARNING PROGRAMMES AND THE PLACE OF INDIGENOUS KNOWLEDGE IN C2005

At classroom level implementation of C2005 begins with the development of learning programmes. These learning programmes aim to translate the intended learning outcomes (critical and specific outcomes) to planned learning experiences (activity outcomes) involving one or more teaching approaches. Viewing C2005 as incorporating the technical approach and some stages of the non-technical approach to curriculum development suggests the following generalized procedure that teachers are expected to consider for the development of learning programmes:

- Selection of the phase for which learning programme is intended.

- Selection of the phase organizer to provide the focus of the learning programme.

- Selection of the programme organizer to provide specific content and context.

- Selection of critical outcomes that are relevant to the learning programme.

- Selection of specific outcomes that are relevant to the learning programme.

- Development of activities that guide learners to achieve the specific outcomes.

- Setting the activity outcomes for the developed activities.

- Setting assessment criteria to determine whether the outcomes (critical, specific and activity) have been achieved.

- Ascertaining whether the selected activities reflect the scope and depth indicated in the range statements.

- Selection of performance indicators to determine whether the assessment criteria and range statements have been achieved.

- Presenting a report on the learner's progress in terms of the specific outcomes.

The selection and development of activities provides the niche for the development of a wide range of activity outcomes using the non-technical approach to develop individuals to their fullest potentials and prepare them for living in an unstable, changing world. The use of explicit outcomes, however, will not deviate from the definite focus for the learning process because in these activities the emphasis is on problem-solving processes and social-human relations skills rather than just acquiring content. Klein's remark (1991:340), "although explicit objectives may be used, they do not play a major role in this

design as when subject areas are used as a basis for decision making" reinforces the view that the non-technical approach can apply to C2005.

It is at this point (the selection and development of activities) that teachers and learners are provided with considerable latitude in the choice of appropriate learning experiences that is compatible with the skills-driven, outcomes based, learner centred integrated approach emphasised in C2005. Indigenous knowledge can at this point cut across an entire domain of knowledge to encompass the many cognitive skills related to science and the other learning areas as well as affective and psychomotor learning. These indigenous knowledge activities can serve to blend science with the other learning areas and most importantly to persistent life situations and social problems that youth need to address. Well-planned learning programmes using indigenous knowledge, in C2005 delivery in the ways projected in the Revised National Statement Grades R-9 (Schools) Policy can thus abound when using the non-technical approach and the Authorizing Cycle depicted in Figure 26.

In a nutshell C2005 can be viewed as a socio-political curriculum that incorporates both the technical and some stages of the non-technical approaches and the objective-subjective interpretation of reality. This interpretation sees teachers as consumers, (using the technical approach) and also as active producers (taking ideas from the curriculum framework and preparing activities and setting activity outcomes that are tailor made to teaching situations). In line with this interpretation, implementing C2005 invariably demands teachers and administrators possessing several skills. In listing these skills, Shulman (1987:7) mentions content knowledge, general pedagogical knowledge, curriculum knowledge, pedagogical content knowledge, knowledge of learners and their characteristics, knowledge of educational contexts and knowledge of educational philosophies. The collaborative efforts of teachers with such skills are hence pre-requisites to facilitate implementation efforts across the school population to enhance the "evolving" or "emerging" of C2005 and to make it successful.

Figure 26: The Authorizing Cycle: An example of Curriculum Enactment (Source: Sowell 2000:251

2.6 CRITICISMS OF C2005

Much of the criticism of C2005 has been regarding the composition of the planning committees, its structure and design, its assessment policy and its implementation (Moodie 1996:6; Review Committee on C2005 2000:18-21). Some of the pertinent criticisms to this research study cited from these sources are listed and elaborated on as follows:

- The notion of consultation with stakeholders (representatives of teacher organizations and some curriculum planning committees) has excluded the teachers in the schools from the curriculum process. Political representation thus deprived planners of the benefit of a broad band of exchange of views and meaningful involvement in the process. Providing teachers the opportunities to develop personal meaning for envisaged changes to take effect were thus denied. Hall's contention (1992:898) of "one of the failures of understanding about implementation 20 years ago was that we did not accept the reality that a school did not change until each individual teacher within the school successfully implements the innovation" was certainly not heeded. Furthermore this exclusion marginalized the overwhelming majority of teachers, leading many of them to have variations in the understanding of C2005 and supporting the innovations to merely shift from the old emphasis of collecting knowledge to a new emphasis on interpreting, evaluating and applying knowledge.

- The mechanical attitude towards classroom change gathered by implication from the policy documents of about how learning programmes ought to be developed is untenable as the complex, confusing language and at times contradictory language used in the OBE-NQF-C2005 discourse is a maze through which only experts can find their way. Policy documents are inaccessible to the majority of the teachers, trainers and officials. The numerous jargon-laden concepts and structures are too obscure to allow most of the teachers to get a good grasp of their meaning and apply them in the classroom.

- Based on visions of overcoming the devastating legacy of apartheid and to prepare South Africans for global competitiveness, curriculum planners attempted to meet these challenges by using the technical approach to curriculum planning i.e. the development of the critical and the specific outcomes. These intended learning outcomes represent what learners are expected to be able to do with the "evolving" curriculum content through

planned learning programmes involving one or more teaching agents. But how are learners to develop attitudes, interests, appreciations, thinking skills and other cognitive strategies and develop to their fullest potential remain elusive as these are not easily framed as intended learning outcomes and can only be communicated by a highly qualified, theoretically body of implementers, “change facilitators” and resources as shown in Figure 27. This, however, does not exist. The range statements, performance indicators and expected levels of performance are also inefficient mechanisms to provide progression features because planners have attempted to avoid prescribing content to allow the curriculum to “emerge”.

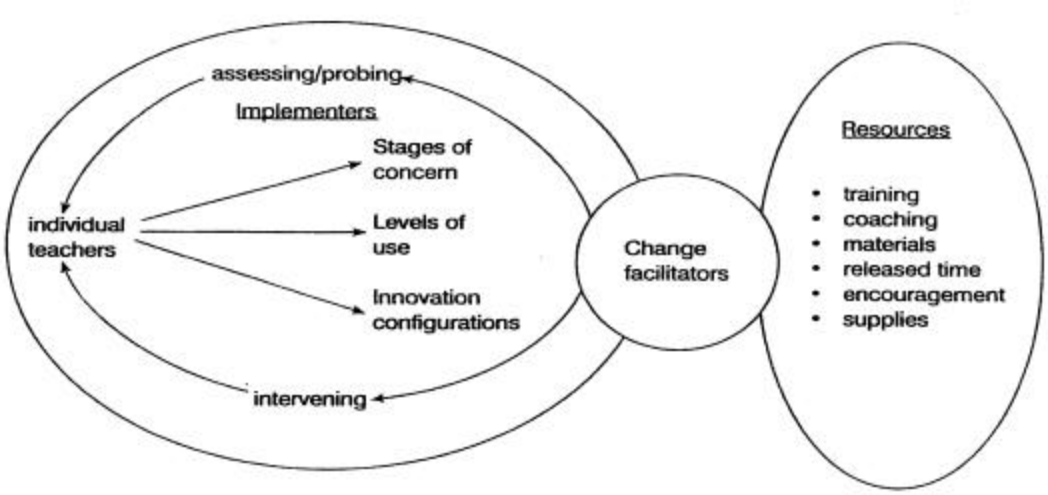


Figure 27: Relationships amongst Implementers, Change Facilitators and Resources in the Concerns-Based Adoption Model
(Source: Sowell 2000:247)

- Emphasising assessment more than learning in the classroom is pedagogically unsound. This is evident in the lack of alignment between C2005 and its assessment policy as well as clarity regarding assessment policy and practice. Too much time is devoted to being spent on assessment, leaving minimal time for classroom work.

- The claim about the relationship between the system of education and economic growth is overly simplified. The implementing of C2005 in the education and the training process cannot be posed as a panacea for productive economic growth and an automatic increase in the rate of employment. Education cannot secure economic development on its own. An intrinsic weakness of the economic system impacts negatively on economic growth.

- Last but not least the implementation C2005 has been too rushed. The National Education Department ignored how the social and educational context will impact on the success of the policy. In other words, a policy applicable for an education system with no stratification was implemented under conditions in which the quality of resources, teaching, learning and educational performance showed considerable variation amongst provinces, districts and schools. Insensitivity was also shown to material resources, race and residence. Substantial changes could probably have accrued if reducing disparities between schools and allowing them to start afresh on equal footing such as well resourced schools with trained and retrained teachers, new forms of assessment, classroom organization and time for managing the process, monitoring and evaluation of implementation, trained managers and principals, parental support and involvement, new learning resources and opportunity for teacher dialogue and exchange were well planned rather than rushing the implementation process of C2005 within unmanageable and unrealistic timeframes. In short the entire system needs to be re-engineered to support the new curriculum.

2.7 RECOMMENDATIONS OF THE REVIEW COMMITTEE

The Review Committee (2000:21-24) recommended that strengthening the curriculum required the following:

- Infusing human rights education and education for civil responsibility throughout the curriculum.

- Streamlining its design features.

- Simplifying its language.

- Reducing the curriculum design features from eight to three by dropping the 66 specific outcomes, assessment criteria, phase and programme organisers, range statements, performance indicators and expected levels of performance. The design features should include critical and developmental outcomes, learning outcomes and assessment standards.

- Promoting conceptual coherence by specifying learning outcomes and assessment standards grade by grade and providing more time for languages and mathematics in the GET band.

- Promoting integration across learning areas by using critical outcomes and assessment exemplars.

- Promoting integration within learning areas by learning area statements and learning programmes.

- Reducing the number of learning areas from 8 to 6 in the GET band. Technology should be coupled with Science and Economic Management Services should be dropped.

- Strengthening the implementation process by improving teacher orientation and training, learning support materials and provincial support.

- Relaxing the timeframes for implementation.

2.8 THE REVISED NATIONAL CURRICULUM STATEMENT GRADES R-9 (SCHOOLS) POLICY

In June 2000, the Council of Education Ministers accepted the recommendations of the Review Committee and in July 2000, Cabinet resolved that: “The development of a National Curriculum Statement, which must deal in clear and simple language with what the curriculum requirements are at various levels and phrases, must begin immediately. Such a Statement must give a clear description of the kind of learner in terms of knowledge, skills, values and attitudes-that is expected at the end of the General Education and Training band (DoE 2002:6).

The revision of C2005 resulted in a Draft Revised National Curriculum Statement for GradesR-9 (Schools) Policy which was released on 30 July 2001 for public comment for a period of three months. In November 2001, public hearings were held and in December 2001, the curriculum working groups of the Ministerial Project Committee were reconvened to incorporate suggested changes for improving the curriculum. The Revised National Curriculum Statement gazetted in May 2002 is the result of the process that started in July 2000. It is not a new curriculum but a streamlining and strengthening of C2005. The principles, purposes and thrust of C2005 are kept intact. OBE is still central to the curriculum. In the Revised National Curriculum Statement there are 8 learning areas not 6 as recommended by the Review Committee of C2005. The learning areas are:

Learning Areas in Revised National Curriculum Statement
• Languages • Mathematics • Natural sciences • Technology • Social Sciences • Arts and Culture • Life Orientation • Economic and Management Services

Box 4: Learning Areas in Revised National Curriculum Statement Grades R-9 (Schools) Policy
Source: (DoE 2002:9)

Each learning area has a learning area statement that provides a guideline of the goals, expectations and outcomes from Grades R-9 for schools in the GET band. Each learning area statement identifies the main learning outcomes to be achieved by the end of Grade 9. By stating these outcomes the Revised National Curriculum Statement Grades R-9 (Schools) Policy aims to emphasis both the process and the content of education. A total of 34 learning outcomes (Table 12) are identified.

Each learning area statement also specifies assessment standards. Assessment standards will enable the learning area outcomes to be achieved. For each grade assessment standards are defined. This defines the depth and the breadth of what learners should know and be able to do. Assessment standards show how conceptual and skill development can take place. The assessment standards can be integrated within areas as well as across grades. Assessment standards thus aim to achieve integration across learning areas (where necessary and educationally sound) and conceptual progression from grade to grade.

LEARNING AREAS				
Languages	**Mathematics**	**Natural sciences**	**Technology**	**LEARNING OUTCOMES**
1. **Listening:** Listen for information and enjoyment, and respond appropriately and critically in a wide range of situations.	1. **Numbers, Operations and Relationships:** Able to recognize, describe and represent numbers and their relationships and can count, estimate, calculate and check with competence and confidence in solving problems.	1. **Scientific Investigation:** Investigate relationships and solve problems in Science, Technology and Environmental contexts.	1. **Technological Processes and Skills**: Able to apply technological process and skills ethically and responsibly using appropriate information and communication technologies.	
2. **Speaking:** Able to communicate confidently and effectively in a spoken language in a wide range of situations.	2. **Pattern, Functions and Algebra:** Able to recognize, describe and represent patterns and relationships, and solve problems using algebraic language and skills.	2. **Constructing Science Knowledge:** Know, interpret and apply scientific, technological and environmental knowledge.	2. **Technological Knowledge and Understanding:** Able to understand and apply relevant technological knowledge ethically and responsibly.	
3. **Reading and Viewing:** Able to read and view for information and enjoyment, and respond critically to the aesthetic, cultural and emotional values in texts.	3. **Space and Shape:** Able to describe and represent characteristics and relationships between 2-D shapes and 3-D objects in a variety of orientations and positions.	3. **Science, Society and Environment:** Able to demonstrate an understanding of the inter-relationships between science and technology, society and environment.	3. **Technology, Society and Environment:** Able to demonstrate an understanding of the inter-relationships between Science, Technology, Society and the environment	
4. **Writing:** Able to write different kind of factual and imaginative texts for a wide range of purposes.	4. **Measurement:** Able to use appropriate measuring units, instruments and formulae in a variety of contexts.			
5. **Thinking and reasoning:** Able to use language to think and reason, and access, process and use information for learning.	5. **Data Handling:** Able to collect, summarise, display and critically analyse data in order to draw conclusions and make predictions, and to interpret and determine chance variation.			
6. **Language Structure and Use:** Able to use the sounds, words and the grammar of a language to create and interpret text.				

Table 12: Learning Areas and Learning Outcomes in the Revised National Curriculum Statement Grades R-9 (Schools) Policy (Source: DoE 2002:20 -28)

LEARNING AREAS				
Social Sciences	**Arts and Culture**	**Life Orientation**	**Economic and Management Sciences**	**LEARNING OUTCOMES**
1. **Historical Enquiry:** Able to use enquiry skills to investigate the past and the present.	1. **Creating, Interpreting and Presenting:** Able to create, interpret and present work in each of the art forms.	1. **Health Promotion:** Able to make informed decisions regarding personal, community and environmental health.	1. **Knowledge and Understanding of the Economic Cycle:** Able to demonstrate knowledge and understanding of the economic cycle in addressing the economic problem.	
2. **Historical Knowledge and Understanding:** Able to demonstrate historical knowledge and understanding.	2. **Reflecting:** Able to reflect critically on artistic and cultural processes, products and styles in past and present contexts.	2. **Social Development:** Able to demonstrate an understanding of and commitment to constitutional rights and responsibilities and show an understanding of diverse cultures and religions.	2. **Understanding of Sustainable Growth and Development:** Able to demonstrate an understanding of sustainable growth, reconstruction and development, and reflect critically on related processes.	
3. **Historical Interpretation:** Able to interpret aspects of history.	3. **Participating and Collaborating:** Able to demonstrate personal and interpersonal skills thorough individual and group participation in arts and culture activities.	3. **Personal Development:** Able to use acquired life skills to achieve and extend personal potential to respond effectively to challenges in his/her world.	3. **Managerial, Consumer and Financial Knowledge and Skills:** Able to demonstrate knowledge and the ability to apply responsibly a range of managerial, consumer and financial skills.	
4. **Geographical Enquiry:** Able to use enquiry skills to investigate geographical and environmental concepts and processes.	4. **Expressing and Communicating:** Able to analyse and use multiple forms of communication and expression in arts and culture.	4. **Physical Development and Movement:** Able to demonstrate an understanding of, and participate in activities that promote movement and physical development.	4. **Entrepreneurial Knowledge and Skills:** Able to demonstrate entrepreneurial skills, knowledge and attitudes	
5. **Geographical Knowledge and Understanding:** Able to demonstrate geographical and environmental knowledge and understanding.		5. **Orientation To The World of Work:** Able to make informed decisions about further study and career choices.		
6. **Exploring Issues:** Able to make informed decisions about social and environmental issues and problems.				

Table 12: Learning Areas and Learning Outcomes in the Revised National Curriculum Statement Grades R-9 (Schools) Policy
Source: (DoE 2002: 20-28)

The learning outcomes and the assessment standards were designed down from the critical outcomes (Box 5) and the developmental outcomes (Box 6) that in turn were derived from the Constitution. The design elements of the Revised National Curriculum Statement Grades R-9 (Schools) Policy thus interact with each other as shown in Figure 28

Critical Outcomes
• *Identify and solve problems and make decisions using critical and creative thinking.* • *Work effectively with others as members of a team, group, organisation and community.* • *Organise and manage themselves and their activities responsibly and effectively.* • *Collect, analyse, organise and critically evaluate information.* • *Communicate effectively using visual, symbolic and/or language skills in various modes.* • *Use Science and Technology effectively and critically showing responsibility towards the environment and the health of others.* • *Demonstrate an understanding of the world as a set of related systems by*

Box 5: Critical Outcomes in the Revised National Curriculum Statement Grades R-9 (Schools) Policy.
(Source: DoE 2002:1)

Developmental Outcomes
• *Reflect on and explore a variety of strategies to learn more effectively.* • *Participate as responsible citizens in the life of local, national, and global communities.* • *Be culturally and aesthetically sensitive across a range of social contexts.* • *Explore education and career opportunities.* • *Develop entrepreneurial opportunities.*

Box 6: Developmental Outcomes in the Revised National Curriculum Statement Grades R-9 (Schools) Policy.
(Source: DoE 2002:1)

The outcomes listed in Box 5 and Box 6 are reflected in the South African Qualification Act.

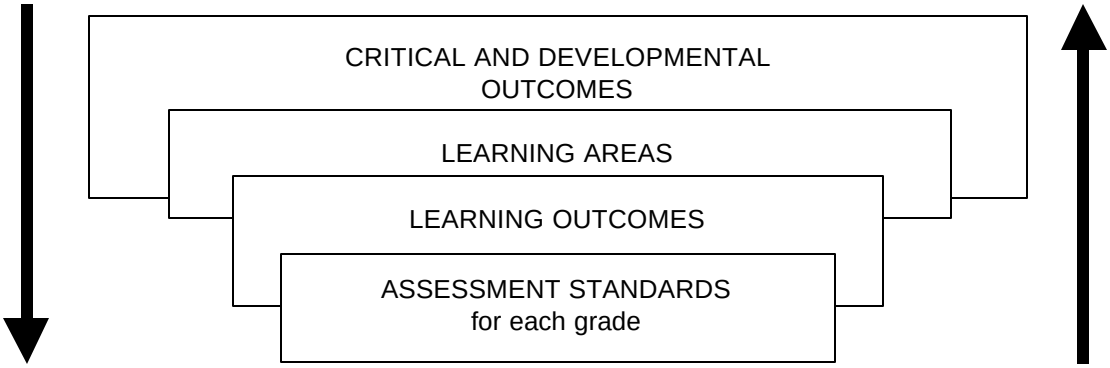


Figure 28: The Interaction between the Design Elements in the Revised National Curriculum Statement Grades R-9 (Schools) Policy. (Source: DoE 2002:76)

The learning programmes and time allocations in the foundation phase and the intermediate and senior phases differ as shown in Tables 13 and 14.

Learning Programme	Time (%)
Literacy	40
Numeracy	35
Life Skills	25

Table 13: Learning Programmes and Time Allocation for Foundation Phase in the Revised National Curriculum Statement Grades R-9 (Schools) Policy.
(Source: DoE 2002:17)

Learning Area/Programme	Time (%)
Languages	25
Mathematics	18
Natural sciences	13
Social Sciences	12
Technology	8
Economic and Management Sciences	8
Life Orientation	8
Arts and Culture	8

Table 14: Learning Programmes and Time Allocation for Intermediate and Senior Phases in the Revised National Curriculum Statement Grades R-9 (Schools) Policy.
(Source: DoE 2002:18)

From the preceding statements, it can be seen that many of the recommendations of the Review Committee were implemented in the Revised National Curriculum Statement Grades R-9 (Schools) Policy. While this is welcomed, phenomenal challenges for the successful implementation of this revised curriculum still face the teachers who are ultimately going to be responsible for the planning of their own learning programmes per phase as listed below:

- Selection of the phase for which learning programme is intended.

- Selection of critical outcomes and developmental outcomes that are relevant to the learning programme

- Selection of learning outcomes that are relevant to the learning programme.

- Development of activities that guide learners to achieve the learning outcomes.

- Setting the activity outcomes for the developed activities.

- Setting assessment standards to determine whether the outcomes have been achieved.

- Presenting a report on the learner's progress in terms of the specific outcomes.

To facilitate the above, it is envisaged that policy guidelines for relevant and appropriate learning programmes will be developed at national level in collaboration with provinces. Policy documents are envisaged to provide information and guidance on:

- Integration within and across learning areas.
- Clustering of assessment standards.
- Relationships between learning outcomes.
- Time allocation.
- Assessment.
- Barriers to learning.
- Designing a learning programme.
- Policy and legislation.
- Training, development and delivery.
- Resourcing and support.
- Planning and organisation.

2.9 CRITICISMS OF THE REVISED NATIONAL CURRICULUM STATEMENT GRADES R-9 (SCHOOLS) POLICY

Too much is expected from teachers in the existing social and educational context. The assumption that all teachers and learners can operate on an equal basis in the next few years is highly unlikely. There are too many teachers and too little time. An inadequate fiscal base for the implementation will seriously undermine the likelihood of success.

Change is a process, not an event and it is also a highly personal experience. Change occurs over time, usually a period of years and during this time individuals will respond to changes in different ways. Expecting teachers to change collectively is therefore not going to occur as assumed.

The scope and the complexity of the revised curriculum to be implemented may be viewed as a major change to teachers who are

just getting to grips with the first version of C2005 or to those who are implementing the first version as “traditional OBE”.

The revised curriculum is still an “imported” curriculum although claims have been made by Asmal cited in DoE (2002:1) that the “curriculum is written for South Africans by South Africans who hold dear to the principles and practices of democracy”. This is not disputed but again excluding the teachers from the curriculum process deprives them “ownership” and indigenisation of the curriculum. As difficult as this may be, especially with large number of teachers, it is imperative for each teacher to develop ownership. Ownership will bring “a sense of clarity, skill, and commitment required for the institutionalisation of change” (Sowell 2000:240). Without possessing ownership one-way communication about the revised curriculum and its implementation will again take place. Furthermore, indigenising of the curriculum will be made difficult. Slotting in some assessment standards pertaining to indigenous knowledge and expecting teachers to incorporate it in their learning programmes cannot indigenise the curriculum. For teachers who adopt a Westernised lifestyle, planning learning programmes that will indigenise the curriculum, can pose major problems. The chances of indigenising the curriculum are greater when community members together with an entire body of teachers are consulted. An indigenised curriculum “is of significance in accomplishing the construction of meaning in a new situation” (Jegede and Aikenhead 1999:45). To make meaning out of classroom experiences learners need “to negotiate a cultural transition from their life-world into a world of school…” (Jegede and Aikenhead 1999:61). An example worth mentioning and something for South African curriculum developers to be cognisant of is “The Japanese never lost their cultural identity when introducing modern science and technology, because they introduced only the practical products of Western science and technology, never its epistemology or worldviews” (Jegede and Aikenhead 1999:61).

2.10 STRENGTHS OF C2005

Despite the criticisms levelled against C2005, the curriculum can serve more than a political tool. Paquet cited in Prinsloo (1999:53) expresses a similar sentiment.

> *"If education can be used not as a political tool but as a tool to equalise rather than retard intellectual growth and academic knowledge, the present, seemingly hopeless scenario can, because of mutual desire for peace and harmony, be turned to good. If however, the classroom remains the battleground for potential gain and power, yet another generation will become intellectually stunted and academically handicapped and the full potential of a united South Africa will remain a utopian dream".*
>
> Paquet cited in Prinsloo 1999:53

The curriculum based on the account of Goodland and Su cited in Sowell (2000:4) concerning levels of curriculum implies that C2005 has the societal level, the institutional level, the instructional level and the experiential level embodied in its design. Inclusion of these levels increases the scope of the curriculum and provides opportunities to fit the curriculum with the school as it exists within society. Appropriate needs and interests of learners, consistent with societal and cultural realities can be aligned with the content selected for the curriculum. The cultural diversity of South Africa's children and youth can be accommodated. The content selected can become sensitive to a number of issues such as the increase in environmental deterioration, the rapid loss of non-renewable resources, the rapid loss of indigenous knowledge, the value of indigenous knowledge, the increasing types and levels of literacy demanded by employers, HIV/Aids, the increasing number of children who do not have homes or are being cared for by someone other than family largely because of the Aids epidemic or parents being away from home for employment reasons etc.

In essence the curriculum design has vast potential to provide learners with opportunities for learning multiple forms of knowledge: Ryle's declarative-procedural knowledge, commonly referred to as formal

knowledge and skills respectively and Bereiter and Scardamalia's "multiple knowledges" (Sowell 2000:68). In addition to formal (declarative) knowledge and skills (procedural knowledge), Bereiter and Scardamalia cited in Sowell (2000:68) found that every person has several other forms of knowledge or multiple knowledge that include:

- Informal knowledge or "educated common sense", knowledge that requires deep understanding not obtained in books.

- Impressionistic knowledge that involve "feelings" about knowledge that typically operate in the background.

- Self-regulatory knowledge or self knowledge of one's own intellectual functioning that may include informal and impressionistic knowledge.

In short, C2005 encompasses the following:

- Language literacy, cultural literacy, science literacy and information literacy (Ministry of Education: 2000:28).

- Knowledge is not a passive commodity to be transferred from teachers to learners (Semali and Kincheloe 1999:27).

- Learners should not be made to absorb knowledge in a spongy fashion (Semali and Kincheloe 1999:27).

- Knowledge cannot exist separate from the knower (Mwadime 1999:247).

- Learning is a social process mediated by the learner's environment (Semali 1999:101; Jegede 1999:127).

- Indigenous knowledge of the learner or learner's community is of significance in accomplishing the construction of meaning in a new situation (George 1999:84; Jegede 1999: 120).

Outcomes pertaining to knowledge in C2005 can be identified in the learning domains that are represented as cognitive, affective, or psychomotor (Table 15). Bloom's cognitive taxonomy (Table 16), Krathwohl, Bloom and Masia's taxonomy of affective learning (Table 17) and Harrow's taxonomy of psychomotor learning (Table 18) that over the years have been acknowledged pedagogically sound despite criticisms levelled against them are thus implied in the learning outcomes in the revised curriculum.

Conceptions of Knowledge	Domain of Learning	Classroom Learning Outcomes
Formal Knowing-that Skills	Cognitive	Verbal information
Knowing-how	Cognitive	Intellectual skills: • Concepts, principles, generalizations, academic rules
Informal Knowing-how Self-regulatory	Cognitive	
Informal Impressionistic Self-regulatory	Affective	Cognitive strategies: • Thinking strategies, Study skills
Informal Self-regulatory Knowing-that	Psychomotor	Problem-solving skills Attitudes Motor skills

Table 15: Relationships among Conceptions of Knowledge, Learning Domains and Classroom Learning Outcomes.
(Source: Sowell 2000:71)

Level	Description
Complex	
Evaluation	Making judgements about the value of information in terms of internal evidence or external criteria
Synthesis	Putting parts of information together to form a whole, in a pattern not clearly present before
Analysis	Breaking information into parts including elements, relationships, or organizational principles
Application	Using information in a slightly different setting from the one in which it was learned
Comprehension	Understanding information at the lowest level; relationships with information on similar topics not intended
Knowledge	Recalling information from memory
Simple	

Table 16: Taxonomy of Cognitive Learning Based on the Work of Bloom and his Associates.
(Source: Sowell 2000:73)

Level	Description
Internal to learner	
Characterized by a value or value complex	Making certain values part of one's philosophy of life to direct one's actions
Organization	Thinking about, clarifying, and putting one's values into a system
Valuing	Showing acceptance, preference of one thing over another, becoming committed to that thing
Responding	Showing willingness to respond; participating satisfactorily
Receiving	Showing awareness and willingness to receive or give attention to stimuli
External to learner	

Table 17: Taxonomy of Affective Learning Based on the Work of Krathwohl, Bloom and Masia
(Source: Sowell 2000:77)

Level	Description
Complex adaptive skills	
Non-discursive communication	Involving expressive movement through posture, gestures, facial expressions, and creative movements
Skilled movements	Involving games, sports, dances and the arts
Physical abilities	Relating to endurance , strength, flexibility, agility, reaction-response time and dexterity
Perceptual abilities	Relating to kinaesthetic, visual, auditory, tactile , and coordination abilities
Fundamental movements	Involving walking, running, jumping, pushing, pulling, and manipulating one's body
Reflex movements	Involving segmental and intersegmental reflexes
Simple adaptive skills	

Table 18: Taxonomy of Psychomotor Learning Based on the Work of Harrow (Source: Sowell 2000:79)

From the preceding statements, it is evident that C2005 is not to be seen as a radical change to what leading educationalist advocated. Domains and taxonomies of learning, known for more than 40 years to the education community, continue as major classifications of learning outcomes and these can only be achieved if they are "filtered through our experiences and applied in our lives" (Lenox and Walker 1994:58).

2.11 CONCLUSION

The revised curriculum that centrally positions OBE in its design continues to use domains and taxonomies of learning. The strengthening of C2005 and the conceptualisation of the revised curriculum makes the latter more accessible to teachers than the former. This, however, still places enormous demands on the diverse body of teachers who have been excluded from the curriculum process. The technical approach dominates the curriculum process, hence one-

way communication about the revised curriculum and its implementation is probably again anticipated. The planning of some learning programmes and the indigenisation of the curriculum to conceptualise an inclusive and just science education, implies the use of stages of the non-technical approach that presently seems beyond most teachers. Teachers and administrators thus need time to be trained and re-trained to implement the curriculum successfully.

While it is relatively simple for the National Department of Education to envision ways in which the education system can address the implementation of the revised curriculum, it remains at this stage important to focus on the practical steps needed to shift an under-performing system to a performing system as there is no master plan that we can generate for all times. Master plans are illusions.

CHAPTER THREE

INDIGENOUS KNOWLEDGE: WAYS OF SEEING ITS INCLUSION IN THE REVISED NATIONAL CURRICULUM STATEMENT GRADES R - 9 (SCHOOLS) POLICY

3.1 INTRODUCTION

> *"At present our pupils learn to despise even their own parents because they are old fashioned and ignorant; there is nothing in our existing educational system which suggest to the pupil that he [she] can learn important things about farming from his [her] elders. The result is that he [she] absorbs beliefs about witchcraft before he [she] goes to school, but does not learn the properties of local grasses; he [she] absorbs the taboos from his family but does not learn the methods of making nutritious traditional foods. He [she] gets the worst of both systems"*
>
> Julius Nyerere 1968:278.

> *"Modern… education makes young people unfit for useful function in life. The vast majority of people that sent their children to the [modern] schools were agriculturalists…There is no doubt that the young people when they came back knew not a thing about agriculture, were indeed contemptuous of the calling of their fathers… Almost from the commencement, the text-books… never [teach a student] any pride in [his] surroundings. The higher he goes, the farther he is removed from his home, so that at the end of his education he becomes estranged from his surroundings. He feels no poetry about the home life. The village scenes are all a sealed book to him. His own civilization is presented to him as imbecile, barbarous, superstitious and useless for all practical purposes. His education is calculated to wean him from his traditional culture".*
>
> Gandhi cited in Prakash 1993:11.

Nyerere (1968:278) and Gandhi reflect dilemmas created by the concept, indigenous knowledge (IK) and the way it competes with "modern education" in non-Western education systems in Tanzania and India respectively. Both men, lament the failure of the school's curriculum to provide learners with an intercultural education or as Orr (1992:32-33) encapsulates it, to acquire an intimate "knowledge of specific places and their particular traits of soils, microclimates, wildlife, and vegetation, as well as its history and cultural practice that work well in each particular setting".

To date, situations like the ones lamented by Nyerere and Gandhi also confront both learners and teachers in the school system in South

Africa. More importantly, tensions and contradictions abound between what is intended by using IK in the teaching of science in C2005 and what actually gets implemented in class. In other words, dilemmas of curriculum inquiry and indigenous literacy (Semali 1999:103) are readily exposed throughout the majority of South African schools.

This chapter examines the social, cultural and political issues that surround IK and the school curriculum. It focuses specifically on the effect of IK on the teaching and learning of natural science through the Western worldview as proposed in C2005 and how IK can affect cognitive processes within a specified context. The way of conceptualizing IK and classroom knowledge in the teaching and learning of natural science recognized decades ago by Nyerere and Gandhi and which until today remains unresolved, is being addressed.

3.2 DEFINING INDIGENOUS KNOWLEDGE

Defining IK is somewhat problematic, problematic in a sense that there is no universally accepted definition of the term (Johnson 1999:4) and because many analysts themselves are uncertain who should be talking about this term (Semali and Kincheloe 1999:3). Nevertheless the value of IK and its relevance to meet the challenges of science teaching as envisaged by C2005 and to contribute to human resource developmental needs of South African science teachers warrant an effort to address this dilemma.

What is IK? Rather than answering this question abstractly references to sources A -M are made to reflect the term.

Source A

IK "is people's cognitive and wise legacy as a result of their interaction with nature in a common territory. Indigenous people, with a common history of colonisation by Western culture, constantly regenerate this knowledge".

Maurial 1999:62

Source B

"Indigenous knowledge is the local knowledge that is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for local-level decision making in agriculture, health, care food preparation, education, natural resource management and a host of other activities in rural communities".

Warren 1991:1

Source C

Indigenous knowledge is "the information base for a society which facilitates communication and decision making. Indigenous information systems are dynamic, and are continually influenced by internal creativity and experimentation as well as by contact with external systems".

Flavier et al 1995 cited in von Liebenstein 2000:7

Source D

IK is "the unique, traditional and local knowledge existing within and developed around specific conditions of women and men indigenous to a particular geographic area".

Grenier 1998:1

Source E

"Indigenous knowledge includes the botanical or pharmacological lexicons of peasants and tribal people, farmers' knowledge of soils, hunters' knowledge of animals, bakers' knowledge of yeast and dough, shamans' ability to read oracle bones, and the rules of football played in the schoolyards and sandlots around the world… Broadly defined, indigenous knowledge is the systematic information that remains in the informal sector, usually unwritten and preserved in oral tradition rather than texts…A narrower definition refers to the knowledge systems of indigenous people and minority cultures".

Brush 1996:4

Source F

The concept of IK includes "elders, parents, and neighbors teach[ing] and learn[ing] traditions that emphasise staying well rooted; strengthening the knowledge and skills needed to nourish and be nourished by their own places".

Prakash and Esteva 1998:3

Source G

Indigenous knowledge "reflects the dynamic in which the residents of an area have come to understand themselves in relationship to their natural environment and how they organise that folk knowledge of flora and fauna, cultural beliefs and history to enhance their lives".

Semali and Kincheloe 1999:3

Source H

"It *embraces knowledge of tools and techniques for assessment, acquisition, transformation, and utilisation of resources in their locality. It is indigenous (or local or tacit or practical) because it differs from the known forms of 'formal knowledge' (scientific, Western, modern, colonial) in the contextual sense (as IK is deeply rooted in its environment, history, and new experiences) and its epistemological nature (in the sense that IK is holistic)".*

Mwadime 1999:247

Source I

"Indigenous knowledge is not always visible, and even when it is, it is not always easy to understand because it is incorporated in a way of life… is characterised and circumscribed by local history, the environment, language, traditions and culture. These characteristics are however, unique to a community, even though they are constantly changing".

Semali 1999:103

Source J

Indigenous local knowledge is "the accumulation and dissemination of information in the form of shared environmental knowledge, beliefs and rules and techniques for productive activities. This form of traditional knowledge has developed over generations as a product of man-environmental interactions. During this development, its shared pattern of cognition and resource management strategies are constantly refined and modified by assimilating knowledge and strategies from surrounding cultures. The result is a set of shared terminologies (land types, soil types, plant indicators, climate, social organisation etc.) and accepted patterns of productive behaviour and interactions from the cognitive framework within which rural societies operate. Their knowledge systems may be seen to comprise a shared cognitive model of the empirical world, plus a set of rules and techniques for converting this model into meaningful activity which sustains the growth and development of society.

*At*te 1992: 3-4

Source K

"IK is unique to a particular culture and society. It is the basis for local decision making in agriculture, health, natural resource management and other activities. IK is embedded in community practices, institutions relationships and rituals. It is essentially tacit knowledge that is not easily codifiable".

Warren 1998:1

Source L

"You people get knowledge from books. We get knowledge from animals and things. The honey-cuckoo shows us where to find honey…".

Mukahamubwatu, Zambian Woman cited in Lalonde and Morin-Labatut 1993:1

Source M

"Indigenous knowledge – knowledge that has been produced by groups of people living in an area (such as province, country, continent) for a long period of time. Some of this knowledge may have served as the basis for modern technologies. In some instances, this knowledge and the wisdom that accompanies it have been lost, either because established practices have been changed or because people have moved away from the well-known environments"

DoE 2002:87

From sources A-M, it can be seen that none of the authors comprehensively define the term, indigenous knowledge. Several descriptions are afforded. However, an analysis of key words from their comments (Table 19) point to features that would enable many Western academics to assess IK production or comprehend its relationship with or place in the science curriculum.

Source	Key Words Defining IK	Analysis of Key Words
A	cognitive, wise; legacy;	IK passed down from generation to generation IK encompassed wisdom
	interaction with nature;	Relate to habitat in harmonious ways
	common territory;	People in a specific area
	colonisation by Western culture;	'Western' knowledge (WK) dominates. Differences between IK and WK exist
	constantly regenerated;	Dynamic and changing
B	local knowledge;	Knowledge of people in a specific area; IK is local
	unique to given culture or society;	IK is culture based
	IK contrasts with international knowledge;	Differences between IK and WK exist
	basis for local-level decision making in agriculture, health care…;	Not individualistic – number or people involved; adaptations to environment/ecosystems in which indigenous people live – IK is holistic
	rural;	Implies that IK may not be possessed by urban, nomadic or migrant communities.
C	information base;	Baseline from which knowledge can be drawn and added
	facilitates communication and decision making;	Not individualistic
	dynamic, continually, influenced by internal creativity;	Changing; ongoing; indigenous people themselves modify knowledge to enhance their lives; IK is holistic
	experimentation contact with external systems;	Selected IK modified by Western science which indigenous people 'feel' can enhance their lives; IK is holistic
D	unique, traditional and local knowledge;	Knowledge possessed by people in a specific area – IK is local
	developed around specific conditions;	Relate to habitat in harmonious ways
	particular geographic area	Demarcates given area/territory

Table 19: Analysis of Key Words from Source A – D

Source	Key Words Defining IK	Analysis of Key Words
E	botanical or pharmacological lexicons of peasants and tribal people, farmers' knowledge, hunters' knowledge, bakers' knowledge, shamans ability, rules of football played in schoolyards and sandlots;	Implies that any community – rural and urban, settled and nomadic, original inhabitants and migrants possess IK
	informal sector;	Implies knowledge possessed by elders and parents who have no paper qualifications
	unwritten, oral tradition rather than texts;	Not documented; passed on by word of mouth; IK is not written down ('agrapha')
F	elders, parents and neighbours;	Informal education
	emphasise, staying well rooted;	Implies living in harmony with the environment; IK is local
	strengthening knowledge and skills needed to nourish and be nourished;	IK is dynamic and changing to maintain sustainable lifestyles; IK is holistic
G	reflect the dynamic;	IK evolves – not static
	residents of an area;	Specific group of people in a specific area
	understand themselves in a relationship to natural environment;	Relate to habitat in harmonious ways; IK is holistic
	organise folk knowledge of flora, fauna, cultural beliefs;	Environmentally based; IK is holistic
H	Embraces knowledge of tools, techniques of assessment acquisition, transformation and utilisation of resources in their locality, deeply rooted in environment, history and new experiences and its epistemological nature;	IK is local; IK is holistic; IK is dynamic; IK acquires knowledge from other systems; IK closely related to environment; IK developed over a period of time
	local, tacit, or practical;	IK is local and part of people's lives; IK is holistic
	differ from 'formal education';	Differences between IK and WK exist

Table 19: Analysis of Key Words from Source E-H

Source	Key Words Defining IK	Analysis of Key Words
I	not always visible, not always easy to understand, incorporated in a way life characterised and circumscribed by local history, the environment, language. traditions and culture; unique to a community; constantly changing	IK is immersed in a whole culture; IK is alive in people culture; IK cannot be easily separated from people's everyday lives; IK is influenced by socio-cultural environment; IK is holistic Specific group of people – IK is local Dynamic
J	Accumulation and dissemination of information – environmental knowledge, beliefs and rules, techniques for productive activities, product of man – environment interactions, traditional knowledge; developed over generations; shared pattern of cognition and resource management and strategies, constantly refined and modifies by assimilating knowledge and strategies from surrounding cultures; rural societies meaningful activity…sustains growth and development	Knowledge developed over years; Knowledge passed on to younger generation; Many IK dimensions involved Based on experiences; often tested over centuries of use; IK is alive; dynamic and changing Community involved; Urban, migrants, nomadic communities excluded; People lead sustainable lifestyles;
K	unique to a particular culture; basis for local decision making in agriculture… Embedded in community practices, institutions, relationships rituals; tacit knowledge uneasily codifiable;	IK is local Community decision; Many IK dimensions involved IK is alive immersed in people's culture; IK is alive in people's lives; IK cannot be easily separated for everyday people lives
L	knowledge from books, knowledge from animals, knowledge from things;	IK differs for WK
M	groups of people in an area; long period of time; basis for modern technology; well known environments;	IK is local IK is developed and tested over time IK has been linked to modern systems Relates to specific areas

Table 19 : Analysis of Key Words from Source I - M

The analysis implies that many of them in their attempt to define IK:

- Link the term inextricably with colonialism.
- Take as their point of departure the WK system.
- Provide a perspective of human experience that differs from Western empirical science.
- Indirectly focus on the differences between two worldviews (Western science and IK).

Some of the differences between IK and Western science that emerge from the analysis shown in Table 19 and from the works on the subject, IK by researchers such as Viergever (1999:334-336) Mosha (1999:209-210) Jegede (1999:125) and Johnson(1992:77-8) are:

- IK is culture specific while Western Science is de-cultured (Brush 1996:4).
- IK is local and is not separated from practical life.
  Western science is learned and taught in a situation usually abstract from the applied context. Different from Western science IK is neither found in archives nor in laboratories (Maurial 1999:63; Johnson 1992:7; Mwadime 1999:247).
- IK is holistic; Western science is reductionist.
  Western science deliberately breaks down data into smaller elements to understand the whole and complex phenomena. IK views ideas and practices as one (Johnson 1992:7; Maurial 1999:63; Mwadine 1999:24). What Western science calls botany, zoology, physics, chemistry, etc. does not exist in IK. These various disciplines with others are “produced and reproduced within relationships as well as in their relationship with nature” (Maurial

1999:63). This Mosha (1999:209-210) succinctly describes as: “Everything that is thought, said and done is done in relationship to the whole of life experience. Everything that is known is known in the context of the entirety of life and for the purpose of furthering intellectual, moral, and physical growth…For them life is one, and knowledge is an intimate part of it”.

- IK is basically transmitted through oral tradition.
  Western science use written records (Johnson 1992:7; Brush (1996:4); Prakash and Esteva 1998:3; Mosha (1999:204); Semali and Kincheloe 1999: 8). Maurial (1999:63) describes this transmitting through oral traditions as agrapha, “not written down [directly]”.

- Learning in IK is communal.
  In Western science learning is an individual enterprise (Atte 1992: 4-5; World Bank 1998:1; Jegede 1999:125; Semali 1999:103).

- IK is mainly qualitative.
  Western science is mainly quantitative (Johnson 1992:7; Semali and Kincheloe 1999:8-9,13).

- IK is based on data generated by communities,
  Western science is generated by a group of researchers. Communal collection of data makes it more inclusive than Western science which tends to be more selective and deliberate in the accumulation of facts (Johnson 1992:8).

- IK is intuitive in its mode of thinking; Western science is analytical. Intuitive thought emphasises” emotional involvement and subjective certainty of understanding” (Johnson 1992:7). Analytical thought emphasises abstract thinking (Johnson 1992:7). Analytical reasoning is founded on the epistemological separation of knower

and known. This bifurcation lead to the conception of the world as a mechanical system divided into two distinct realms: an internal world of sensation and an objective world composed of natural phenomena. Using this bifurcation, Western science works in isolation from human perception and in doing so seeks to objectively undercover the laws of physical and social systems (Semali and Kincheloe 1999:26).

- IK is cumulative and collective experience that is constantly being revised daily and seasonally by creative and inventive community members as well as by external factors (Viergever 1999:336). In direct contrast Western science uses methods of generating, testing and verifying hypothesis and establishes theories and general laws as its explanatory basis (Johnson 1992:8).

- IK is based on shared knowledge of community members; Western science is hierarchically organised and compartmentalised (Johnson 1992:8).

The contrasting of Western science and IK reveals that IK is multi-faceted and can pertain to knowledge systems of indigenous people and minority cultures or to local, folk or informal knowledge in general. It is more often used as the former. IK is culture defined and it encompasses many ideas and concepts. The knowledge is built by a group of people living in a specific area and occurs over generations of living in close contact with nature. It includes a system of classification, observations about the local environment and self-management practices that govern resource use. It is orally transmitted and is both cumulative and dynamic, building upon the experience of earlier generations and adapting to new technological and socio-economic changes of the present.

It can therefore be said that IK includes information, skills, data, inspiration, intuition and wisdom that is always seen in the context of indigenous people's worldview and it is a holistic approach to life. This makes IK inclusive of two main aspects: education for living and education for life (Mosha 1999:216-217). An education for living is a formation process in which children and youth learn all necessary information, skills and techniques to live their culture and to earn a livelihood. An education for life, on the other hand, is one that moulds "the inner most core dispositions of a person" (Mosha 1999:217). It provides wisdom and enlightenment to enable one to acquire fundamental human dispositions such as reverence for others, self-control, thoughtfulness, courage, co-operation, hard work honesty etc. Education for life is the foundation on which education for living is based (Mosha 1999:217). The ideas and concepts of local, holistic, contextual, cultural, "agrapha", nature, environment, sustainable living etc. thus abound in attempts in defining the term.

The linking of the term with colonialism, using WK as the point of departure and indirectly focussing on the differences between Western science and IK is an unconventional way of defining a term. Why analysts and researchers adopt this stance warrants asking the following question:

Why is Western science used as the benchmark in defining IK?

A key to comprehending the power of Western science involves its acceptance as the dominant knowledge system in both the Northern and the Southern hemispheres (von Liebenstein 2000:6). Western science, like any other system constructs or makes the world it studies and describes (Semali and Kincheloe 1999:28). With the coming of the Scientific Revolution, or the Age of Reason in the 16th and the 17th centuries, Western scholars began contemplating a new way of perceiving the natural world, a way that would enable them to understand and control the outside world (Semali and Kincheloe 1999: 26). Along with Sir Francis Bacon, who established the supremacy of

reason over imagination, Descartes, with his *cogito ergo sum* (separation of mind and matter) and Newton, with his belief that the future of any aspect of a system could be predicted with absolute certainty if its condition was understood in precise detail and the appropriate tools of measurement were used, laid the foundation that allowed Western science and technology to change the world (Semali and Kincheloe 1999:27-29). Once established this Cartesian-Newtonian concept was developed in schools, universities, research institutions and industrial firms in the Northern hemisphere (von Liebenstein 2000:6). This concept gradually spread over the developing world as the dominant political, value and career system (von Liebenstein 2000:6). Such a way of seeing served to devalue IK because Western scientists rejected the knowledge of indigenous people as anecdotal, non-quantitative, without method and unscientific (Hobson n.d.:1). The notion of IK as a "subjugated knowledge" which Foucault (1980:82) describes as "disqualified knowledge" because of it being inadequate to its task or being insufficiently elaborated thus emerged (Semali and Kincheloe 1999:31).

The subjugation of IK by Western science and its episteme according to Shiva (1993:9712) created monocultures of the mind "which made local knowledge [IK] disappear, "very much like the introduction of monocultures destroying the very conditions for diverse species to exist". This meant that IK was denied the opportunity to play a role in aspects of life. Education was no exception. As a consequence IK was classified as non-scientific, non-universal and treated in contrast with Western science. In this context Western science established itself as being the only knowledge worth discussing in academic settings (Semali and Kincheloe 1999:31). The knowledge Western science produced became the benchmark in the late 17th century by which IK was measured (Semali and Kincheloe 1999:31). This Western view, considered as "superior stages of society" with its "super truths" of modernity i.e. progress, civilization, development, and literacy (Maurial 1999:60) "justified the civilizing efforts of the white man's burden and the pedagogical dynamics embedded in the concept" (Semali and

Kincheloe 1999:31) from the late 17th century until the early 20th century.

Resistance to Western science dominating classroom science teaching and learning such as the ones quoted by Tagore (cited in Pandey 1991:221) and Rains (1999:328-329), against this "civilizing efforts" that entangled Western society "in a mode of perception that limited thinking to concepts that stay within white, Western, logocentric boundaries, far away from the No Trespassing sign of indigeneity" (Semali and Kincheloe 1999:34), subsequently occurred in the early 20th century.

"*We have for over a century been dragged by the prosperous West behind its chariot, choked by the dust, deafened by the noise, humbled by our own helplessness, and overwhelmed by the speed. We agreed to acknowledge that this chariot-drive was progress…If we ever ventured to ask "progress towards what, and progress for whom?' it was considered to be peculiarly and ridiculously oriental…Of late, a voice has come to us bidding us to take count not only of the scientific perfection of the chariot but of the depth of the ditches lying across its path".*

Tagore cited in Pandey 1991:221

"As an indigenous educator and scholar I am gravely concerned that when we fail to include sophisticated understandings of indigenous knowledge in the curriculum …when we buy into the contemporary intellectual authority, we are granting jurisdiction over our complacency within the status quo. The time has come…It is essential that indigenous knowledge be acknowledged as legitimate and valuable, but just as importantly, it is crucial to understand how it can be denied, for herein lies the power to consider change, to consider social justice, as well as the social and political ramifications of a hegemony composed of historical amnesia and intellectual authority. Let no child suffer the consequences of our inertia about indigenous knowledge, and how too often it is relegated to the status of the "Other." It is time we learn our collective history."

Rains 1999:328-329

Inspired by ideologues, theoreticians and pedagogues such as Gandhi, Nyerere and Tagore and by Agenda 21 of the Earth Summit held in Rio de Janeiro, for IK to receive acceptance on a global level and not be seen as inferior, "subjugated knowledge", provided opportunities in the 20th century to IK analysts which included Western scholars concerned with the plight of IK being deployed "as a tool of oppression" (Semali and Kincheloe 1999:25) to enter in profound transformative

negotiations around the complexities of the two different world views: Western science and IK. The task to deconstruct the Western version of the term, IK thus began.

This task, however, needs to be approached with due respect and caution to avoid further marginalization of non-Western people (Semali and Kincheloe 1999:18). Adopting the cautionary approach also requires analysts to heed the warnings of Paulo Freire and Antonio Faundez cited in Semali and Kincheloe (1999:22) and Reynar (1999:293). The former cautions analysts to avoid the tendency of romanticization that often attempt to restore the indigene to a pure pre-colonial cosmos. The possibility of some magical return to an uncontaminated pre-colonial past does not exist, as all cultures are perpetually in a state of change (Semali and Kincheloe 1999:22). Reynar (1999:293) cautions analysts not to view IK as a resource that can be exploited for economic growth. Hence Semali and Kincheloe (1999:44) advocate that IK be framed not as a resource to be exploited for economic benefit of the West but "as a perspective that can help change the consciousness of Western academics and their students". Hence in this reconceptualized epistemological context analysts are cautioned by Semali and Kincheloe (1999:3) to carefully tread the "dangerous terrain" in their attempt to deconstruct the Western version of the term IK. Analysts are urged "to consider the process of knowledge production and the truth claims in relation to the historical setting, cultural situatedness, and moral needs of the reality they confront" (Semali and Kincheloe 1999:18). Such action is deemed necessary to force analysts "to consider their political and pedagogical actions in a more tentative and culturally informed manner" (Semali and Kincheloe 1999:18). This negates analysts simply turning to the authority of Western science.

Another probability as to why Western science is used as a benchmark is afforded by Semali and Kincheloe (1999:45). They state:

- Western science is a powerful force at work both at the macro-structural level and in the everyday micro-dynamics of our lives.

- A key to an individual's education involves an understanding of the socio-political role of Western science.

- No discourse has a positive claim to universal, authoritative knowledge.

- There is no universal indigenous curriculum to be factually delivered to learners in various locations.

Contrasting WK and IK is thus seen as being "more empowering than a narrow focus on homogeneous cultural traditions" (Semali and Kincheloe 1999:47).

Such an approach can reduce the chance of any study of IK falling prey to the proponents of Western science. Informed in this way it is envisioned that attacks directed at IK such as "one more example of "irrationality", of a "return to the Dark Age, of "barbarians at the gate of civilization" (Semali and Kincheloe 1999:28) will be overcome. Instead it is hoped that individuals come to believe that Western science is not the only legitimate knowledge producer and that all "can learn from difference, from profound insights and the limitations of the various ways of seeing the world and the humans that inhabit it" (Semali and Kincheloe 1999:51-52).

3.3 RATIONALE FOR THE INCLUSION OF IK IN THE NATURAL SCIENCE LEARNING AREA OF C2005

South Africa, like many other independent African countries inherited and adapted the former colonizer's system of education. During the apartheid years the colonial worldview dominated other worldviews.

Central to the colonial worldview was the notion of the superiority of Western science and the inferiority of IK. A clear dichotomy thus emerged between Western science and IK. Science policy documents during the apartheid years thus reflected Western patterns that served to legitimise this notion and concurrently de-legitimise IK. IK therefore was not part of what learners learnt at schools. Hence schools undermined IK. Three main ways on how this was done can be identified. First, it failed to put forward IK as worthwhile subject matter for the learning process. This implied an imposition of Western culture over other cultures. Second, it limited the exposure of learners to IK of their communities. Very little was done to raise awareness of the importance of local resources, values and indigenous modes of production and management. Third, it created attitudes in learners that militated against the acquisition of IK. The result of these three negative ways detached learners from their daily lives and attempted to destroy the science and technology of their cultures and hence their cultural, social and ecological roots.

The education policies and programmes implemented by the former government therefore brought learners to believe that their IK is primitive relative to knowledge gained from formal education. These policies thus operated to deeply erode IK s' cultural rubrics and usher in a Western type of science inscribed with ideas of modernism. This meant that learners having different perspectives, other than the Western one, had to find a way to accommodate and make sense of both worldviews (the traditional and the Western one) to provide the skills to function in traditional societies and to master the abstract body of Western science knowledge. As a result the two worldviews competed for attention and "conflictual education" (Maurial 1999:66) emerged in the majority of science classrooms. Along with this, there was also spatial conflict that surged from Western science pedagogy's practice of indoor education (Maurial 1999:69). Doing scientific experiments, in ecology, of which many are often mere verifications is

insufficient to claim that schools are equipping learners to be ecologically literate. This spatial conflict reflects a break with the local aspect of indigenous knowledge practices (Maurial 1999:70). In addition, Western science pedagogy creates temporal conflicts (Maurial 1999:70). This it does by the fragmentation of science knowledge into different disciplines and courses that are further fragmented into designated time periods through the adherence to a school schedule (Maurial 1999:70). IK does not talk about or set time to study botany, zoology, life sciences, chemistry, physics, physiology, mechanical engineering, biochemistry etc. All this is immersed and alive in people's culture.

Thus, the former government's education policy grounded in a Western modernist epistemology of disciplinary fragmentation and superior truths created a curriculum divide between "indigenous" and "modern". This divide failed "to teach students the unique cultural patterns by which people develop and advance their social worlds, and it ignores the ways in which cultural beliefs and practices, combine with folk and modern ways of doing things" (Semali 1999:96). The ultimate goal to facilitate the empowering of learners with an indigenous base to understand and evaluate what Western science has to offer and to make judicious choices between their IK and Western science when such situations arise was deliberately overlooked.

In summary, science education that ought to be "a cultural and human enterprise involving the transmission of cultural heritage of a people" (Jegede 1999:126) attempted to erase and decontextualise IK and concurrently render teachers and learners vulnerable to the myths employed to perpetuate Western science domination. A political and not an educational choice decided what was knowledge and what was not knowledge.

Given the above history, curriculum designers of the natural sciences learning area of C2005 found it necessary to include IK in its Western science curriculum to initiate the process to produce an indigenously informed, inclusive and just science education. This type of science education endeavours to broaden the curriculum and make it distinctively South African (DoE 2002:12). The use of IK in the teaching and learning of science is prescribed only for learning outcome 3. This according to the Revised National Curriculum Statement Grades R-9 (Schools) Policy (DoE 2002:10-13) means that the inclusion of IK offers opportunities to the science teacher to:

- Provide education that could help people to become problem solvers by revisiting traditional/indigenous practices and technologies.

- Rediscover people's wisdom that has been almost lost in South Africa in the past 300 years and critically examine its value for the present day.

- Permit learners to acquire increased understanding of the way values influence people's choices of technological and scientific solutions.

- Engender greater respect for the different worldviews that learners bring to the science classroom and to learn from these ways of knowing to foster a new but really old literacy, an ecological literacy to effectively manage the environment in which people live and depend on.

Although just four implications of using IK are prescribed in The Revised National Curriculum Statement Grades R-9 (Schools) Policy

(DoE 2002:10-13) further implications are revealed from a literature study. Including IK in the curriculum and using it cautiously to avoid further marginalization of non-Western people and exploitation of IK as a resource:

- Opens a new dialogue about the nature and the production of knowledge (Maurial 1999:70).

- Indicates that Western science is not the only lens through which to look at the world (Semali and Kincheloe 1999:47).

- Questions Western science's pretensions to universality (Maurial 1999:73).

- Reduces the risk of supravaluation of Western science and the continued devaluation of indigenous ways of knowing thereby granting IK a level of respect it has traditionally not received (Semali and Kincheloe 1999:47).

3.4 THE USE OF IK IN THE TEACHING AND THE LEARNING OF SCIENCE

The statements below from the Revised National Curriculum Statement Grades R-9 (Schools) Policy (DoE 2002:7) create an opportunity to use more IK than stipulated in the natural sciences learning area.

> *The core knowledge and concepts (Appendix 1) "represent a time allocation of 70% of the time for the natural sciences Learning Area in a Phase. Teachers are encouraged to view the remaining 30% of the time as available for extending the core and for curriculum development around contexts which are significant to learners and the local community. These may be economic, environmental, social or health contexts. This policy creates an opportunity for curriculum development and teacher professional development at schools and district levels, and enables learners to demonstrate outcomes in issues which have relevance to their lives"*
>
> DoE 2002:7

This extract implies that the use of IK need not be restricted only to learning outcome 3. IK can also be used in the development of learning outcomes 1 and 2. Operating in this way enables teachers to construct a curriculum that moves away from restricting itself to the narrow confines of content to a broader scope that allows for cultural diversity and critical inquiry to empower learners to evaluate different word-views and make informed choices for the conduct of their lives in their traditional societies and in the world of capitalism and global economy. Seen in this light C2005 is deemed as being "an enabling document rather than a prescriptive one" (DoE 2002:12).

Given this flexibility, this research study embarked on a literature study to elicit the dimensions of IK that can be applicable to the senior phase of the natural sciences learning area. Due to space constraints, it is impossible to provide all the details of rural people's knowledge in the selected dimensions of IK. Some examples of the dimensions of IK (coded A-J for referencing later) that would allow for more meaningful science teaching and learning at the senior phase are therefore listed in Table 20.

IK Dimension Code	IK Dimension – Knowledge of…	Literature Source
A	their physical environment	(Maurial 1999:65; Atte 1992:1-16)
B	their flora and fauna	(McDonald Fleming 1992:69-87; Maurial 1999:65; Warren 1992:2-3)
C	their agricultural practices	(Parrish 1999:270-275; Easton and Ronald 2000:1-4; Warren 1991:1-31)
D	their veterinary practices	(McDonald Fleming 1992:69-87)
E	Plants for medical treatment	(George 1999:85; Moran 1999:1-4; Lambert 2001: 1-4; van Damme 1999:85-91)
F	life processes and healthy living	(George 1999:85; Prakash 1999:163,171; Mwadime 1999: 254-255)
G	conserving the environment	(Warren 1991:1-31; Warren 1992:2-3; Mosha 1999:214; Atte 1992:1-16)
H	conserving natural resources	(Warren 1991:1-31; Warren 1992:2-3; Mosha 1999:214; Atte 1992:1-16)
I	conserving biodiversity	(Warren 1991:1-31; Warren 1992:2-3; Mosha 1999:214; Atte 1992:1-16)
J	indigenous engineering	(Parrish 1999:275-276; Quiroz 1999:310; Atte 1992:1-16)

Table 20: Rural People's knowledge applicable to Science Teaching at the Senior Phase

An analysis of the core knowledge and concepts reveals where in the senior phase natural sciences learning area the tabulated IK dimensions could be used to teach science in a more meaningful way and hence capture the interest and challenge the intellect of learners. Tables 21-24 show the selected core knowledge and concepts and the IK dimension (depicted in code form) which, could be used in the teaching of science. The selected core knowledge and concepts could be used to build and/or extend the learning outcomes 1-3 to provide opportunities for teachers to:

- Expose learners to both knowledge systems i.e. IK and Western science (George 1999:85).

- Focus on the ways knowledge is produced and legitimatised (Semali and Kincheloe 1999:34).

Life Processes and Healthy Living	**IK Code**	**Interactions in Environment**	**IK Code**	**Biodiversity, Change and Continuity**	**IK Code**
Senior Phase					

Life Processes and Healthy Living	IK Code	Interactions in Environment	IK Code	Biodiversity, Change and Continuity	IK Code
Humans go through physical changes as they age; puberty means that the body is ready for sexual reproduction.	F	Human reproduction is more than conception and birth; it involves adults raising children, which requires judgement and values and usually depends on the behaviour of other people in a community and environment.	F	Natural selection kills those individuals of a species which lack the characteristics that would have enabled them to survive and reproduce successfully in their environment. Individuals who have characteristics suited to the environment reproduce successfully and some of their offspring carry the successful characteristics. Natural selection is accelerated when the environment changes; this can lead to the extinction of a species.	G H
Conception is followed by a sequence of changes in the mother's body, and during this period the future health of the unborn child can be affected.	F	Each species of animal has characteristic behaviours which enable it to feed, find a mate, breed, raise young, live in a population of the same species, or escape threats in its particular environment. These behaviours have arisen over long periods of time that the species population has been living in the same environment.	A B	Biodiversity enables ecosystems to sustain life and recover from changes to the environment. Loss of biodiversity seriously affects the capacity of ecosystems and the earth, to sustain life. Classification is a means to organise the great diversity of organisms and make them easier to study. The two main categories of animals are vertebrates and non-vertebrates, and among vertebrates the five classes are amphibians, birds, fish, reptiles and mammals.	B I

Life Processes and Healthy Living	IK Code	Interactions in Environment	IK Code	Biodiversity, Change and Continuity	IK Code
Knowledge of how to prevent the transmission of sexually transmitted diseases, including the HI Virus, must be followed by behaviour choices.	E F	All organisms have adaptations for survival in their habitats (such as adaptations for maintaining their water balance, obtaining and eating the kind of food the need, reproduction, protection or escape from predators.)	A B	Human activities, such as the introduction of alien species, habitat destruction, population growth and over-consumption, result in a loss of biodiversity. This becomes evident when more species become endangered, or, ultimately, extinct	B G
Water makes up large proportion of all living things, and their health depends on water passing through them in various ways, using structures (such as kidneys, skin or stomata) which can fulfil this function.	F	An ecosystem maintains numerous food webs and competition between different individuals and population. South Africa has certain ecosystems which have exceptional biodiversity. All uses of these areas must be based on principles of sustainable development.	A B G H I		
		Pollution interferes with natural processes that maintain the interdependencies and diversities of an ecosystem.	G		
		Many biological changes, including decomposition and the recycling of matter in ecosystems and human diseases, are caused by invisibly small, quickly-reproducing organisms.	C		

Table 21: Core Knowledge and Concepts in Life and Living that lends itself to IK Teaching

Energy Transfer and Systems	IK Code	Energy and Development in South Africa	IK Code
Senior Phase			
Energy can be stored in a system as potential energy, either by the position of the bulk parts of the system or by its particles (atoms and molecules) which have the potential to react with each other and release energy. Examples of potential energy are the stored energy of a compressed spring or the stored energy of particles which could react in a fuel-and-air mixture, or in the food and body of a living thing	J	Energy sources such as wind, sun, and water in high dams are renewable. Fuels such as coal, gas and oil are not renewable energy sources, because they cannot be replaced.	J
Potential energy can be released as kinetic energy in the motion of parts of the system, either in the motion of bulk parts of the system or in the motion of particles of the system. Examples of the release of kinetic energy are the motion of a released spring or the faster motion of the particles of hot gases when a fuel-air mixture burns, or the body movement of humans or animals. Kinetic energy is transferred to parts within the system and energy is also transferred to the system's surroundings. When energy is transferred, it causes changes in the system and the system's surroundings.	J	Many people in South Africa use wood for heating and cooking. Plants such as trees can be a renewable energy source if more trees are planted and the soil is managed well.	A F
There is an unlimited umber of systems which can be made to store or transfer energy. The possible systems include electrical, mechanical (including spring and friction systems), chemical, gravitational, nuclear, solar, biomass, optical (light), acoustical (sound) and thermal (heat) systems as well as human bodies and ecosystems.	J		
Hot object transfer energy to colder objects, until the objects reach the same temperature. Hot objects transfer their energy, as heat, in three ways: by conduction, by convection and by radiation. These transfers may be useful or wasteful. Wasteful heat transfer can be controlled by reducing conduction, convection and radiation in a system. Similarly, useful heat transfer can be increased by improving, conduction, convection and radiation in a system.	J		
All organisms in an ecosystem need energy from other parts of the ecosystem. Energy is transferred from part to part of an ecosystem and each part retains only a fraction of the	A B		

Energy Transfer and Systems	IK Code	Energy and Development in South Africa	IK Code
energy it receives.			
Light travels away from a light-giving body until it strikes an object. The object may then absorb the light, refract it or reflect it. Light transfers energy to other objects.	J		
Objects can exert force on each other, thereby forming a system which can store or transfer energy. They may do so by physical contact or by forces which act through a field. Field forces are the magnetic, electrical and gravitational forces. All forces act in pairs, so that if body A exerts a force on body B, B exerts an equal and opposite force on A.	J		

Table 22: Core Knowledge and Concepts in Energy and Change that lends itself to IK Teaching

Our Place in Space	IK Code	Atmosphere and Weather	IK Code	The Changing Earth	IK Code
Senior Phase					
The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle.	C F			Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crystal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.	A

Table 23: Core Knowledge and Concepts in The Planet and beyond that lend itself to IK Teaching

Properties and Uses of Material	IK Code	Structure, Reaction and Changes of Material	IK Code
Senior Phase			
Substances in different states ('phases') have distinctive properties such as crystalline structures, or compressibility/incompressibility, or tendency to diffuse.	D E J	Many chemical reactions need some energy to get started; many chemical reactions give off energy as they happen	J
A pure substance cannot be separated into different substance, while a mixture can be separated, usually by physical means. Differences in properties can be used to separate mixtures of different substances (by methods such as filtration, distillation, evaporation, chromatography or magnetism).	D E J		
Extracting useful materials from raw materials depends on chemical reactions and methods of separation.	E I		
Raw materials, from which processed materials are made, must be mined, grown or imported from other countries. Raw materials that are mined non-renewable and mining have environmental costs. Growing raw materials involves choices about the use of arable land and water catchment areas.	A G H		

Table 24: Core Knowledge and Concepts in Matter and Materials that lends itself to IK Teaching

George (1999:85) opines that it could be possible to illustrate relationship/s between IK and Western science by using the following four categories:

- Category 1- The indigenous practice can be explained in Western Science terms.

- Category 2- A Western science explanation for the IK seems likely, but is not yet available.

- Category 3- A Western science link can be established with the IK, but the underlying principles are different.

- Category 4- The IK cannot be explained in Western science terms.

Categories 1 and 3 lend themselves to easier implementation than categories 2 and 4. Examples cited by George (1999:86) and Mwadime (1999:252) illustrate the difficulty level regarding implementation. Categories 2 and 4, make fertile ground for research that could go beyond the capabilities of learners at the senior phase (George 1999:86). The overall aim of science teaching in this regard should therefore be to expose learners to both systems so that learners would be better empowered to make their own decisions about how they would wish to conduct their lives (George 1999:86).

Whilst the use of IK in the teaching of science is strongly advocated (Semali and Kincheloe 1999:53; Maurial 1999:73; George 1999:84; Semali 1999:110; Jegede 1999:136; Mosha 1999:217; Mule 1999:238; Mwadime 1999:263) it must be borne in mind that the process of using IK in the classroom is not a simple one. The main hurdle to be overcome is the fact that IK is not normally “packaged” as Western science materials are. The teachers must, therefore, first access the IK, then understand it and its likely relation to what is going to be taught in the science class. Furthermore, teaching strategies for using it

effectively must be devised. These are unfamiliar activities for teachers (George 1999:84). South African teachers are no exception.

3.5 COLLATERAL LEARNING AND SCIENCE EDUCATION AS PROPOSED IN C2005

The majority of learners attempting the natural sciences learning area at the senior phase are learners from a non- Western culture. This implies that many of these learners enter science classes with a traditional cosmology that is not acceptable to Western science (Jegede 1999:130). These learners therefore live in two domains (Jegede 1999:131). When faced with science in the classroom a non-Western learner begins to grapple with the need to resolve understanding a science concept from the two domains. If this is what happens to most of the non-Western learners, then a pertinent question to ask at this point is:

Will the teaching of the core knowledge and concepts of C2005, that are mainly orientated toward Western science, preclude an understanding of science as proposed in the policy?

To date, very little is known about how non-Western learners learn and the cognitive processes that occur when learning science concepts (Jegede 1999:119). However, research conducted over a decade into science teaching and learning in non-Western cultures with particular reference to Africa, seem to point to the influence of socio-cultural factors on the learning process and the theory of collateral learning as points of departure to afford some insight to the question posed above (Jegede 1999:129-135).

The socio-cultural factors control, to a very large extent what a learner in a Western science class learns because every person “tends to resolve puzzles in terms of the meanings available in a particular socio-cultural environment…” (Ogunniyi 1988:10). Furthermore, these meanings become firmly implanted in the cognitive structure of a

person and “may act as templates, anchors or inhibitions to new learning” (Ogunniyi 1988:10). What this means is that a strong relationship exists between what socio-cultural knowledge is implanted in a person cognitive structure and what is learned. The two appear inseparable with the former nurturing the latter.

Atwater (1994:560) supports the above view by claiming that a learner’s “prior knowledge, expectations, and preconceptions serve as filters for information”. She further states that “in science classes the ideal way for students to understand science concepts includes students challenging the new concept, grappling with it, attempting to make meaning of it and eventually integrating it with what they already know” (Atwater 1994:560). When this happens, Jegede (1999:131) states, that collateral learning results.

Jegede (1999:133) opines that four major types of collateral learning can occur when a non-Western learner learns Western science and teachers can guide a learner’s progress from one to another type. The four major collateral learning types are parallel, simultaneous, dependent and secured collateral learning.

Parallel learning occurs when a learner learning new science concepts acquires and maintains in long- term memory opposing schema about an idea or concept. The learner displays no confusion. He/She perhaps just readjusts memory to accommodate the two worldviews. The new information coexists in his/her schemata while attempts are made to understand what they all mean (Jegede 1999:134).

A non-Western learner is sometimes placed in a situation where he/she has to learn ideas about a particular concept from an indigenous perspective and from a Western perspective at the same time. A learner, depending on the extent of his/her knowledge base, therefore interacts with both sets of ideas and concepts simultaneously. The concept, however, does not become embedded immediately in the long-term memory. The information has to be processed over a period

of time. Simultaneous collateral learning occurs when the two sets of ideas are simultaneously assessed (Jegede 1999:134).

Dependent collateral learning occurs when a schema from a worldview challenges another from a different worldview. This triggers the process to permit a learner to modify his/her existing schemata. A belief can be altered by incorporating ideas from the new schema or by the rejection of the one being held (Jegede 1999:134).

Secured collateral learning occurs when a learner encounters and resolves cognitive conflict. The learner evaluates the seemingly conflicting worldviews and draws from them a convergence towards commonality. This strengthens the learning process and "secures the new conception"(Jegede 1999:135).

These four types do not necessarily occur separate from each other. Ogunniyi (1988:10) supports this theory of collateral learning using the argument of duality in belief and understanding and Cobern (cited in Jegede 1999:133) emphatically declares that traditional culture [IK] "poses no threat to logic and thus need not be viewed as an impediment to the learning of modern science".

The above discussion therefore seems to point to the belief that the cognitive activity of non-Western cultures and its associated IK, in theory need not be viewed as an impediment to the learning of Western science. Successful implementation of C2005 will, however, hinge on having critical, multicultural, science teachers that must :

- Give IK the necessary seriousness it warrants in the natural sciences curriculum and not see it as a mere curricular add on that provides diversity and "spice" to the Western aspect of the curriculum.

- Focus attention on the way knowledge is produced and legitimated.

- Become researchers (hermeneutists and epistemologists).

3.6 CONCLUSION

The term IK defies a universal definition. Different authors use the term to denote the different methods of teaching and learning that exists within the social, political, cultural, ecological and epistemological contexts of local people. Knowledge production of indigenous people as well as of any other defined community is embraced by them. The term is inextricably linked with colonialism, takes as its point of departure WK and highlights differences between the two worldviews. The reductionistic binarism of IK versus WK is done more to empower than to narrowly focus on homogenous cultural traditions.

An analysis of the term, IK indicates its multi faceted nature. Many ideas and concepts such as local, holistic, contextual, oral tradition (agrapha), community, communal, qualitative, intuitive, cumulative, collective, shared knowledge, indigenous people and lay people are encompassed. IK is not fragmented and indigenous people in their existential, holistic paradigm view education's two elements (education for life and education for living) as being inseparable.

In spite of IK's usefulness for a variety of purposes in a plethora of contexts, Western science viewed IK as "subjugated" knowledge. This, however, is changing. From the early 20th century to date interest in IK has grown, is still growing and efforts of including IK in school curricula are increasing.

The re-conceptualising of education for transformation in South Africa in the post apartheid era sees IK as an essential component of C2005. A content analysis of the core knowledge and concepts at the senior phase of the natural sciences learning area reveals more scope for the use of IK in the teaching and learning of science than what is actually

stipulated in the Revised National Curriculum Statement Grades R-9 (Schools) Policy.

Presently an enormous gap exists between Western science and IK. In order to promote IK in C2005 that is literally loaded with “superior truths” of modernity i.e. progress, civilization, development, it is imperative for researchers, curriculum and instructional designers and expert professionals who advice governments, to develop progressive teachers who will not conceal, crush or hinder the development of the learner’s thinking (Mule 1999:237). The four types of collateral learning being guided to progress from parallel through simultaneous, through dependent and finally to secured collateral learning, from a theoretical perspective, seem to point a way forward to school science addressing both knowledge systems.

Admittedly, developing and empowering teachers with such pedagogical skills are intellectually demanding and will take much time and detailed research and study for everyone involved as a number of issues are implicated. The adoption of IK will not in itself make education more sensitive and relevant to the socio-cultural environment of the learner as it is rarely a purely educational issue. This, however, should not deter one in South Africa with its “enabling” C2005 from creating channels to foster a workable beginning toward an intercultural education with an inclusive and just science curriculum that Nyerere and Gandhi called for decades ago. A starting point for all involved in education could perhaps be respecting IK, acting ethically and “seeing broadly” in their endeavour to achieve the critical and developmental outcomes outlined in C2005.

CHAPTER FOUR

DESIGN OF THE RESEARCH PROCESS

4.1 INTRODUCTION

The fragile state of the planet Earth is highlighted in Chapter One. Modernist, human activities are cited as the main agent leading to this dismal picture. Heeding the “wake up” call sounded by the Living Planet Report of 2002 to help prevent further degradation of the planet lies possibly with the use of IK in the teaching and learning of science at school level. This is no easy task. The rapid erosion of IK and the dysfunctional state of the education system in many South African schools lingers like long shadows over this possibility.

The design of C2005, its promises and realities and ways of seeing the inclusion of IK in C2005 outlined in Chapters Two and Three respectively, however, does show rays of hope. The inclusion of IK concerning the use and management of natural resources in some of the science learning programmes at the Senior Phase is probably a beginning to allow learners to think deeply about how humans can use IK and WK to help overcome the present ecological deficit. Such a science would link all its practitioners and participants (indigenous and modern ones) in bonds that are respectful towards our fragile Earth. Moreover it would be supportive of IK’s struggle to revaluate its status and this in turn would lead to South Africa’s envisioned, indigenised curriculum for the natural sciences at the senior phase.

This chapter focuses on a research design to:

- Elicit from a sample of people well versed with the topic IK of how South African natural science teachers may perceive the use of IK in the teaching and learning of science, the delivery of lessons using IK as a teaching resource, the possible obstacles facing these teachers and possible strategies they may use to draw IK from their communities.

- Plan relevant learning programmes that could contribute to the use and management of natural resources to help save the Earth.

4.2 THE RESEARCH DESIGN

The research design depicted in Figure 29 is the plan and structure of investigation envisioned to obtain the perceptions of the interviewees regarding the use of IK in the teaching and learning of science. The design strategy shown in the rectangle is the focus of this chapter. The remaining aspects of the research design (data analysis and interpretation, research reporting, recommendations and implications) will feature in the subsequent chapters.

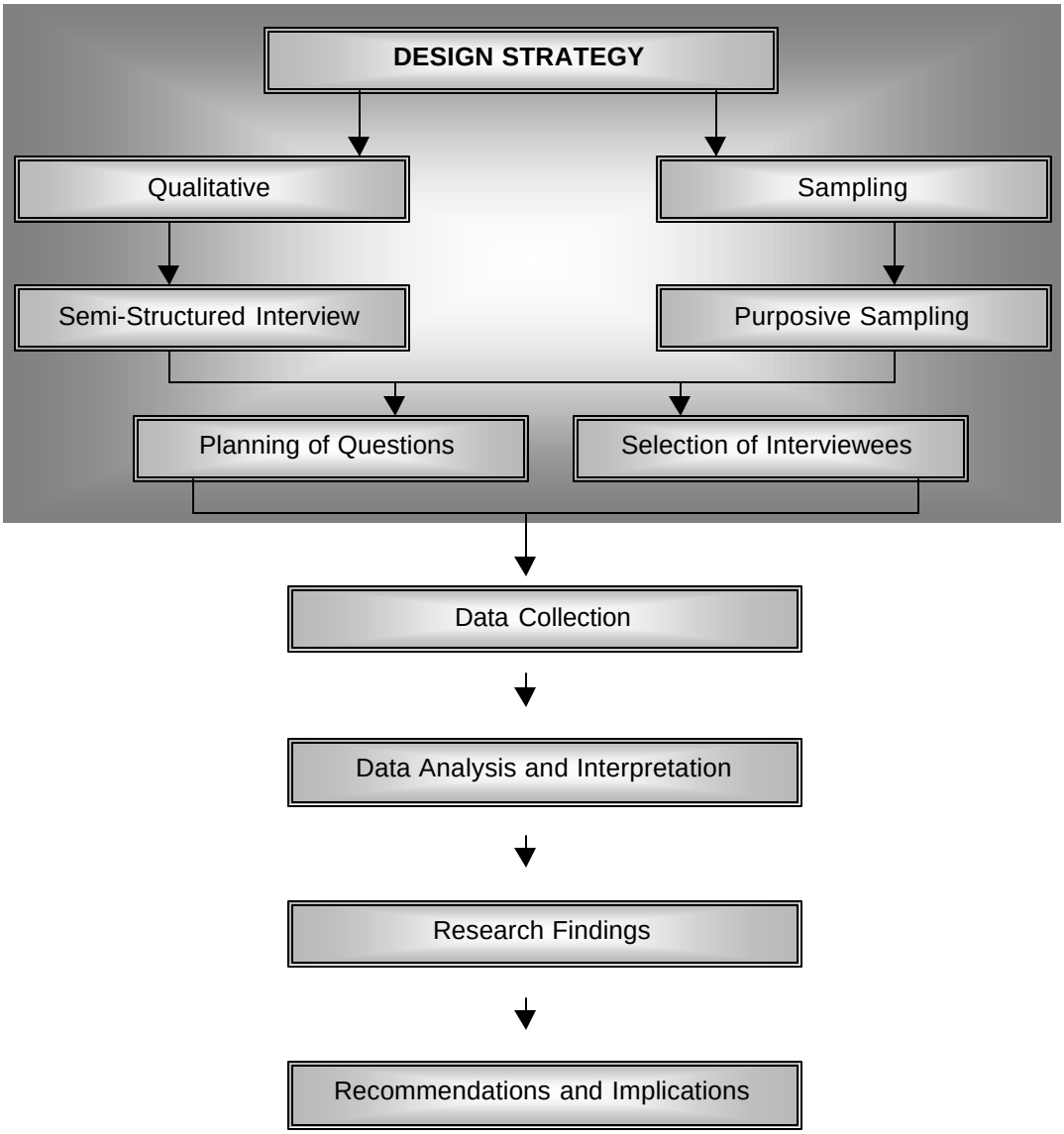


Figure 29: Flow diagram illustrating the Research Design

4.3 DESIGN STRATEGY: QUANTITATIVE OR QUALITATIVE RESEARCH METHOD?

Quantitative and qualitative research methods are forms of inquiry in research studies. Either one of these two research methods or a combination of both can be useful and legitimate for a research study (Hammersley 1992:182; Babbie 1998:38; Silverman 2000:12). This implies that the design strategy (Figure 29) can assume only a quantitative research method, only a qualitative research method or a combination of both.

The quantitative research method elucidated by Descartes in 1637 emphasised that natural philosophy should be refocused around the "certainty and self-evidence" of mathematics (Denzin and Lincoln 1998:116). Quantitative research thus tends to gather data in the form of numbers (Gable and Rogers 1987:692) that can be statistically analysed, ranging from simple averages to complex formulas and mathematical models (Babbie 1998:37).

Not all philosophers, however, supported Descartes's stance (Denzin and Lincoln 1998:116). In 1781 Kant proposed the idea of qualitative thinking and the fact that "perception is more than seeing" (Denzin and Lincoln 1998:117). Kant (cited in Denzin and Lincoln 1998:117) proposed that human perception depends on evidence obtained from the senses and also that obtained from mental processes that organize the incoming sense impressions. This proposition that deviated drastically from Cartesian objectivism may have ushered in the possibility of qualitative research (Denzin and Lincoln 1998:117). Its origin, however, emerged in the late 18th century from the attention given to the collection of data on human conditions (Denzin and Lincoln 1998:117).

Quantitative and qualitative research methods defy simple descriptions (Smith 1987:173; Silverman 2000:1). Nonetheless features commonly

used in defining these two methods are afforded by Halfpenny (cited in Silverman 2000:2). These features are shown in Table 25.

Qualitative	Quantitative
Soft	Hard
Flexible	Fixed
Subjective	Objective
Political	Value-free
Case study	Survey
Speculative	Hypothesis testing
Grounded	Abstract

Table 25: Claimed Features of Qualitative and Quantitative Methods (Halfpenny cited In Silverman 2000:2)

The features in Table 25, however, do not point to which research method should rule the roost as a form of inquiry simply because it depends entirely on a researcher's point of view (Silverman 2000:1). Some may view the quantitative method as being superior because it is supposedly value free whilst others might argue that value freedom in societal issues is undesirable or impossible. The same sort of argument can arise about flexibility. For some flexibility creates opportune grounds for innovations whilst for others it may mean a lack of structure. (Silverman 2000:2) In a similar manner the other features of the research methods can be debated at length with no finality about which research method to choose. A dilemma concerning choice thus arises. Babbie (1998:38) and Hammersley (1992:182) suggest a way out in the quotations listed below:

"The good news is that you do not have to choose…You will discover that some research situations are more amenable to qualitative examination, others to quantifications".

(Babbie 1998:38)

Hammersley (1992:182) argues that "the process of science is the same whatever method is used, and the retreat into paradigms effectively stultifies debate and hampers progress".

Based on the suggestions made by Babbie (1998:38) and Hammersely (1992:182) the researcher selected the qualitative research method as the form of inquiry for this research study. Other reasons for this selection of method are reflected in the statements listed below:

- The 'qualitative revolution' that has been taking place for more than two decades. This sees qualitative research as a major tool when observing the world (Denzin and Lincoln 1998:11).

- Various disciplines use qualitative research as a form of inquiry. Qualitative research therefore belongs to no single discipline (Denzin and Lincoln 1998:5).

- The maturation of qualitative research and subsequently its inclusion into the mainstream of educational research provides, those interested with a picture of what is really happening in a classroom or a school (Fetterman 1987:4).

- The growing acceptability of qualitative research that is attested by increasing inclusions of relevant papers in journals, the development of new journal outlets, the growing acceptability of qualitative dissertations and the inclusion of qualitative guidelines by authors, funding agencies etc. (Guba and Lincoln 1998:217).

- The belief that qualitative research can lead the way toward a deeper understanding of education and society in the 21st century (Duquesne University 2003:1).

- The position afforded to the researcher to better situate himself/herself in the inquiry setting to understand how the social, political, economic, environmental and cultural realities shape education and society (Duquesne University 2003:1). It is believed that the particular physical, historical, material and social environment in which people find themselves has a great bearing

on what they think and how they react. Qualitative research is thus viewed as being context-sensitive (Smith 1987:175). Providing contextual information, it is argued, can redress the imbalance caused when a researcher focuses on selected subsets of variables that strip from consideration, through appropriate controls, other variables that exist in the context that might, if allowed to exert their efforts, greatly alter findings (Guba and Lincoln 1998:197).

- The introduction of the notion of "personhood" of the researcher and the roles and relationships that are formed between the researcher and the Other (Smith 1987:175). This takes into consideration the Other's intentions, beliefs, interests and views of the researcher (Smith 1987:175). Such considerations are useful to provide rich insight into human behaviour (Denzin and Lincoln 1998:11). Human behaviour according to Guba and Lincoln (1998:198) cannot be understood without reference to the meanings and purposes attached by human actors to their activities.

- Qualitative research draws upon and utilizes many paradigms, perspectives and methods (Denzin and Lincoln 1998:22). It has no theory, no paradigm or a set of methods that are distinctly its own. Multiple theoretical paradigms and perspectives that include positivism, postpositivism, poststructuralism, postmodernism, constructivism, critical theory, feminism, cultural studies and ethnic models of inquiry structure and organize qualitative research (Denzin and Lincoln 1998:185 -186). Each of these paradigms and perspectives in turn adopt its own set of criteria assumptions and methodology (Guba and Lincoln 1998:195) that further influences the structure and organization of the research method. These different practices Nelson (1992:2) opines "can provide important insights and knowledge" and that no specific method or practice can be privileged over any other and none can be eliminated. Hence qualitative research is viewed as being richly variegated (Smith 1987:173)

4.4 CRITICISMS OF THE QUALITATIVE RESEARCH METHOD: THE DOUBLE CRISIS CONFRONTING QUALITATIVE RESEARCHERS

Although qualitative research is cited as being an important form of inquiry in research, the issue of how best to describe and interpret the experience of other peoples and cultures remain under assault today (Lincoln and Denzin 1998:411). The problems of representation and legitimation (the double crisis) surfaces and confronts qualitative researchers (Denzin and Lincoln 1998:21).

The crisis of representation asks the questions: Who is the Other? Can the qualitative researcher speak authentically of the experience of the Other? If the qualitative researcher cannot speak authentically, how then does he/she create a science that includes the Other? (Lincoln and Denzin 1998:411).

The answers to the above questions are not simple. Ways need to be sought to provide answers (Lincoln and Denzin 1998:411). Some of these ways include:

- Participatory, or collaborative research.

- Conducting an experiment wherein Others are trained to engage in their own social efforts and are thereafter assisted in devising answers to the questions of historical and contemporary oppression.

- The Other becoming co-authors in narrative adventures.

- The construction of “messy” texts where multiple voices speak, often in conflict and where the reader is left to sort out which experiences to his/her personal life.

- Presenting to the inquiry and policy community series of auto-histories, personal narratives, lived experiences, poetic

representations and sometimes fictive and/or frictional texts that allow the Other to speak for himself/herself.

The choice of a way(s) from the above, however, does not always denote authenticity, reciprocity and trust (Stacey cited in Lincoln and Denzin 1998:412). Stacey (cited in Lincoln and Denzin 1998:412) argues that contradictions are still bound to occur in a research because “actual differences of power, knowledge, and structural mobility still exist in the researcher-subject relationship”.

The above dilemma thus raises questions of validity/truth and the reliability of qualitative research. Such questioning leads to the next crisis, the crisis of legitimation that relates to validity and reliability. This crisis asks the following questions: How are qualitative studies to be evaluated? What happens to validity and reliability?

Once again there are no clear answers. Lincoln and Denzin (1998:422) maintain that tensions will continue to operate as the field of qualitative research continues to define itself in the present and in the future. Moreover too much of critique will stifle qualitative research and all its promises (Lincoln and Denzin 1998:410). Such a situation is not needed (Lincoln and Denzin 1998:411) and it is time to get on with qualitative research (Lincoln and Denzin 1998:410). Some other qualitative researchers argue that the concern for reliability and validity of observations arises only within the quantitative research tradition (Silverman 2000:10). These researchers see these criteria as irrelevant when evaluating their work and contend that these criteria produce a science that “silences too many voices” (Denzin and Lincoln 1998:10). Marshall and Rossman (cited in Silverman 2000:10) argue, that because social reality is always in flux, it makes no sense to worry about reliability in qualitative research. Giroux (1983:17); Kincheloe and McLaren (1998:286) and Lincoln and Denzin (1998:422) also downplay the critics of qualitative research. Giroux (1998:17) maintains that “methodological correctness” will never guarantee valid data (Giroux 1983:17). Kincheloe and McLaren (1998:286-287) notes that “critical

researchers do not search for some magic method of inquiry that will guarantee the validity of the findings" and validity may not be an appropriate term. Trustworthiness, it is argued, would be a more appropriate term to use in qualitative research.

Other sources cited in Lincoln and Denzin (1998:422) respond not as politely as Giroux and Kincheloe and McLaren to the critics. These sources according to (Lincoln and Denzin 1998: 422) blatantly state the following: "we care less about our "objectivity" as scientists than we do about providing our readers with some powerful prepositional, tacit, intuitive, emotional, historical, poetic, and empathetic experience of the Other via the texts we write"

4.5 FURTHER CONSIDERATIONS PERTAINING TO THE DOUBLE CRISIS

The criticisms levelled against qualitative research do not go unnoticed as qualitative inquiry moves further and further away from postpositivist models of validity and reliability. Development of a set of rules concerning knowledge, its production and its representation, if followed, properly may according to Scheurich cited in Lincoln and Denzin (1998:414) allow a text to bear witness to its own validity.

To ensure trust in a text's claim to validity qualitative researchers are summoned to take steps to be certain that the "words they put in subjects' mouths are in fact spoken by those subjects" (Lincoln and Denzin 1998:412). Contrary cases and negative findings must also be reported (Babbie 1998:422; Silverman 2000:11). Meticulous checking of facts is thus called for by the ethics of text production (Lincoln and Denzin 1998:412).

4.6 SELECTION OF THE QUALITATIVE APPROACH: THE SEMI-STRUCTURED INTERVIEW

To provide the opportunity for the interviewees to talk for themselves, the semi-structured interview was deemed appropriate by the

researcher. It was with these people in mind that a dialogue was necessary as it is their perceptions that can contribute to the process of transformative educational change in South Africa.

The greatest value of the semi-structured interview lies in the depth of information and detail that can be secured (Copper and Schindler 2001:299). The interviewer can also use multiple strategies to improve the quality of the information received than with another approach (Copper and Schindler 2001:299). The interviewer also can have more control than with other kinds of research approaches (Copper and Schindler 2001:299). The interviewer can set up and control interviewing conditions, can adjust the language of the interview as he/she observe the effects and the problems the interview is having on the interviewees (Cooper and Schindler 2001:299). Prompts and probes are also possible as “open” questions may require an extended response (Gillham 2000:3). In short the semi-structured interview affords flexibility as to what emerges.

With the advantages listed above come some disadvantages. Probably the greatest reasons are the costs involved in terms of money, time and security (Copper and Schindler 2001:299). The researcher is the only one that can overcome this disadvantage. It is personal. Last but not least interview bias can adversely affect the research study (Copper and Schindler 2001:299). This must at all costs be avoided. The interviewer must at all times strive to overcome this disadvantage by ensuring that both the interviewer and the interviewee understand his and her role in the interview as the provider of impartial information.

4.7 SELECTION OF THE SAMPLING METHOD: NON-PROBABILITY AND PURPOSIVE SAMPLING

The use of a non-probability sampling procedure was opted for this research because there is no list of all natural science teachers implementing IK in their classroom teaching nor is going to be possible to create such a list. Additional reasons for choosing non-probability

over probability sampling are cost and time. Probability sampling will call for more planning and more travelling. These activities are beyond the budget of the researcher. Non-probability sampling was therefore the only feasible alternative. From this technique, purposive or judgemental sampling was chosen as being appropriate because the researcher wished to select interviewees to conform to the three criteria listed below. Interviewees must:

- Be individuals who have a rich memory of IK and social and environmental change.

- Have some knowledge of the C2005 and its envisioned aims.

- Have or have had experience with teachers and learners in South Africa.

The rationale for the selection of the above criteria is that the researcher expects individuals with "specialist knowledge" to be more favourably disposed towards the promises and realities of the use of IK in the teaching and learning of natural science than people who not totally familiar with the topic, IK and its implication for teaching and learning.

4.8 THE SELECTION OF INTERVIEWEES

Initially, the researcher intended to conduct the interviews with ten individuals, three from the Department of Education, one from the Department of Science and Technology, one from a tertiary institution, three from NGOs supporting teacher development initiatives in South Africa, one from the NRF and one from the San community. This envisioned plan, however, did not materialize. One individual from the Department of Education and those from the NRF, the tertiary institution and the San community were not able to participate in the research. These individuals were too busy to be interviewed.

To increase the number of interviewees a deputy director from the KZN Department of Social Welfare and Population Development helped to establish links with two other individuals that have a very rich knowledge of IK and are presently members of the poverty reduction team targeting mainly HIV/Aids programmes in KZN.

This inclusion covered a wider spectrum of interviewees than envisioned. Furthermore, it allows for comparisons to be made between the differing perceptions of individuals closely associated with science teaching on the one hand and with those concerned with socio-economic developments in South Africa. In total eight individuals were interviewed.

4.9 GENDER OF THE INTERVIEWEES

To avoid marginalizing either men or women, both male and female interviewees were sought. Identifying men who were willing to participate in the research proved much more difficult than identifying women, largely because the researcher is a female. An important reason to include both sexes in the research is based on the premise that men and women generally specialize in different tasks. Men therefore may know something that women do not know and vice versa. Tapping the IK and the perceptions of both sexes was thus deemed necessary.

In this research four men and four women participated. This 1:1 ratio was not intentionally sought. The eight that agreed to participate in the project just worked out to be four men and four women.

4.10 INTERVIEWEES' PROFILE

Interviewees were interviewed and were requested to complete a questionnaire (Appendix 2) to elicit personal details. This was deemed necessary to obtain information about their professions as well as their knowledge base. The interview sought to capture the social change,

environmental change and indigenous knowledge systems that interviewees experienced.

INTERVIEWEE I

Interviewee 1 joined the Department of Science and Technology as a Deputy Director in 2003. Prior to that he served as a teacher for a year at a high school in KZN and thereafter as a senior researcher for seven years at the Human Science Research Council in Pretoria.

He grew up and received his primary and secondary school education in Ladysmith, Northern KZN. Thereafter he completed a degree and a teaching diploma at the University of Durban Westville and the B Ed and M Ed at the University of South Africa.

His paper “Making a case for Including Indigenous Knowledge Systems (IKS) into the South African School Curriculum” bears testimony to his belief that IK forms an integral part of a learner’s education in the school setting.

INTERVIEWEE 2

Interviewee 2 was born in Ghana. He holds an Honours degree in economics and political science from the University of Ghana, a Masters degree in Science from the University of Leeds in the United Kingdom and a Doctorate in economics from the University of New England (Australia).

Following a career as a lecturer at the University of Ghana that culminated in his appointment as Professor of Economics at the University of Natal, he joined the KZN Provincial Treasury as Chief Director in 1998 and was appointed as Deputy Director-General of Housing in 2000. He is currently Deputy Director General in the KZN Provincial Treasury.

His paper, “Development Thinking in the New Millennium” considers development in a different light than most other economists. To him development involves the transformation of people and society. This, however, does not mean movement from the traditional way of doing things to modern ways of doing things. Transformation to him is any process that improves upon the existing, whether it is an accumulation of new knowledge or whether it is the development of new alternatives. It is a process that ought to give people a variety of choices to expand their scope of activities and knowledge.

He regrets his negativism towards IK as a student and laments not knowing most of the IK that his late father possessed. “It is too late now, the old man is gone with all that knowledge” he sadly says.

His is a very widely travelled person and is very passionate about contributing towards the alleviation of poverty.

INTERVIEWEE 3

She describes herself as a “converted” person, meaning that it is only recently that she fully appreciates the IK that indigenous Africans possess. She and her colleague have conducted workshops in the Pietermaritzburg region with natural science teachers. The use of the turpentine reed, known in Zulu as *isiqunga*, as a remedy for flu was used to illustrate how IK can be infused into science teaching. With pride and conviction she re-iterates throughout her interview how excited and enthusiastic the natural science teachers were about the use of IK in the teaching of science.

Interviewee 3 was born in Marianhill, KwaZulu-Natal, South Africa. She obtained her primary and secondary education at a mission school in Marianhill and at Inanda Seminary respectively. Being a student activist in the Black Consciousness Movement forced her to leave the country to continue her studies in Botswana.

She holds a B Sc degree and a teaching diploma from the University of Botswana. From 1978 to 1996 she taught science in Botswana. From 1996 she is a biology subject advisor in the KZN education department. She serves on various science committees in KZN and is also the convenor of the Further Education and Training (FET) panel working on the National Curriculum Statement for Life Sciences.

In 2001 she completed her M Ed in science education at the University of Durban Westvillle. Her research title reads ”An Investigation and Identification of Indigenous Science Understanding among Zulu communities, Elders and the Impact on the Understanding on the Zulu Secondary School Learner”.

INTERVIEWEE 4

Interviewee 4 is an American (citizen of USA) who holds a MBA degree from Averett University in the USA. She is currently completing her Doctorate in Community College Education at the George Mason University in the USA. Interviewee 4 first came to South Africa in 2000. In South Africa she worked as a Deputy Chief of Party for Aurora Associates International for the period 2000-2001. In 2002 she worked at ABT Associates as Contracts Manager. Both these agencies work under the auspices of USAID. One of her responsibilities in South African was the evaluation of service providers who tendered for the provision of science equipment and training for the 102 schools of excellence (Dinaledi Project). This project was the initiative of the Deputy Minister of Education as part of the National Strategy for Mathematics, Science and Technology Education in General and Further Education and Training.

Prior to this she worked in as Project Manager in The Office of Food for Peace in the USA. This involved her working closely with the developing African Countries. Her experiences in Tanzania brought her in very close contact with very poor people who relied on IK for their

survival. She is now a director at Project HOPE (Health Opportunities for People Everywhere) a US based NGO.

INTERVIEWEE 5

Interviewee 5, a Director of Socio-Economic Development in the Office of the Premier (KZN), currently co-ordinates programmes dealing with poverty alleviation and HIV/Aids in KZN.

Her upbringing in Eshowe and experiences as a social worker during the 1960s and 1970s at a mission hospital in Nquthu, a deep rural area in KZN, has contributed to the immense Zulu IK that she possesses. Her attendance at numerous workshops locally and abroad has widened this knowledge base. In 1997 she attended a conference on the Economic Empowerment of Indigenous People, in Cairns, Australia.

The potential role of traditional lifestyles and IK in rural development form an integral part of the programmes implemented with a view to better the lives of poor rural people living with the HIV/Aids. She believes that the socio-economic development woes, nationally, can be alleviated by the imposition of foreign developmental policies.

She was educated at schools in Eshowe, the University of South Africa and the University of Stellenbosch. At the University of South Africa she majored in sociology and anthropology, completed her BA Honours degree in social work and took further courses in developmental administration. Her Stellenbosch, Masters in Philosophy focused on values and policy.

INTERVIEWEE 6

After completing a BSc Honours degree at Makerere University in Uganda, interviewee 6 worked as a researcher at the Coffee Research Unit at the Kawanda Research Station in Uganda for many years. He

left Uganda in 1980 for Lesotho where he completed his teaching diploma at National University of Lesotho. In Lesotho he taught science at a high school. He came to South Africa in 1983, and was employed as Head of Department in the sciences in schools in the Eastern Cape. Currently he is the science co-ordinator of a NGO that targets advancements of science and mathematics education in South Africa. He meets with hundreds of science teachers across the country every year.

His upbringing in Uganda, his stay in Lesotho and the rural areas of Eastern Cape and his visits to schools in all provinces in South Africa has contributed and continues to contribute to his vast body of knowledge of indigenous systems.

In addition to having completed the B Sc Honours degree from Makerere University and the Post Graduate Certificate of Education from the National University of Lesotho he holds a B Ed degree and three Masters Degrees –M Sc., M Ed. (Science Education) and M. Ed. (Information Communication Technology) - from Rhodes University. He is currently studying for his Doctorate in Philosophy (Information Technology) at the University of Natal.

INTERVIEWEE 7

Interviewee 7 was raised and educated in the North West Province of South Africa. He holds a B Sc Honours degree, a teaching diploma and a MBA. He taught biology in a high school from 1992-19994 and lectured at a college of education from 1994-1995. In 1996 he was appointed Subject Specialist in the sciences in the North West Education Department. In this capacity he is responsible for co-ordinating science and biology programmes in the GET and in the FET phases respectively.

Some of the science programmes organized in 2002 included the development of learning programmes using IK as a teaching resource.

This was made possible by establishing partnerships with agricultural officers, environmental officers, traditional doctors and elders in the community.

He is also currently a member of the panel of examiners for the provincial (North West Province) Senior Certificate Examination papers for biology.

INTERVIEWEE 8

Interviewee 8's deep involvement in education, especially formal schooling and work with vulnerable learners in rural and urban areas, covers over 3 decades. With a strong commitment to redress the injustice of apartheid, she started teaching biology in Glencoe, Northern KZN in 1967. She has taught in a number of high schools in KZN. In 1990 she was appointed principal of a high school.

During her term of employment in the Department of Education she was responsible for the teaching of biology and general science (now called natural science), developing support material and guiding a wide range of teachers and learners in schools. During some weekends she worked with the Shell Science Education Project. For about 20 years she was a member of the Departmental Biology Subject Committee. She was also a Senior Certificate examiner and a moderator for biology in KZN.

She grew up and received her primary and secondary school education in Dundee, Northern KZN. She has a BSc Honours degree and a teaching diploma from the University of South Africa and a B Ed degree from the University of Natal. She has travelled widely in Africa, Europe, North America, and the Far East. These travels and the invaluable lessons learned from her mother who lived for 95 years have played a significant role in her interest and knowledge pertaining to IKS of the world. She believes that the survival of every human society depends upon educating its young people in the home and the school settings.

Both knowledge systems are imperative and ought to be treated on par. Currently she is retired but still maintains a keen interest in all aspects concerning the “business of education”.

A summary of the profiles of the interviewees is shown in Figure 30.

4.11 CONCLUSION

This chapter serves to place the research method in context. In an attempt to provide answers as to how natural science teachers may perceive the use of IK in the teaching and learning of science, their delivery of lessons using IK, the obstacles that they may encounter when using IK is used as a teaching resource and possible strategies that they may use to draw IK from the communities, the researcher selectively sampled eight individuals and interviewed them using the semi-structured interview approach of the qualitative method. The eight interviewees are all post- graduates who have a very good knowledge of IK.

Their ages range from 30 to 60 + years. Five of them are South Africans. The others include one American (citizen of USA), one Ghananian and one Ugandan. The ethnic groups represented in the sample include a White, two Indians and five Blacks. Although all are not South African, all of them are cognisant of educational changes envisaged in C2005 and all have work experience in South Africa.

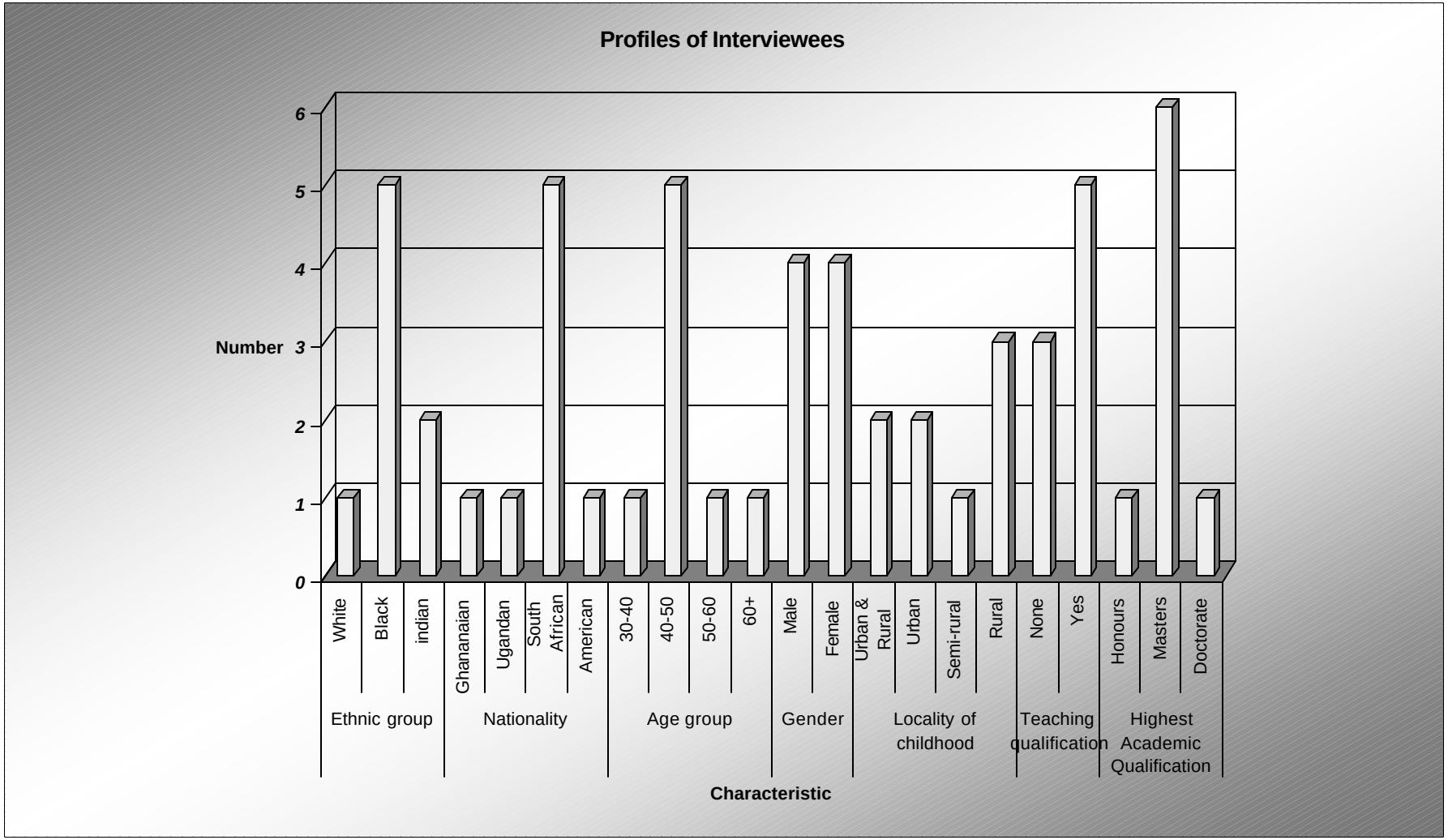


Figure 30: Profile of Interviewees

CHAPTER FIVE

ANALYSIS AND INTERPRETATION OF THE USE OF IK IN THE NATURAL SCIENCE CURRICULUM

5.1 INTRODUCTION

The research thus far looks at issues concerning the environment, the promises and realities of C2005 and indigenous knowledge systems (IKS) from a science education point of view. The challenges to South African natural science teachers posited by the latest Living Planet Report of 2002, C2005 and IKS are contextualized. Amongst other issues, Chapter Three examines the disdain for IK, the "winds of change" blowing worldwide to re-valuate IK and South Africa's idea of a Western-indigenous partnership approach to the teaching of natural science at the senior level of the GET phase.

The idea of a Western-indigenous approach for the conceptualisation of an inclusive just science education, calls for a paradigm shift to provide natural science teachers an opportunity to make science a discipline that views every learner as a scientist and every area as a science academy (Hoppers 2002:viii). The new education dispensation seeks not for a return of the dark ages or some golden age but for a transformation to a new, better future. It envisions providing learners the opportunity to become "critical explorers of human and societal possibilities" (Hoppers 2002: ix-x).

The challenge that this call posits to natural science teachers is immense. There is, therefore, a need in the present context to collect data as to how science teachers would perceive this approach, what are their competency to deliver learning programmes using IK as a teaching resource, what possible obstacles would confront them and what are some possible strategies that can be developed to conceptualise the Western-indigenous approach in science teaching and by doing so, dismiss learners at school being seen as *tabula rasa* that need to be filled.

This chapter places in context the use of the selected method of data collection discussed in Chapter Four and the analysis of the collected data.

5.2 DATA COLLECTION

5.2.1 Questions used in the semi-structured interview

The selected method of data collection was the interview, using a semi-structured conversational approach. Five open-ended questions were initially formulated in an attempt to collect the data. Open-ended questions were opted for to allow the interviewees the freedom to address the issues in question and present the data in a way he/she felt was most appropriate.

To identify any major problems, the researcher submitted the five questions for scrutiny to an academic based at the University of South Africa. Scrutiny revealed an overlap between questions 2 and 5. Accordingly question 2 was revised and question 5 dropped. The interview process thus made use of four questions (Table 26) for the interview process. In addition to these four questions the researcher used probes that appear in the transcripts to either gain clarity or to ascertain more interesting experience and knowledge.

Question Number	Core Questions
1	How would teachers react to the inclusion of IK in the natural science curriculum?
2	What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further?
3	What are some of the possible obstacles to the inclusion of IK in the natural science curriculum?
4	What are some of the possible strategies that could be used to draw out knowledge from the community/communities?

Table 26: Core Questions of Interviews

5.2.2 INTERVIEW METHOD

Preliminary interview

Before the formal interviews, the researcher (interviewer) telephoned each interviewee to explain the objectives of the research, what would happen to the information recorded, and the four questions that would be asked during the actual interview. Interviewees were also given the opportunity to clarify any issue that required more elaboration. Once these preliminaries had been settled, a time and in six instances a place for the interviews were established.

Communication approach

All interviews were conducted on a one is to one basis. Six of these interviews were personal interviews. The remaining two interviews were conducted with the use of a computer - "e-mail chatting". The e-mail option made it possible to interview the interviewees residing in the USA and the North West Province of South Africa at a reasonable cost. The research's main focus was to ascertain specialized knowledge relating to IK in the education sector, as linked to personal histories and anecdotes

from interviewees. To attain successful interviews two broad criteria were met:

- The interviewees possessed the information being targeted.

- The interviewees understood his/her role in the interview as the provider of accurate information.

Location and length of interview

Six interviews were conducted in an informal and a convenient setting in KZN. Five were conducted in restaurants and one at the interviewee's work office. The length of the interview varied depending upon the interviewee's interest and availability; the average session lasted about 40 minutes. This duration of time was generally enough for in-depth discussion of the four questions, to reflect on the discussion and in some instances to clarify any particular points.

5.2.3 RECORDING INFORMATION

All six interviews conducted in KZN were recorded. The audio recorder was used because one cannot rely on one's recollections of conversations. It is also simply impossible to remember matters as pauses, overlaps, in-breadths etc (Silverman 2000:149). Sachs cited in Silverman (2000:149) adds further dimensions to this use by stating the following:

"My research is about conversation only in this incidental way, that we can get the actual happenings on tape and transcribe them more or less, and therefore have something to begin with. If you can't deal with the actual detail of actual events then you can't have a science of social life".

(Silverman 2000:149)

"I could get my hands on it and I could study it again and again. And also, consequentially, others could look at what I have studied, and make what they could, if they wanted to disagree with me".

(Silverman 2000:149)

An assistant operated the tape recorder to enable the researcher to keep track of the questioning, encouraged the interviewee by expressing interest through eye contact and other responses, take some notes during the interviews, writing down points and terminology for later clarification.

5.3 INTERVIEWING PROBLEMS

One interviewee told the interviewer that the topic IK is so vast that she could go on talking forever. She, however, furnished brief points during the e-mail chatting session. By attempting to reduce costs the interviewee highlighted the responses in point form. The interviewee felt restricted in terms of addressing other issues that were of importance. This illustrates one of the most difficult aspects of the interview method using the e- mail facility: getting individuals to talk in detail about issues perceived by both the interviewer and the interviewee as relevant. The briefness necessitated the researcher to probe for more detail and arrange to continue the interview at another time. This was particularly problematic. The interviewee was too busy. Contact for the next interview was scheduled six weeks later. The break interrupted the flow of the interview.

Another constraint included an interviewee's uneasiness about recording all his responses. Trying to memorize or take notes of the responses not taped, slowed the dialogue, distracted the interviewer from the questioning and caused the loss of valuable eye contact with the interviewee. Despite this, the interviewee provided the data sought.

The last constraint in this research was the pronounced tendency of many of the interviewees to respond indirectly to the questions posed. Transmission of the data was mainly narratives that were closely related to the individual's past, their experiences in their work field and from sources of literature that they had read. The tendency to romanticise the past was evident in these narratives. Although this

provided the necessary, valuable data using interesting metaphors in an indirect way, it at times evoked anxiety in the interviewer. Allowing the interviewees to continue, expand and provide the data frequently led them to wander away from the questions posed. Eliciting the data pertinent to the research, at times prompted the interviewer to asking leading questions that are not advisable when conducting interviews.

5.4 TRANSCRIPTIONS OF INTERVIEWS

Following the interviews, the interviewer transcribed the tapes. The production and the use of transcripts according to Atkinson and Heritage (cited in Silverman 2000: 150) are essentially research activities that ought not to be viewed as technical detail prior to the main business of analysis. The convenience of the transcript of the entire recording for presentational purposes is more than an added bonus (Silverman 2000:150). This provides for making complete sense of what the interviewee has said, for the rigorous application of reliability and validity criteria and is amenable to computerization (Gillham 2000:62; Copper and Schindler 2000:430).

The tedious, time consuming transcribing process involved tremendous concentration and a good deal of rewinding and forwarding the tape and writing down everything, including the main questions asked and the probes used. After writing down everything verbatim, the tapes were run through twice more, listening for anything that might have been missed. At times the need arose to double check some of the statements by asking someone else to listen to them and transcribe them without sight of the interviewer's attempt.

5.5 TRANSCRIBING PROBLEMS

Repetition in some of the interviews was tiresome in written text but was necessary for emphasis and elaboration. Another problem was subjecting interviewees to "think on their feet", that is working mentally on the topic that had been presented to them. This in some instances

left statements either incomplete or disconnected. Hence key statements lost some of their meaning and significance. This is unavoidable as none of us speak like a tightly edited text. However, one transcript merely flowed like a river of words in which the real substance very often sunk to the bottom, making it very difficult at times to ascertain what the interviewee was saying. This problem was resolved by going back to the interviewee who agreed to edit the original transcript.

5.6 SELECTION OF ANALYSIS TECHNIQUE

The technique of starting at line 1 of the transcript and working down the page was unsatisfactory as it resulted in an ad hoc and an analysis that was often difficult to categorize. Thus proceeding with the analysis beyond the agreed transcripts involved using the content analysis technique that correlates very closely to Glaser and Strauss's constant comparative method (Maykut and Morehouse 1994:150-164).

Content analysis is about organizing the substance content of the interview: the content that is of substance (Gillham 2000:59). Content analysis has been described as "a research technique for the objective, systematic, and quantitative description of the manifest content of a communication" (Copper and Schindler 2000:428). This definition, however, is sometimes confused with counting just words or attributes, overlooking the latent content, the symbolic meaning of messages and qualitative analysis. Recently, it embraces this wider field that is succinctly described in the book authored by Copper and Schindler (2000:429).

"In any single written message, one can count letters, words, or sentences. One can categorize phrases, describe the logical structure of expressions, ascertain associations, connotations, denotations, elocutionary forces, and one can also offer psychiatric, sociological, or a multitude of contents even to a single receiver. All of these may be simultaneously valid. In short a message can convey a multitude of contents even to a singly receiver."

This technique comprises of two essential strands of analysis:

- Identifying key substantive points.

- Placing the key, substantive points into categories.

The substantive points are also referred to as units. These units may be syntactical, referential, propositional or thematic (Copper and Schindler 2000: 429). Syntactical units are illustrated by words, referential units may be objects, events, persons etc., prepositional units use several frameworks and may show relationships among the actor, the mode of acting and the object and thematic units are higher-level abstractions inferred from their connection to a pattern in the context (Copper and Schindler 2000: 429).

Categories are simple headings whereby a body of data is partitioned (Gillham 2000:59; Copper and Schindler 2000:425). Choosing and identifying categories is a subjective matter. Arriving at categories according to (Copper and Schindler 2000: 425) follows four rules. These rules are referred to as appropriateness, exhaustiveness, and mutual exclusively and single dimension.

Appropriateness means that the categories must provide the best partitioning of data for testing hypothesis and showing relationships. Year by year revision to the curriculum, age, and attitudes may be important to the research study. If these are critical for testing relationship, then one must choose the best groupings. If not considered carefully these categories may not precisely match the data with which one wishes to make comparisons at the time of research completion. Exhaustiveness means that the set of categories must tap the full range of information in the data while mutual exclusively is met when a specific phrase / statement can be placed in only one cell in a category set. The single dimension rule means that every phrase / statement in the category set is defined in terms of one concept.

5.7 THE METHOD OF CONTENT ANALYSIS OF TRANSCRIBED INTERVIEWS

The following procedure was used to analysis each of the transcripts:

- Took each transcript in turn.
- Went through each one highlighting substantive units. These included highlighting, syntactical, referential, prepositional and thematic units.

- After the completion of all the transcripts, went back and read the transcripts thoroughly again to see whether there were any units that were not highlighted or whether highlighted units were really substantive.

- Went back to the beginning again and went through the highlighted units to derive a set of categories and in some instances a set of rules for the inclusion to the responses.

- Looked at list of categories and rules for inclusion and ascertained when some of them could be combined or, alternatively, split up.

- Went through the transcripts again with the list of categories and the rules for inclusion beside them and checked each unit against the category list if it could be placed somewhere.

- Marked those units that could not be assigned to any category.

- Modified or revised the category heading so that they fit the unit better.

The use of the procedure described, finally led to the derivation of fifteen categories (Table 27). Thirty five rules for inclusions for eight of the fifteen categories were also derived (Table 27). The remaining

seven categories were self contained and warranted no further elaboration.

Next synonymous words for the first four categories (acceptable, unacceptable, manageable and unmanageable) and the fifteen categories with the rules for inclusion where applicable were coded. Numbers 1-15 and fifteen different colours were selected to denote each of the fifteen categories. Just the code number as a superscript denoted the synonymous words and the categories without rules for inclusion. Alphanumeric codes as superscripts denoted the categories with rules for inclusion. Table 27 denotes this coding.

Following the coding an audit trail that allows an individual to go through the collected data and its analysis from beginning to end was done. Understanding the path taken by the researcher and judging the trustworthiness of the outcomes (Maykut and Morehouse 1994: 164) was thus made possible. The use of the relevant colour and code for each of the selected, substantive word or phrase or statement for the four questions and the probes in each transcript denotes this trail (Appendix 3). At times it was found that some of the responses to a particular question were answered in another question or in other questions. In these cases the answers were colour coded, number coded, or alphanumeric coded in respect of the question it most appropriately answered. Colour codes, number codes and alphanumeric codes for a particular question may therefore be seen in answers pertaining to another question or other questions.

Code	Category	Colour Code	Rules for Inclusion
1	Acceptable		1a. Upbringing 1b. Pride 1c. Culture 1d. Politics and Overcoming Oppression 1e. Usefulness of IK 1f. Loss of IK
2	Unacceptable		2a. Domination by Western Education/Subjugation of IK 2b. Western Lifestyle and Urbanization 2c. Ethnicity and interpretation of concept IK 2d. Intergeneration values 2e. Cultural adherence
3	Manageable		3a. Creativeness
4	Unmanageable		4a. No/insufficient past/present support and teachers' lack/insufficient knowledge base 4b. Sensitive nature regarding choice of IK 4c. Personal Cultural Beliefs 4d. Low self-esteem
5	Shortcomings of educational stakeholders and learners		5a. Reluctance of elders to divulge information 5b. Shallow elaboration of IK in teaching and assessment 5c. Insufficient insight about the transformation process 5d Personal/ cultural bias 5e. Insufficient insight about IK/WK 5f. Attitude: indifferent, afraid and tired 5g. Language
6	Complexity of IK		6a. Holistic nature 6b. Contextual nature 6c. Undocumented format 6d. Diverse nature 6e. Unstructured, unvalidated nature 6f. Sensitivity
7	Implementation Shortcomings		7a. Insufficient resources/data 7b. Lack of a coherent plan to empower educational stakeholders
8	Intellectual Property Rights		
9	Heterogeneous Classes		

Code	Category	Colour Code	Rules for Inclusion
10	Acceptance of IK		
11	Re-valuating IK		
12	Establishing Partnerships		12a. Education Department and Community. 12b. Education Department and Tertiary Institutes 12c. Education Department and NGO's, Corporates and other Government Departments. 12d. Further research: Tertiary Institutes, Education Department, Communities
13	Refining C2005		
14	Empowerment and provision of resources		
15	Establishment of database		

Table 27: Colour, Number and Alphanumeric Codes

Table 27: Colour, Number and Alphanumeric Codes

5.8 ANALYSIS OF QUESTION ONE

From the audit trail it can be deduced that the inclusion of IK in the natural science curriculum at the senior level of the GET phase is perceived by all eight interviewees to draw a mixed reaction from natural science teachers. The mixed reaction includes a perception of IK being acceptable and unacceptable.

Qualitatively reinforcing this finding are the following extracts from the transcripts:

ACCEPTANCE

"…I think that the indigenous African teacher will embrace it.
Looking at the past and what they used to bring to the classroom was never considered by them to be their thing. If teachers who are not indigenous African understand what IK means they will also embrace it and attempt to use it in their classroom teaching. I have not found any resistance with the teachers…".

Interviewee 3

" …Now they are in a situation where they will be talking to the curriculum. This will make them comfortable. Given the political landscape that the majority of teachers are Black, I can assume that the majority of teachers will be comfortable with the inclusion of IK in the curriculum. Regarding the natural sciences I would say that teachers coming from the rural communities will be absolutely comfortable with the inclusion of IK in their teaching. IK expresses itself in the Natural Science curriculum

such as lets take a medicinal plant or any other kind of herb and start a discussion in class. A child will come with 100s of uses of that particular plant. They will tell the teacher how to plant it, how to harvest it, etc because that is the experience of life that the child brings. It is a laboratory of life rather than a laboratory of bricks and mortar.

It is like now turning the mirror upside down. Before the scientists used to go in and get the rats to experiment but now the rats are coming to the scientists. So this is the inversion of life that I was taking about earlier.

Because IK within a community is dying, the elders are now very excited…".

Interviewee 1

"…These teachers in their upbringing were taught many lessons by their parents and elders that were essential for their survival. The lessons enable them to explore and utilize resources gainfully, sparingly, co-operatively and efficiently. It also helped them to understand the risks and dangers of tampering with the environment. Many of them especially those out in the rural areas still cling on to them. The teachers will now have an opportunity to use it in the classroom….".

Interviewee 7

"…I do believe that they may be happy because of the pride that would confront them when teaching IK.

…many of them that will be happy about including IK in their teaching because this is politically correct…".

Interviewee 6

"…So you see how teachers are going to perceive the use of IK in their class is going to be dependent on their IK, their teaching skill and their current lifestyle. Practically everyone possesses IK, the extent however will vary depending on their upbringing and their current life style. The reality of the majority of this country's teachers is that they lead dual lives; they uphold traditional and Western practices. My perception therefore is that the majority of the teachers will respond positively. They have now been offered an opportunity in the democratic South Africa to talk about their IK..."..

Interviewee 2

"…I think for a lot of teachers it will be very challenging and quite exciting because they have perhaps in their own families valued the orientations and understandings that they have been brought up with…".

Interviewee 5

"…The emergence of Black Power Movement, Black Studies, Afro-American Studies and most important South Africa's democracy have conscientised the majority of teachers about the stereotypes and prejudices. So I believe that the perception of the majority of teachers will expand from moderately to extremely receptive. These teachers recognize that Western and indigenous systems can complement each…".

Interviewee 4

UNACCEPTANCE

"…I think one of the difficulties in our situation at the moment is that we are moving very rapidly towards the Coca Cola culture and the kind of traditional beliefs of many of our African people have been chucked out and are leaving us with a bit of a vacuum. People have felt that if they embrace the Coca Cola culture, they've made it..."..

Interviewee 5

"…In urban areas some teachers have abandoned most of their traditional beliefs and associated IK. The pull towards a Western lifestyle is vogue. Promises of a better, easier life accompany this choice. These teachers obviously will not be happy to teach lessons involving IK…."

Interviewee 7

"…The mistake that many people usually make is that they think that IK is only African. It actually does not mean that. Everyone has IK. The other groups who are not indigenous African may therefore initially be astounded and may offer resistance to include IK in their classroom teaching. …Many teachers also cling to concepts passed on by the previous generations…".

Interviewee 3

"A minority however would oppose it. These will be mainly the young teachers in urban schools because they are still not at a stage to appreciate this kind of knowledge and also some of the older ones. The Western lifestyle is the way to go.".

Interviewee 2

"…Stereotypes exist about IK in the school curriculum. Somehow it is conceived by some teachers that Western education paves a way for a better quality of life. To these teachers the application of IK in the natural science curriculum may expand from vaguely receptive to total rejection. This group may comprise largely of Whites teachers who firmly believe that IK is less systematic than Western scientific knowledge and oppressed non-white teachers who have internalised the colonists' denigrating views of IK..."..

Interviewee 4

"…some of them may not believe that it is irrelevant. Because that is how they were taught. We were brought up to abandon our traditions by the education system. There has always been a demarcation between the knowledge that you came with and the one presented by the education system…".

Interviewee 6

"…Hard to tell exactly who will be positive and who will be negative but wherever educators have not been given the opportunity to study and teach within attainable norms of the Western body of scientific knowledge they will feel deprivation, so to present them with IK will have the effect of them perceiving it as a step backwards, rather than exploration of new avenues. This will be the first group in opposition to teaching IK. The second group will be educators with all the advantages of access to the best in Western scientific education and school facilities to teach in. While they rigidly pursue curricula, tests and examinations they will be reluctant to be innovators. These educators will constantly compare this new curriculum with curricular across the seas. They too will oppose IK as a step backwards…".

Interviewee 8

Viewed quantitatively (Tables 28 and 29 and Figures 31 and 32) the following are also apparent:

- Seven of the eight interviewees (87.5%) perceived that teachers would accept the initiative because of the usefulness of IK. This inclusion, cited as the main one, draws a response frequency of 22.6%. Upbringing, cited by six of the eight interviewees (75%) and which draws a response frequency 19.4% ranks second. Pride and politics rank third. Five interviewees (62.5%) constituting a response frequency of 6.1% felt that these inclusions were significant. Culture and the loss of IK, cited by four interviewees (50%) and constituting a response frequency of 12.1% assumes fourth place.

- The domination of Western knowledge accompanied by IK subjugation is the main perceived reason why teachers may not accept the initiative. This is closely followed by urbanization and the assimilation of a Western lifestyle. These perceived inclusions by six (75%) and five (62.5%) of the interviewees draw a response frequency of 27.3% and 22.7% respectively. The Western form of knowledge, urbanization and the adoption of a Western lifestyle, thus contributes to 50% of the inclusions as to why teachers may oppose the inclusion of IK in the curriculum. Ethnicity and the interpretation of the concept IK on one hand and cultural adherence on the other, perceived by four interviewees (50%) and corresponding to a response frequency of 18.2% ranks third. A response frequency of 13.6% for the inclusion, intergenerational values is shared by 3 (37.5%) of the interviewees as a reason for the category, unacceptable and it ranks last.

Although generalizations cannot be made from the preceding findings the qualitative and quantitative analyses bring the following perceptions to the fore:

- The majority of South African natural science teachers will accept the inclusion of IK in the teaching of school science, thereby signifying the possibility of the emergence of a new direction in

science education. In short, IK gains legitimacy in science education.

- IK is being lost and concerted efforts have to be made to prevent further loss.

- The term, IK is problematic to some teachers.

Rules for Inclusion	Frequency	Percent
Upbringing	6	19.4
Pride	5	16.1
Culture	4	12.9
Politics (Overcoming Oppression)	5	16.1
Usefulness of IK	7	22.6
Loss of IK	4	12.9
Total	**31**	**100.0**

Table 28: Frequency and percentage of Responses for the Category: Acceptable of Question One.

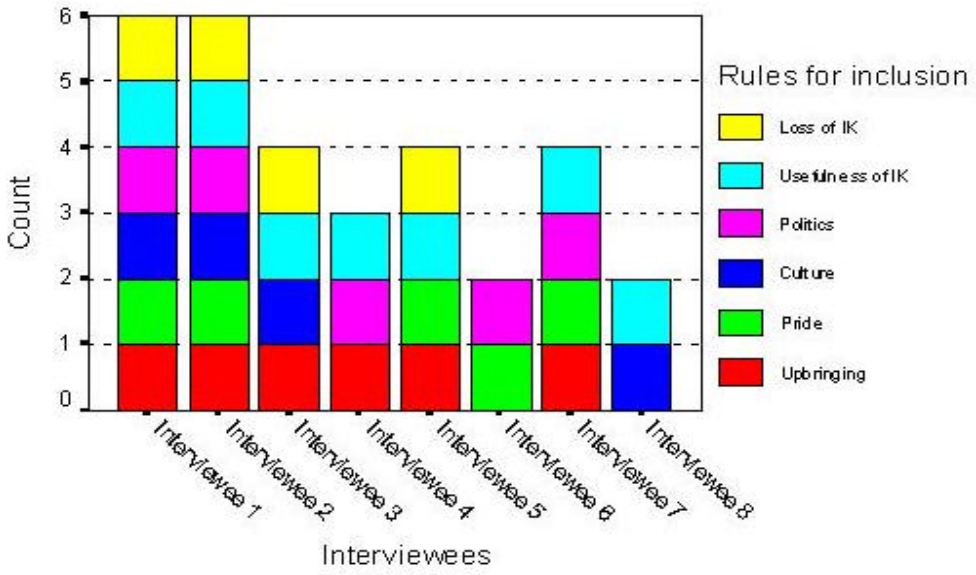


Figure 31: Count of Interviewees' rules for inclusion for the Category: Acceptable of Question 1

Rules for Inclusion	Frequency	Percent
Domination by Western Education/Subjugation	6	27.3
Western lifestyle and urbanization	5	22.7

Ethnicity and interpretation of concept of IK	4	18.2
Intergeneration values	3	13.6
Cultural adherence	4	18.2
Total	**22**	**100.0**

Table 29: Frequency and percentage of responses for the Category: Unacceptable of Question One

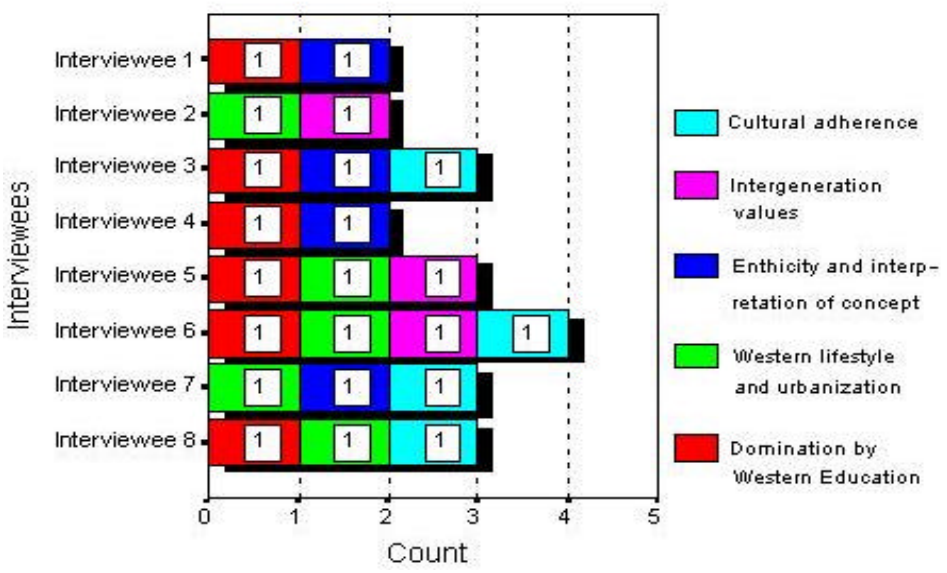


Figure 32: Count of Interviewees' rules for inclusion for the category: Unacceptable of Question 1.

5.9 LITERATURE REVIEW FOR QUESTION ONE

The findings so far are not surprising as they come close to statements, included on subsequent pages, made by numerous researchers interested in IK (Prakash 1999:164,166; Viergever 1999:339; Hountondji 2002:23; Crossman and Devisch 2002:116; Semali 1999:96,98-99; Jegede 1999:119; Maurial 1999:59; Semali and Kincheloe 1999:37; George 1999:84; Mosha 1999:96; and Hoppers 2002:8,14).

Prakash (1999:164) and Viergever (1999:339) opine about the loss of IK and the efforts to conserve IK. Prakash (1999:164) notes that the majority of the IK systems have "either already been rendered extinct or teeter on the brink on extinction" due to the colonizing global spread of modern knowledge systems, technologies and institutions. However, hope prevails because of the recent flourishing of interest about IK particularly among post-modern thinkers and educators concerned

about ecological illiteracy among the so- called “educated” in the present society. In short he opines that IK studies are now more than anthropological curiosities: they now offer “genuine alternatives to initiation into the “monoculture” of modernity” (Prakash 1999:164). Viergever (1999:339) espouses a similar viewpoint as Prakash and also contends that the efforts to conserve IK are not effective enough as they concentrate on documentation and ex-situ storage. Only operating in this manner is ineffective. It is “like arguing that the creation of libraries is sufficient to stimulate the production of literacy works” (Viergever 1999:339). Despite the importance of IK for the world as a whole and for indigenous communities and calls being made from the 1990s for the conservation of IK, this research finds that not much has changed. IK continues to be lost.

Researchers (Hountondji 2002:23; Hoppers 2002 :8, 14; Crossman and Devisch 2002:116; Semali 1999: 98,101; Jegede 1999:119; Maurial 1999:59; Semali and Kincheloe 1999:37; George 1999:, 84; Mosha 1999:213) discuss the impact that IK, especially the cultural aspect and politics, have on holistic education. They maintain the following:

- Many people still depend on IK. It is not forgotten. It is still widespread, though probably less so than it used to be in the pre-colonial times. It is still largely operational to an extent that the so-called “educated” at times refer to the practitioners of traditional knowledge as an alternative to their own failure (Hountondji 2002:23).

- IK is part of culture (Hoppers 2002:8) and science is not free of culture (Crossman and Devisch 2002:116).

- IK encompasses a relationship between culture and successful learning (Semali 1999:101).

- Culture of a learner plays a very significant role in learning, determining how concepts are learnt and how they are stored in long term memory as schemata (Jegede 1999:119).

- Schools have imposed a curriculum that devalues IK (Maurial 1999:59) and now an opportunity has arisen for the construction of a just and inclusive curriculum (Semali and Kincheloe 1999:37).

- The Western worldview isolates human beings from nature (Maurial 1999:59), cultural beliefs and practices (Semali 1999: 98).

- IK arises directly out of learners' real life experiences, hence its incorporation into school work can serve to motivate learners as they begin to see that recognition is given to what they do and say in their communities. Furthermore, IK can be used to explore values, to recount history, to analyse changes in attitude over time and to permit learners to make informed choices regarding IK and Western school knowledge (George 1999:84).

- IK forms the basis of food security, health and the livelihoods for traditional people (Viergever1999:333) and it provides community cohesion that conserves biodiversity, controls pest etc. (Prakash 1999:166).

- IK is knowledge and education that underscores the importance of bondedness, cooperation, altruism, generosity and environmental protection (Mosha 1999: 213).

- The legacy of Western rationalism is no longer unchallengeable (Hoppers 2002:14).

George (1999:82); Mosha (1999:96,108); Mbatha (1997:17) reinforce some of the rules for inclusion for the category, unacceptable. George

(1999:82) found in her research that young people in the village, who have had a greater exposure to school science than their parents, display some ambivalence to IK while Mosha (1999:96) notes that the Western-style education system in Tanzania "contributes to a widening gap between youth and elders in many rural African contexts and perpetuates a false assumption that modernization is a unilateral process". Mosha (1999:108) also notes that some rural people educated outside their communities and relegated with the responsibility of planning and implementing curricula, find themselves living even further away from their indigenous communities and they even pass this on to their children. Mbatha (1997:17) reinforces the inclusion, personal bias by stating that many traditional people believe that growth and development can only occur in urban areas.

Crossman and Devisch (2002:108) support the inclusion of ethnicity and the concept of IK as being problematic. The term is ambiguous and it does lend itself to many definitions as shown in Chapter Two. Crossman and Devisch (2002:108) maintain that over the years the term has assumed a depreciatory status mainly because of historical reasons and in the process it also assumed "an ethnic component". By falling into a historical trap the problem of defining IK compounds.

The claim or implication that both IK and WK have a legitimate place in the science curriculum is of great interest and of pedagogical value. The fact that IK is not seen as the universal authoritative, knowledge system signifies a move in the right direction in curricular development sighting a just and an inclusive science. Hoppers (2002:8) and Hountondji (2002:37) espouse similar feelings when they note:

"The acquisition of Western knowledge has been and is still valuable to all, but on its own, it has been incapable of responding adequately in the face of massive and intensifying disparities…and rapid depletion of the earth's natural resources".

(Hoppers 2002:8)

"We must find ways to reformulate traditional knowledge in terms of the imported knowledge and, vice versa, we must integrate the traditional into the modern in a way that allows the development of new forms of rationally, enlarged and more comprehensive than the forms prevailing today".

(Hountondji 2002:37)

In conclusion to the analysis to question one it can be said that an individual's identity plays a fundamental role in determining whether he or she may accept or oppose the use of IK in the teaching of science.

5.10 ANALYSIS OF QUESTION TWO

The audit trail reveals the perception that natural science teachers in the present context will find the initiative of using IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further, unmanageable. All eight interviewees perceive this although one of them also stated that a few "energised", creative teachers would manage to a certain extent (Table 30).

Rules for Inclusion	Frequency	Percent
Manageable (creativeness)	1	11.1
Unmanageable (No/insufficient past/present support	6	66.7
Unmanageable (Sensitive nature regarding choice of IK)	1	11.1
Unmanageable (Low self esteem)	1	11.1
Total	**9**	**100.0**

Table 30: Frequency and percentage of responses for the Categories: Unmanageable and manageable of Question Two.

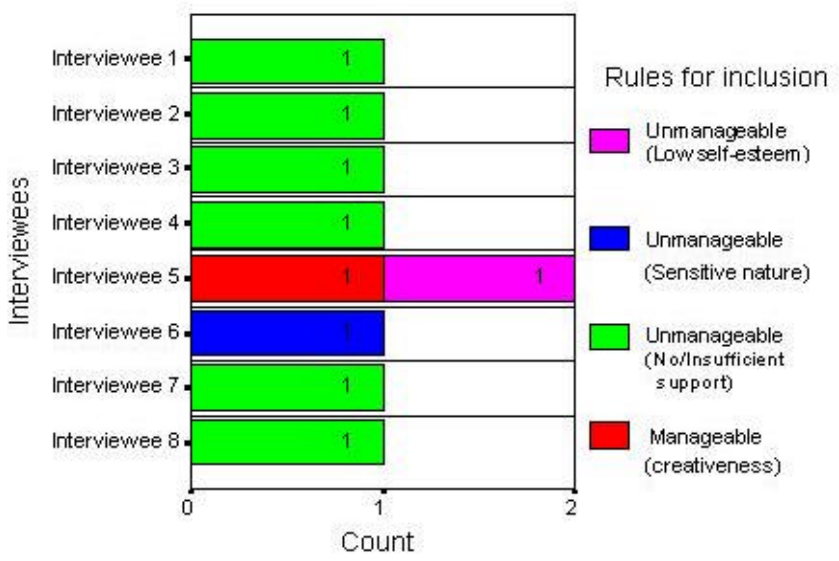


Figure 33: Count of Interviewees' rules for inclusion for the Categories: Unmanageable and Manageable of Question Two.

Interviewee 8 succinctly describes this unmanageability as:

"…*I am saying that the teacher's involvement will be minimal because he has not as yet emerged from the trap of his own education. His knowledge of the scientific method has pulled him into a bucket. He can't see over the rim, he is caught. Things have not changed that much to allow him to come to the top of the bucket. Because of their limitations in the area of knowledge they will find IK both difficult to access and impart. In fact IK will prove greatly challenging to most educators to source, sift, test, verify IK to present in our currently accepted classroom practices. Part of the problem arises from the system of education from which the educator comes. Even more problematic is that different educators are themselves at different levels in the attainment of the traditional Western scientific approach…".*

Interviewee 8

Interviewee 3 provides a primary source of evidence as to why it is perceived as being unmanageable while interviewees 5 and 7 remind one of the ravaging effects of the imposition of the foreign curriculum on South African teachers.

"…The actual delivery of IK in the classroom is going to be very difficult. We actually tried it. Last year we ran a workshop for Natural science teachers and I said lets try and do this specific outcome that has something to do with IK. I think it was SO8 or SO9. We demonstrated to teachers in the Pietermaritzburg area how flu can be remedied using the turpentine reed. In Zulu it is called isiqunga. Prior to this

workshop, teachers never had any idea how to implement SO8 or SO9. After the demonstration teachers asked for more workshops of this nature in order to embrace it in their classroom teaching…".

Interviewee 3

"…It is going to be difficult for teachers and yes it's going to put a lot of demands on them because we have been so moulded by Western thinking particularly in the scientific grounds where the whole kind of way is very black and white as it were and does not allow for grey areas very easily. I think that this is going to be the challenge and that is why I am very surprised that it is coming from you as a science teacher and not from an arts person or a language person or a history person..".

Interviewee 5

"…Yes just educator involvement would be very, very difficult. You have to remember where we come from. The sort of educational system we have from made us believe that IK is for home use and not for classroom science teaching..."..

Interviewee 7

The statement "there are so many different tribes, so whose IK do you teach" made by interviewee 6 is in no doubt a sensitive issue that poses a challenge in setting C2005's indigenous agenda. Another issue that makes the task unmanageable is that in South Africa's post apartheid era the "ghosts" of colonial domination are still haunting many teachers. In this regard, the problem today is that, in the context of colonial domination, many teachers have to a large extent internalized the colonists denigrating views on IK. As a consequence, many teachers undervalued and are still undervaluing their IK. Interviewee 6 and 5 highlight the low self-esteem possessed by many of the teachers.

"…For this to take effect you need dedicated teachers who must cultivate a positive attitude towards IK..."..

Interviewee 6

"…I think that the educational system needs to make a very big contribution to help those learners and teachers to know who they are without baggage. This must be done in a positive way and I think that this will require a lot of very careful orientation and training and strengthening of people to know who they are because I think it is only when people know who they are can they move in new directions with comfort and not feel threatened...".

Interviewee 5

"Fear of not succeeding. Generally speaking people are afraid of failing. Failure is not viewed by many people as being a stepping stone to success.

Diversity in South Africa poses a serious challenge. It is virtually impossible for any teacher to have a deep understanding of all the IK that learners may bring to the class. Most IK is not to be found in books. Behaviour modelling and listening to folk stories imparts IK."

Interviewee 4

Quantitatively analysed the statistics shown in Table 30 and the Figure 33 indicate the inclusion (no or insufficient past or present support for the use of IK in their science teaching) as the primary reason the interviewees perceived teachers will find the initiative unmanageable. This inclusion draws a response frequency of 66,7%. It was followed by the inclusions, low self-esteem and sensitive nature regarding the choice of IK. Each of these inclusions draws a response frequency of 11.1%.

The perception that teachers would find the initiative unmanageable is understandable in the context of past colonial domination and the present context of South Africa's need to find new paradigms to decolonise the education framework with the intent of creating a just and inclusive science. Presently the term, indigenous knowledge, is merely used as a catch phrase in C2005.

Researchers echo a similar sentiment of IK being unmanageable in the teaching of school subjects worldwide. The voices of these researchers and additional reasons for this sentiment follow in the literature review below.

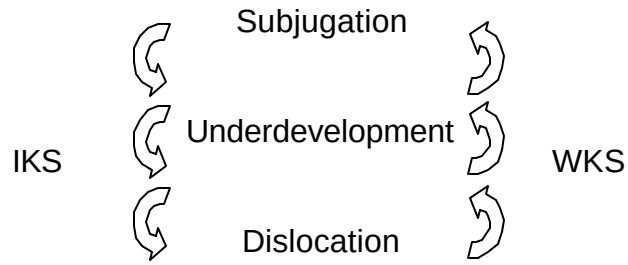
5.11 LITERATURE REVIEW FOR QUESTION TWO

For the successful use of IK in the teaching of school subjects implies that learners no longer need to be subjected to two separate parallel curricular in their lives. In other words IK need not be placed, side by side with WK “in a relationship of mute juxtaposition and mutual ignorance, exclusive of all dialogue and exchange” (Hountondji 2002:24). This is indeed a challenging task as it demands teachers not just mentioning that this is the traditional way of doing things and it is better than the Western way, or, conversely. Teachers are expected to delve deep and martial facts in a way that learners understand both the traditional and the modern way and make use of the good from both of them (Hountondji 2002:26). Interviewee 2 Hoppers and Semali and Kincheloe espouse similar views.

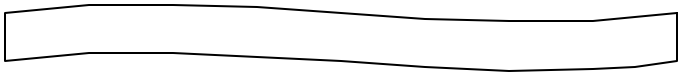
Hoppers (2002:9) states that the idea of using IK demands teachers to explore IK such as forest resource exploitation, atmospheric and climatological knowledge etc. and “recast the potentialities they represent in a context of democratic, equitable participation for community, national and global development in real time”. Teachers becoming hermeneutist (scholars and teachers who structure their world around them) and epistemologists (scholars and teachers who seek to expose how accepted knowledge can be validated) are requirements according to Semali and Kincheloe (1999: 37) for successful implementation of curricular reform with the intent to place IK on par with WK. Teachers and learners are therefore expected to understand multiple epistemologies, possess research skills and be able to interpret the meaning of information from a variety of perspectives.

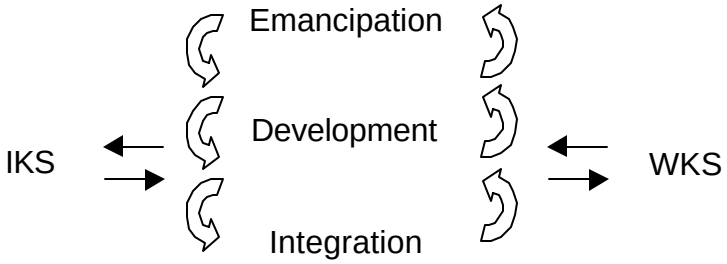
To accomplish the requirements demands:

- A power shift (Hoppers 2002:16) as illustrated on the cover on the book tiled Indigenous Knowledge and the Integration of Knowledge Systems *Towards a Philosophy of Articulation.*



Exploitation





Protection

- IK no longer lying in the margins of science (Hountondji 2002:24). This is also noted by interviewee 2, 6 and 8).
- IK no longer be exploited and be used to serve the Western economy as stated by interviewee 2 and 6 and reinforced by Hountondji (2002:24).

This reversing or correcting trend calls for critical multicultural education in formal educational institutions. This endeavour beckons teachers to know enough about IK and to approach IK in its contextual embeddedness. Only in such a context will critical, multicultural educators emerge and be in a position to engage in meaningful

dialogue between the “North” and the “South”. Critical multicultural educators need to use this intersection between “North” and “South” to achieve all forms of knowledge production and produce a science that responds to the needs of society in the 21st century. By doing this the true meaning of the word education will also emerge and be put into practice.

Central to executing what has been said in the preceding paragraphs is the requirement for specialists from the community and from the academia to construct a framework that could be used to empower teachers. The Eurocentric way, whereby teachers in the past and in many present situations are shown the “truth” and are expected to pass it along to their learners, is no longer the only path to follow. What South Africa needs is for these specialists to envision a way to define, identify and address this challenge to empower teachers. The problem, however, in South Africa is that there is among the “specialist” very little commitment and no coherent plan to string together its human resources to fulfil its vision of including IK in the school curriculum. Interviewee 2 is very cognisant about this “missing link” when he states:

“…In South Africa we form committees, write papers, White papers, come back review them, write again and those things never get implemented….”.

Interviewee 2

Hoppers (2002:6); Hountondji (2002:37 and Ntuli (2002:65) reinforce the absence of this link.

A Western discourse about the “other” is still perpetuated by most formal research institutions in South Africa.

Hoppers (2002:6)

“We have been producing scholarly articles, conference papers and books for them first and only secondarily for our own people… “.

Hountondji (2002:37)

Despite efforts by UNESCO "to commission a nine-volume history of Africa by African scholars and other Africanists, our ignorance persists. Those volumes are still unknown by African educators and, where they are known, they are not prescribed; where prescribed, they are not taught; and where they are taught, they are taught from a Western perspective, thereby negating their very existence".

Ntuli (2002:62)

"The major problem facing us in South Africa is that the academic associations that once stood firm about the apartheid regime have disappeared, and those that still exist are silent on a number of issues related to the radical transformation of our educational system".

Ntuli (2002:65)

To make a fine point to the perception that teachers will not be able to manage the teaching of IK in the science curriculum is to say that very little or no support flows from the education department, tertiary institutions and academic associations to develop new paradigms that can pull teachers "out" of the bucket that they are "trapped in" as espoused by interviewee 8.

5.12 ANALYSIS OF QUESTION THREE

This question draws the greatest number of responses from the interviewees. Collectively these responses, which in fact represent the obstacles that could probably impede the inclusion of IK, are categorised as:

Code 5 - Shortcomings of educational stakeholders and learners.
Code 6 - Complexity of IK.
Code 7 - Implementation shortcomings.
Code 8 - Intellectual property rights.
Code 9 - Heterogeneous classes.
Code 10 - Acceptance of IK.

Selected extracts from the transcripts below describe many of these obstacles. With respect with the categories: shortcomings of

educational stakeholders and learners, heterogeneous classes, implementation shortcomings and the acceptance of IK as legitimate knowledge in the curriculum, interviewees espouse the following:

"…Severe constraining factors to the successful implementation may also lie in the teacher him/herself: their own baggage of social and cultural bias, their own perceptions of where knowledge comes from and to what extent they can identify with the varied pockets of IK learners bring to the classroom..."..

Interviewee 5

"…What I am saying is that C2005 is not enough. There is something missing. What is missing is the traditional aspect of it. Just mentioning use traditional of knowledge is not enough.

In our department many civil servants believe that they must come to work at 7:30 and leave at 4 o' clock. In my office I tell my workers that they only leave when the work is completed, irrespective of time. Now teachers must also adopt this attitude. Once they are given a syllabus or curriculum and they are told what is to be done they must get on with it…".

Interviewee 2

"…The second one is the attitude of the teachers and the learners toward a particular kind of IK. I mean as a Black man if you tell me to teach Irish IK, then I will fail. This will also apply to a Zulu being asked to teach Sotho. Pride is involved here. Asking people to project their own IK could also lead to the creation of competition amongst different people. This could lead to arguments about whose IK is better…".

Interviewee 6

"…The reality is that all of us civil servants and maybe teachers in particular have been subjected to a huge amount of change in a very short space of time without a real commitment to change management and the building of skills and knowledge etc..."..

Interviewee 5

"…Elders usually play an essential and crucial role in bringing the past to the present. There may be situations where elders because of a language barrier may not be able to transmit the required knowledge…".

Interviewee 4

"…Most people and economists construe this to mean movement from the traditional way of doing things to a modern way of doing things. But to me that is not transformation. Transformation to me is any process that improves upon the existing. Whether it is an accumulation of more knowledge, whether it is the development of new alternatives, it a process that ought to give people a variety of choices to expand the scope of activities and knowledge. But the modern way of transforming is making people specialize in a particular direction…".

Interviewee 2

"…Another major obstacle I would say is that community members with expertise would withhold information. Many elders regard the younger generation as being "cash hungry… ".

Interviewee 7

"…because IK is evolutionary in nature and belonging to the people, South African schools are faced with an exciting dilemma: the multifaceted society presents endless opportunities to exchange the once hidden pockets of IK and yet by its very nature such a society can be its own worst enemy to explore this knowledge such as a body of knowledge presented in class for exploration may be completely unknown to others in the class and the teacher hence valuable opportunities to teach and learn IK will be lost..."..

Interviewee 8

"…Each tribe has its own IK. In a multicultural classroom you will have a dilemma of choosing what kind of knowledge to transmit…".

Interviewee 6

"…It is difficult to compartmentalize IK into disciplines such as science, geography etc. IK embodies all the disciplines without differentiating one from the other. In the quest for survival everything goes hand in hand. This means that science teachers have to break up the "survival web" to sift the "science facts". The big question is, are they empowered to do this? Will the IK not be misconstrued when not viewed in its totality?..".

Interviewee 4

"…In terms of the obstacles, the teacher needs to firstly understand that there is an alternate system of education apart from the Western / modern / Euro-centric one. One of the major obstacles is the acceptance of a knowledge system that has survived 1000s of years…".

Interviewee 1

"…The limited knowledge of the teacher and the lack of resources. Sometimes raw materials may be difficult to find in the immediate environment….".

Interviewee 7

"…From a homogeneous society it would be much easier to elicit knowledge of IK yet ironically the store of IK can be dramatically narrowed e.g. a teacher from a rural South African school and his/her students can explore IK e.g. Opuntia, the prickly pear because of its entrenched uses by communities over the years. Yet in an urban school such an example may be quickly dismissed as that alien plant that must be eradicated….".

Interviewee 8

The barriers that culture can present are expressed as:

"…Another problem lies in the fact that IK is so deeply intertwined with culture, folklore and by its anecdotal and often personal nature it is often difficult to draw out at the level of classroom practise. So the teacher and the learners are like ships passing each other in the night and another door on IK is closed…".

Interviewee 8

Using the experience of the San people as an example, interviewee 8 articulates issues of exploitation, valuation and the need for protection of intellectual property.

"…Intellectual property is another problem. In a Southern African context, besides the well documented survival strategies of the San, as late as the turn of this century found a giant Western pharmaceutical company being challenged by the San in attempts by the former to gain world wide patent rights over the Hoodiiae plant – a plant that the San have eaten the roots of to stave off hunger…."

Interviewee 8

Quantitative analysis shows that this question draws the highest frequency of responses (65) when compared with those obtained for question one (53), question two (9) and question four (35). Table 31 and Figures 34 -37 indicate the obstacles in terms of their frequency, their percentage and how each interviewee responded to the citing of the obstacles.

Code of Category	Rules for Inclusion	Frequency	Percent
5	Reluctance of elders to divulge information	3	4.62
	Shallow elaboration of IK teaching and assessment	2	3.08
	Insufficient insight about the transformation process	2	3.08
	Personal/cultural bias	5	7.69
	Insufficient insight about IK/WK	6	9.23
	Attitude: indifferent, fear and tired	7	10.77
	Language	2	3.08
	Total	**27**	**41.55**

Code of Category	Rules for Inclusion	Frequency	Percent
6	Holistic Nature	3	4.62
	Contextual Nature	4	6.15
	Undocumented format	5	7.69
	Diverse Nature	2	3.08
	Unstructured, invalidated nature	1	1.54
	Sensitivity	2	3.08
	Total	**17**	**26.16**
7	Insufficient resources/data	4	6.15
	Lack of a coherent plan to empower educational stake	5	7.69
	Total	**9**	**13.84**
8		**5**	**7.69**
9		**2**	**3.08**
10		**5**	**7.69**
	Grand Total	**65**	**100.01***

* Rounding off error

Table 31: Frequency and Percentage of Responses for the Categories: Shortcomings of Educational Stakeholders and Learners, Complexity Of IK, Implementation Shortcomings, Intellectual Property Rights, Heterogeneous Classes and Acceptance of IK

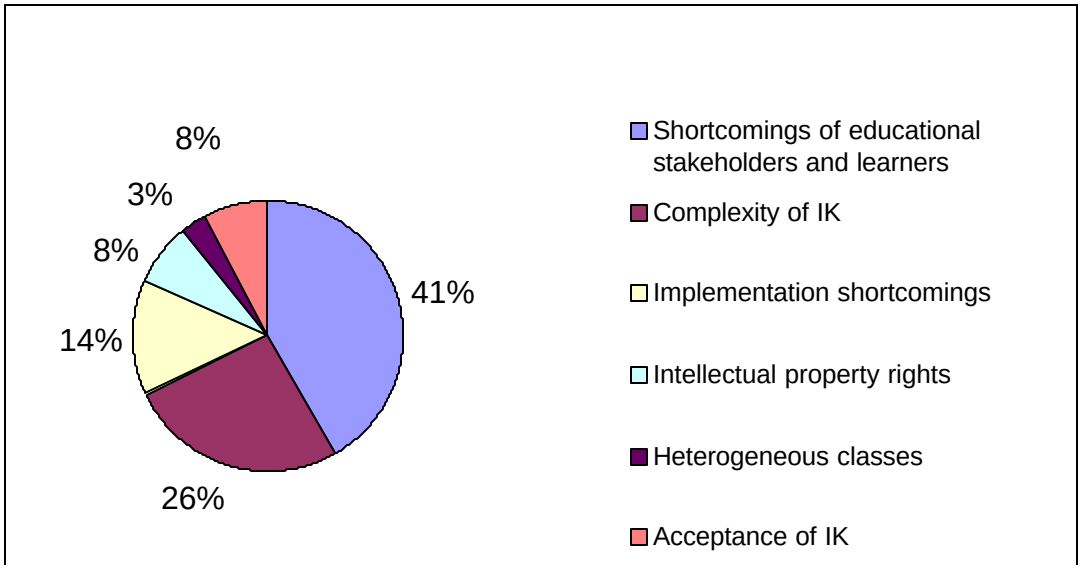


Figure 34: Percentage of Responses for the Category: Shortcomings of Educational Stakeholders and Learners

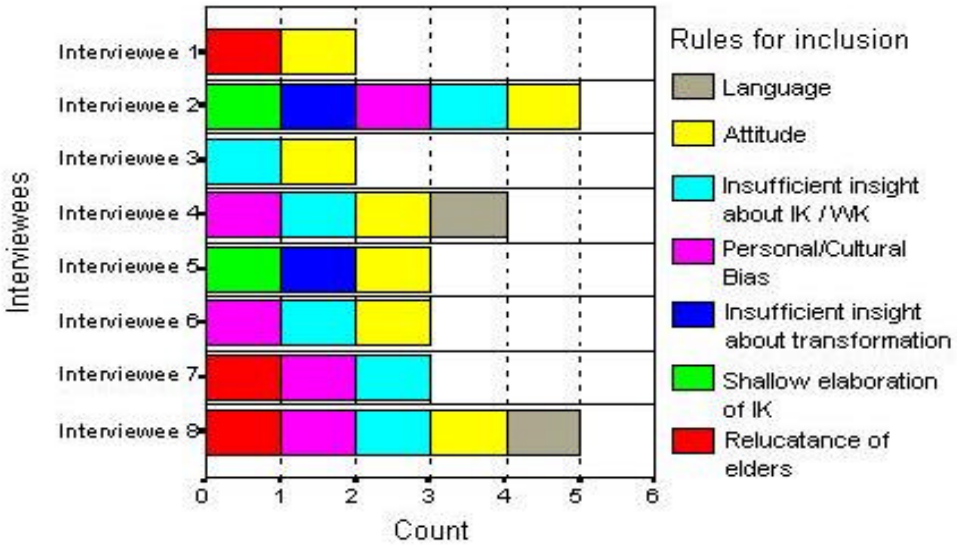


Figure 35: Count of Interviewees' rules for inclusion for the category: Shortcomings of Educational Stakeholders and Learners

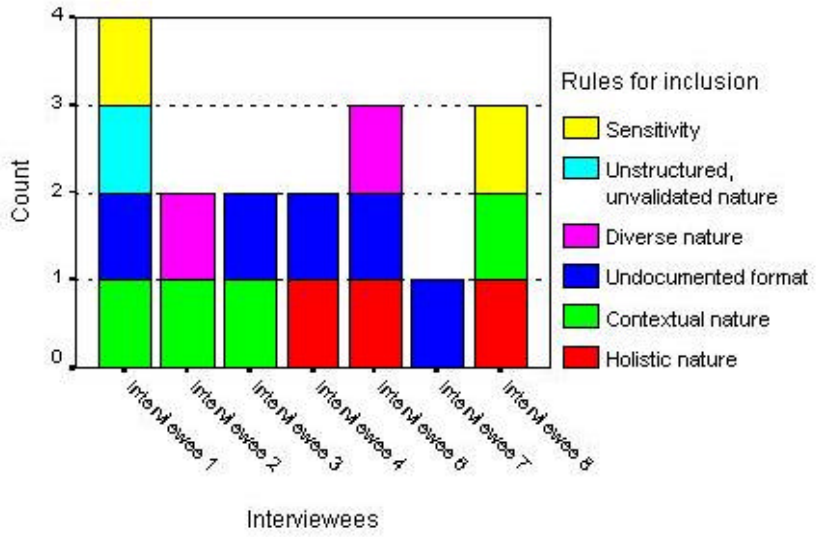


Figure 36: Count of Interviewees' Rules for inclusion for the Category: Complexity of IK

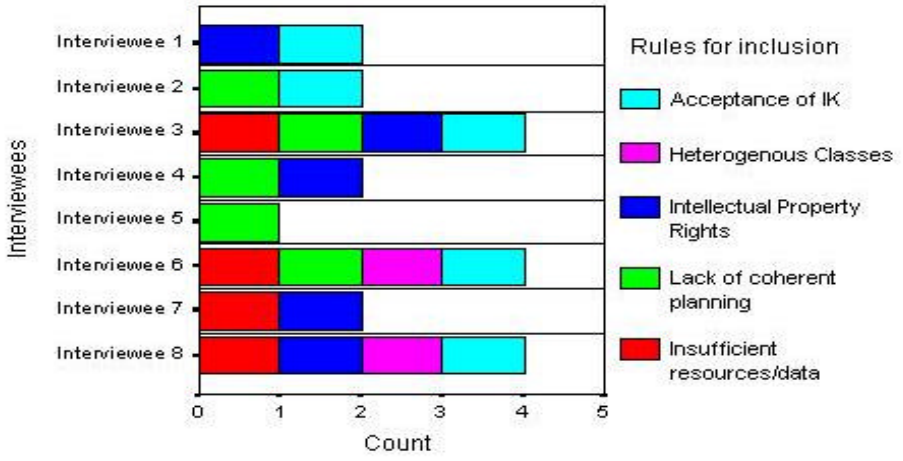


Figure 37: Count of Interviewees' Rules for inclusion for the Categories: Implementation Shortcomings, Intellectual Property Rights Heterogeneous Classes and acceptance of IK

Table 31 and Figure 34 cite shortcomings of educational stakeholders as being the major obstacle. From Figure 35 it can be seen that all eight interviewees stress this as an obstacle. The identification of this as being an obstacle by all eight interviewees adds emphasis to the finding of question two i.e. the use of IK in the teaching of science in the present context is unmanageable. A closer analysis of Figure 34 ranks complexity of IK second, implementation shortcomings third, intellectual property rights and acceptance of IK fourth and heterogeneous classes fifth.

From the above it can be deduced that the inclusions are qualities embedded in the history of a person and in his/her "cultural web". This deduction ties with what Mugo cited in Hoppers (2002: 10) states about colonialism remaining "a factor insofar as it provided the framework for the organized subjugation of the cultural, scientific and economic life of many on the African continent and the Third world".

With reference to the complexity of IK that follows shortcomings of educational stakeholders and learners as an obstacle, Table 31 and

Figures 34 and 36 revealed the undocumented nature of IK as being the main issue. This is understandable considering the historical training that the majority of South African teachers were exposed to during their tertiary education. Hountondji (2002:26) and Tema (2002:129) state that Western education with its methods is still being perpetuated. Documented information such as textbooks has a stranglehold on teaching. Therefore to usher in IK typically characterised by its undocumented nature is definitely going to pose a serious obstacle to the teaching of science.

Tema (2002:135) also contends that personal interests, desires and values are noticeably absent in Western scientific knowledge that seeks objectivity. The prior knowledge and experiences that learners bring to class and which forms the baseline to entrench new knowledge is being overlooked primarily because of academia not fully understanding IK or endogenous knowledge, a term that Crossman and Devisch prefer to use instead of IK (Crossman and Devisch 2002:98).

The remaining inclusions associated with the complexity of IK are also not surprising as IK, unlike WK, is grounded on “the cohesiveness of the human, natural and spiritual world” (Semali and Kinechloe 1999:42). People and all things cannot be separated from either the context or the natural world characterised by diversity and sensitivity. Furthermore IK is communally owned and understood. Seen from this perspective the teaching of IK is a mismatch to the way Western science teaching is broken down, decontexualized and taught in fragments. Expecting teachers, carrying baggage from the apartheid and present regimes, to depart from their present pedagogical methods is thus complex and extremely demanding but central to the provision of a just and inclusive science education.

Implementation shortcomings (that include the inclusions insufficient resources and a lack of a coherent plan), intellectual property rights, heterogeneous classes and the need to accept IK are also valid

obstacles (Figure 37). Implementation shortcomings have already been supported in preceding paragraphs, particularly those pertaining to the shortcomings of educational stakeholders and learners. The lack of a coherent plan to empower educational stakeholders and insufficient resources also contributes directly to the inclusion of IK in the science curriculum being unmanageable.

Intellectual property rights and the subjugated status of IK draws an equal frequency response (8%). Intellectual property rights, according to, Mashelkar (2002:188) is an issue that intellectual related information must revisit. It can no longer be seen as "a distinct and self- contained domain". It has to be seen as an important and effective policy instrument, relevant to a wide range of socio-economic, technological and political concerns" (Mashelkar 2002:188) because "local communities or individuals do not have the knowledge or the means to safeguard their property in a system that has its origins in very different cultural values and attitudes" (Mashelkar 2002:189).

The notion that IK is useless, primitive, barbaric, inferior, full of superstition etc. is comprehensively discussed in Chapter Three. Unfortunately in the 21st century this subjugated status still prevails as revealed in this research. This probably also contributes directly to the low esteem that some teachers possess pertaining to the acceptance of IK having a legitimate place in the curriculum. In respect to this finding Hoppers (2002:20) comments:

"for those who have internalized linearity in history and nature, taking guidance from other knowledge system will seem like going backwards".

The last identified obstacle, heterogeneous classes drawing a frequency response of just 2 is by no means an unimportant one. Semali in Semali and Kincheloe (1999: 13-14) reinforces interviewee's 8 comments concerning classroom discussions about the prickly pear plant when he writes:

"I vividly recall my friend Larry taking me on walks in the forested foothills of the mountains. Never getting lost even at the age of six, Larry would point out to me the medicinal uses of the roots and leaves of various plants…I was fascinated by Larry's knowledge…It was a powerful education...

I remember my surprise when Larry shaken and perplexed asked me what exactly the teacher wanted us to do…Suddenly I was the tutor and Larry the student".

(Semali and Kincheloe 1999:13-14).

In conclusion it can be said that the citing of six categories of obstacles by the interviewees clarifies further the unmanageable task of using IK as a teaching resource by the majority of science teachers. It also becomes clear that educational stakeholders have to bring in new ideas for the shaping just and inclusive science in C2005.

5.13 ANALYSIS OF QUESTION FOUR

Ideas, some of which are not new but which still remain in the margin of curriculum thinking in South Africa are represented in the selected extracts that follow:

"…*the main strategy is to have joint co-operative partnerships with the community. This means that IK is held in the community and by bringing your partners from the community you are going to make learning more meaningful. It is like I mentioned earlier, the laboratory of life will be in your classroom…".*

Interviewee 1

"…It is the responsibility of the education system to make it possible, but the content, curriculum for IK must be evolutionary and within the community as the starting point. Preconceived ideas and perceptions will tend to impose barriers other than grow the process. There must be structures, support services and many educational debates first in place to present some degree of direction to the body of teachers. The outcomes must be researched and evaluated – the final one being a learner emerging from a system with a deep appreciation of knowledge of IK and scientific knowledge..."..

Interviewee 8

"…They will also have to call the different communities to school to demonstrate certain things. Which communities are involved depends on the composition of the class.

They obviously need to study, get resources on different cultural groups. They need a lot of information. Unfortunately a lot of it is not written down. So a lot of it can only be got from word of mouth. You will have to get it directly from people. This will mean that teachers will have to go into the communities. Teachers will have to write it or record what is being said so that in future they will have a knowledge/data base..."..

Interviewee 6

"…Educators will require enormous assistance from both the national education department and the provincial department. This, however, calls for expert advice being provided to these departments. Local as well as global expertise is a necessary pre-requisite. The services of the men in white lab coats and those without them are a must. It is time that the top brass listen and learn from the grass roots...."..

Interviewee 7

"…The second strategy is the use of the interview method: First the teacher / learner would have to identify people in the area who have some body of IK knowledge such as a songoma is an interesting starting point for a body of IK. Stripped of the trapping of Western stereotyping i.e. throwing of bones, and other much publicised rituals, a songoma with years of study in community medicine do some amazing medicine and social work. IK affects their practice in a big way. A songoma collects herbs, collects only enough without damaging the plant…".

Interviewee 8

"…Another strategy is for teachers to plan cost effective tasks for learners to do either on their own or in groups. Interviewing elders at home or in the communities about their life styles can provide invaluable information. This will not be too difficult as story telling is one of the methods whereby home education is achieved. Furthermore this is feasible because many of our learners are being care for by elders...."..

Interviewee 7

"…Encourage "role play" to indicate the holistic nature of IK. This can also be used in situations where there is apprehension to turn the negative to a positive. Successful outcomes can be shown.

Province interpreters for those that are not in a position to communicate effectively because of language barriers….".

Interviewee 4

"…Use of books : small specific publication such as those from the Parks Board , Wild Life Society have historical perspective, often folklore and some IK along with the scientific names and writing. A publication such as from Kew Gardens has publication with the emphasis on IK of that particular plant. So if one really looks, books can yield a lot and the teacher can gain a lot of IK..."..

Interviewee 8

"…Seeking corporate funding to arrange exhibitions concerning IK and using local expertise of community members to present hand on activities at such gatherings would empower the so called educated..."..

Interviewee 7

"…Perhaps a way to go is to get this IK researched further. This is going to require a concerted effort by all people not only the Department of Education. Maybe it should become mandatory for schools to look at the IK of their area. Tertiary institutions being the fertile grounds for investigations have much to do to help find possible strategies for teachers to implement..."..

Interviewee 6

"…I think it was in one of the papers that I sent to you, the whole thing about teaching social history. How do we get to being where we are? What have we gained and what have we lost you know in a very balanced way…".

Interviewee 5

"…So knowing what is existing out there, identifying it, documenting it and then bringing it into the training system of the teachers and from there developing a

curriculum of infusing IK with Western science is a way forward. When you teach chemistry or biology you can teach that this is the modern way and this is the traditional way and in this way you can infuse both knowledge systems…".

Interviewee 2

From these extracts the following strategies emerged:

- Code 11 - A concerted drive to (re) valuate IK.
- Code 12 - Establishing joint partnerships between the Department of Education and the community.
- Code 12 - Establishing joint partnerships between the Department of Education and tertiary education.
- Code 12 - Establishing joint partnerships between the Department of Education and NGOs, corporate and other government departments.
- Code 12 - Researching IK further by Department of Education and tertiary institutions.
- Code 13 - Refining IK in C2005 and thereby developing a framework for the teaching of an inclusive science.
- Code 14 - Empowering academia at national and provincial level and also providing sufficient resources.
- Code 15 - Establishing a database.

Closer looks of the proposed strategies (Table 32 and Figure 38) show two strategies are central to new ways of thinking toward the development of an inclusive science in C2005.

Code of Category	Rules for Inclusion	Frequency	Percent

11		6	17.1
12	DOE and Community	7	20.0
	DOE and Tertiary Institutes	3	11.4
	DOE, NGO's, Business and other Government Departments	3	8.6
	Further research, Tertiary Institutes, DOE, Communities	2	5.7
	Total	**15**	**45.7**
13		5	14.3
14		7	20.0
15		2	5.7
	Grand Total	**35**	**100.0**

Table 32: Frequency and Percentage of responses for the Categories: Rules for inclusion: (Re)valuing IK, Establishing Partnerships, Refining Curriculum, Empowerment and establishment of Database

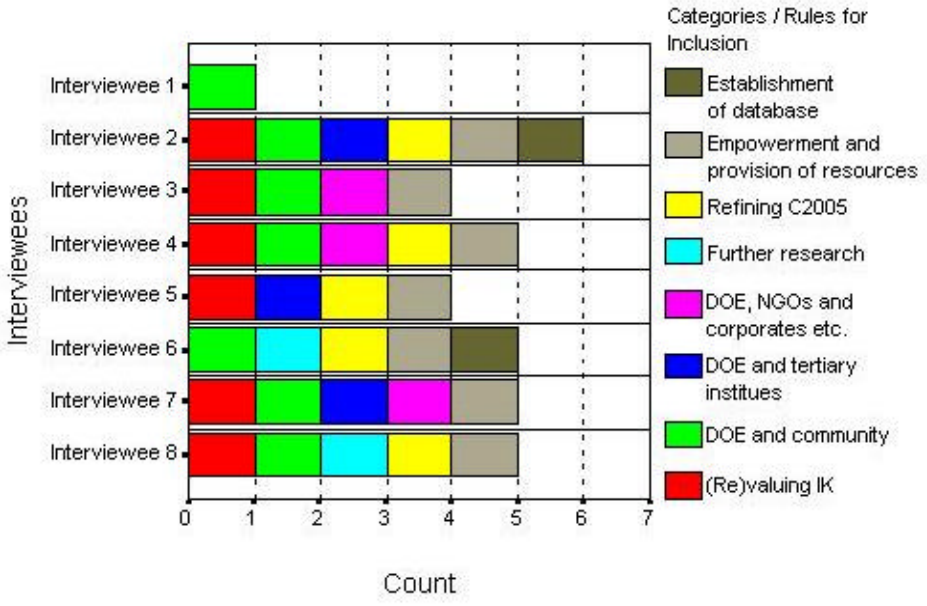


Figure 38: Count of Interviewees' Rules for inclusion for the Categories / rules for inclusion: (Re)valuing IK, establishing partnerships, refining curriculum, empowerment and establishment of database

These strategies, establishing partnerships with the community on the one hand and empowerment of academia on the other hand, are the corner stones of any model new or old, envisioning the beginning of a just and inclusive science in C2005. They represent points on either side of a spectrum of envisioned steps, facilitated by the Department of Education and assisted by inputs from tertiary institution, other government departments, NGOs, and corporates (Figure 39). Hoppers (2002: 2-21); Hountondji (2002:23-37); Ntuli (2002: 53-66) and Semali and Kincheloe (1999:3-53) propose detailed ideals closely aligned to ideas depicted in Figure 39.

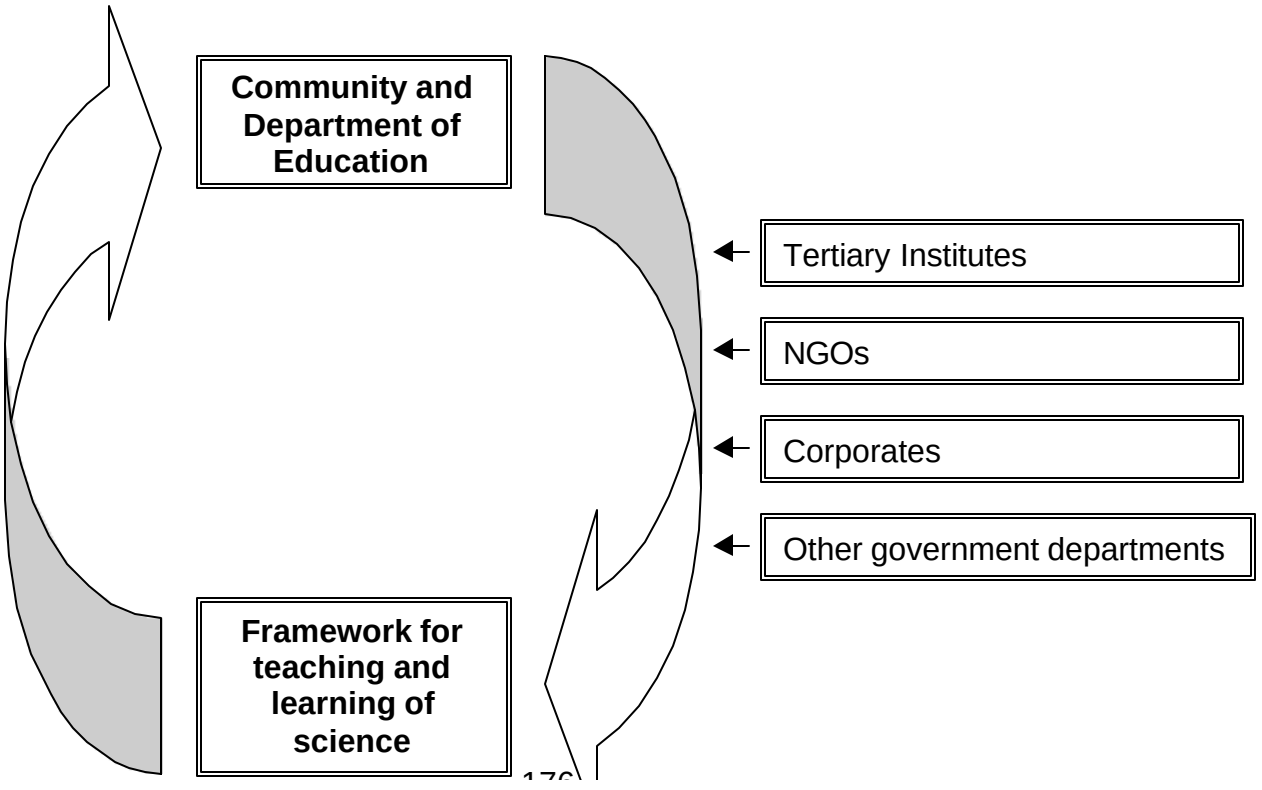


Figure 39: Strategies proposed by Interviewees

Acknowledging an initiative of establishing partnerships with the community by other educational stakeholders ushers in, recognises, (re) valuates IK and open a process of dialogue central to the beginning of an inclusive science. The (re) valuating of IK is a necessary condition for its development. Development is crucial if it is to be integrated with WK to impart holistic education; integration is crucial if IK is to fulfil its potential of the creation of an inclusive science and an inclusive science is crucial for a science that will serve the needs of a society in the 21st century.

Overall it is envisioned, with the coming together of community members, the Department of Education and other educational stakeholders, much more information will be shared. Although sharing provides a way forward for now and in the future, the comments made by interviewee 3 cannot be ignored.

"I think it is a very tall order. They are the very people who contest that IK is not science. Very few have the knowledge to see that IK is a science. Most of them don't even take it seriously. So if you are now saying that you are going to use these very people with this perception to train teachers you are not going to succeed. If this is to be seen as a strategy then you will have to change their perception and this is not going to be easy. There are lots of these kinds of people at university and unfortunately most of them are on the education side.".

Interviewee 3

The lack of commitment to give IK its due respect as espoused by interviewee 3 not only creates a profound tension between the

knowledge systems of teachers and learners but also a giant step backwards in the “negotiation for legitimacy of voice, authenticity of representation and ultimately of what is taken to be knowledge” (Fatnowna and Pickett 2002:261). Concerted research and development efforts grounded in an IK perspective are demanded to rapidly offer advice as to how teachers could and should act.

5.14 CONCLUSION

This research study indicates that the majority of teachers will accept IK provided that a well - researched, workable framework is put into place by the Department of Education to provide the necessary guidance and support for the inclusion of IK in the natural science curriculum. In the present context teaching IK is unmanageable to the majority of teachers who are trapped in a system that still perpetuates an exclusive science. Shortcomings inherent to educational stakeholders, complexities pertaining to IK, implementation shortcomings, intellectual property rights, heterogeneous classes, and the need to accept IK are cited as barriers to the beginning of the creation of a just and inclusive science. A way forward involves reversing or correcting the mindset of the majority of the academia and also some members of the public concerning the status of IK. Entering into a sincere partnership with the community/ communities is movement in the right direction as hearing and acknowledging the voices from grassroots is democratically just and pivotal for the development of model/s that will usher in the beginning of a just and inclusive science in C2005.

CHAPTER SIX

SUMMARY OF THE MAIN FINDINGS, RECOMMENDATIONS AND IMPLICATIONS

6.1 INTRODUCTION

This study served to investigate:

- The role, if any at all, that IK can play in the development of learning programmes in the natural sciences that could contribute to help prevent the Earth from further degradation.

- Whether natural science teachers in the present educational context are able to design learning programmes using the relevant IK and WK.

6.2 THE MAIN LITERATURE REVIEW FINDINGS

The Earth continues to be degraded at an alarming rate (Urquhart and Atkinson 2000:27; Yeld 2002:9; Annan cited in Smallhorne 2002:14) Human activities have been and continue to be cited as the main cause of the Earth's resources being exploited, polluted, and in instances destroyed Kassas 1997:63; Singh 1998:1; Daily, Ehrlich and Alberti 1996:19). The plea to prevent further environmental degradation is valid now as it were many years ago (Loh 2002:1-2). However, while the means of achieving this has developed considerably over the previous half century through scientific processes, so have the means of threatening and comprising them (Johannesburg World Summit 2002). In the meantime political, economic, social, cultural and environmental contexts have also changed profoundly and the role of the sciences and all knowledge systems taking into account gender and cultural diversity in this changed context needs to be defined and pursued: hence the grounds for a new commitment and plan of action at all levels of society.

It is with the above in mind that countries need to develop a corpus of knowledgeable people who can act as catalysts and agents of change to emancipate, develop, integrate and protect "other" knowledge systems (Hoppers 2002:4) . It is time to acknowledge that Western science is one type of knowledge system among many (Semali and Kincheloe 1999: 43-46, 51-52). Sophisticated knowledge of the natural world is not confined to Western science. Human societies all across the world have developed rich sets of experiences and explanations relating to the environments they live in. These other knowledge systems, today commonly referred to as local knowledge or IK encompass an array of information, understandings and interpretations that guide human societies around the world in their innumerable interactions with the natural milieu: in agriculture, struggles against

diseases, naming and explanation of natural phenomena and strategies to cope with fluctuating environments (Nakashima 2000:12; Maurial 1999:65; Atte 1992:1-16; Parrish 1999:275-276; Quiroz 1999:310; George 1999:85; Moran 1999:1-4; Lambert 2001: 1-4; van Damme 1999:85-91; McDonald Fleming 1992:69-87; Easton and Ronald 2000:1-4; Mwadime 1999: 254-255; Mosha 1999:214; Warren 1991:1-31; Warren 1992:2-3; Prakash 1999:163,171). Having said this by no means conveys the message that all IK is useful and that communities around the world have sustaining systems for managing their environment. But in general, communities whose livelihood depends on resources in their immediate area are likely to have accumulated, through trial and error, knowledge and practices of relevance to sustain resource management and conservation of diversity. It is thus time to recognize and tap into the world's wisdom (Wickham cited in Lalonde and Morin-Labatat 1993:4).

Numerous scientists dismiss IK as insignificant. Yet it has contributed greatly to the development of "modern science" (Nakashima 2002:2). Disdain for IK has to be overcome. It still lingers in academic practice in general. Governments, formal research institutions, policy makers and the private sector should therefore demonstrate their readiness to work with the generators and holders of knowledge in rural communities, facilitate their recognition and make concerted efforts to include an IK perspective in formal science education at schools.

In South Africa, although the design of the revised C2005 provides teachers with a vast potential to provide learners with opportunities for multiple learning forms, it still does not fully recognize the potential of IK in the teaching of science. It is still a Western curriculum, foreign to the majority of learners. Interpreting the curriculum to ascertain where and how IK can be used in the development of learning programmes and implementing the non-technical approach shown in Figure 25 and the authorizing cycle shown in Figure 26 demands teachers possessing content knowledge, general pedagogical knowledge, pedagogical content knowledge, curriculum knowledge, knowledge of learners and

their characteristics, knowledge of educational contexts and knowledge of educational philosophies and knowledge of the diverse body of IK (Shulman 1987:7) This, in the present context, is expecting too much from teachers.

The term, IK, defies a simple definition. It is a multifaceted body of local knowledge (Warren 1991:2; Grenier 1998:1; Prakash and Esteva 1998:3; Mwadime 1999:247; Semali 1999:103). Unlike WK it is holistic, contextual, mainly qualitative, intuitive in its mode of thinking, cumulative and a collective experience that is constantly being revised daily and seasonally by creative and inventive community members (Warren 1991:2; Prakash and Esteva 1998:3; Semali and Kinchloe 1999:3, Mwadime 1999:247). Very often it is not documented. It is passed from generation to generation by oral means (Warren 1991:1; Brush 1996:4; Atte 1992:3-4). Obtaining insight into IK involves securing partnerships and entering into dialogue with countries, international organizations, relevant professional institutions and most important the generators and holders of IK who have the necessary expertise (Hoppers 2002:20; Ntuli 2002:65).

6.3 THE MAIN FINDINGS OF THE RESEARCH

The findings of a qualitative survey involving eight academics well versed in IK issues and cognisant about teaching and learning of science in the South African educational context show that:

- The inclusion of IK in the natural science curriculum would draw a mixed reaction from teachers. The majority of them will accept the initiative because of the usefulness of IK, upbringing, pride, politics, culture and to stem the tide of rapid erosion of IK in communities. Interestingly IK and WK were seen as knowledge systems that can complement each other. IK and WK were thus being placed on par.

- The minority that will oppose it may include teachers, who have become too Western and abandoned most of their traditional culture. Ethnicity, misinterpretation of the term IK, intergenerational values and cultural adherence also impact on the choice of not accepting the initiative.

- South African teachers will not be able to manage devising learning programmes using IK to contribute to efforts to prevent further environmental degradation. No or insufficient empowerment to use IK in the teaching and learning of science was put forward as being the stumbling block. The sensitive nature associated with choosing whose IK should be taught and low morale amongst teachers in the present context also contributes greatly to making the task unmanageable.

- Reluctance of elders to divulge information, shallow elaboration of IK teaching and assessment procedures, insufficient insight about the transformation process, personal bias, cultural bias, insufficient insight about IK, insufficient insight about WK, attitude, language, holistic nature of IK, contextual nature of IK, undocumented format, diverse, unstructured, sensitive, invalidated nature of IK, insufficient resources, lack of a coherent plan to empower stakeholders, intellectual property rights, heterogeneous classes and non acceptance of IK all throw up barriers to the use of IK in the teaching and learning of science.

- IK needs to be (re) valuated and researched further. These issues can be best addressed through participatory mechanisms involving all relevant sectors and stakeholders. Generators and holders of IK must assume pivotal roles in these partnerships. “Elites” must learn how to “think from below”;

- The revised C2005 needs refining. With specific reference to the teaching of science, it is important that curriculum designers

"revisit" the content that should be included in the science curriculum. The expected outcome of considering this ought to lead to a curriculum that is inclusive, democratic and one that acknowledges South Africa's heritage, experience, identity and history.

- An IK database and a coherent plan to empower science teachers need to be established. Special attention must be paid to empower science teachers. The science teacher would need to have a full understanding of the IK system operating in the community/ies from which his/her children come. Since there is little documentation of such systems, this approach will call for a great deal of pioneering research work. Science teachers are not likely to have time to carry out such research work and will therefore need enormous support in developing new teaching methods from the Department of Education. However, even with the documentation of these knowledge systems, it must be emphasised that the use of IK must on a continuous basis involve close contact and exchanges with the generators and holders of IK. The set up in the academic institutions have to change to encourage these close contacts and exchanges.
- Science teacher education programmes need to also reconceptualize their curricula and highlight that WK is one way of teaching science. Teacher- trainees need to be encouraged to develop an understanding of and an appreciation for IK, its characteristics and the purposes that it serves in the lives of their learners. The teacher-trainee needs to be trained to deal with such complex situations in the classroom in an attempt to make science accessible to learners.

6.4 RECOMMENDATIONS AND IMPLICATIONS

Recommendation One

It is recommended that the term, indigenous knowledge in the Revised National Curriculum Statement Grades R-9 (Schools) Policy be streamlined.

Motivation

In Chapter Three several definitions of the term, indigenous knowledge were presented. From the discussion presented in this chapter it was apparent that none of the authors comprehensively defined the term. The term thus defied a simple definition. However, from an analysis of key words extracted from the several definitions (Table 3.1), common characteristics of IK emerged. Closer examination of this analysis reveals that IK refers to:

- Ideas, experiences, practices, information that has been generated by a specific group of people living in a specific area or it is generated elsewhere and has been transformed by local people and incorporated in the local way of life.

- Knowledge that relies almost exclusively on intuition.

- Shared knowledge of community members that is usually unwritten and preserved in oral tradition being passed down from generation to generation.

- A dynamic, culture specific, holistic, knowledge system that is deeply rooted in peoples' everyday lives, their environment, their history and their new experiences.

These characteristics broadly expressed, view IK as an interconnected, multidimensional matrix of ideas, experiences, practices and values rather than a miscellaneous collection of facts. Unfortunately this view is not explicitly articulated in the Revised National Curriculum Statement Grades R-9 (Schools) Policy. In its current usage i.e.

“knowledge that has been produced by groups of people living in an area (such as province, country, and continent) for a long period of time…” . (DoE 2002:87), crucial characteristics critical to teacher understanding of IK in the natural science curriculum are omitted. These omissions probably represent one of the weakest links of the revised C2005’s call for the use of IK in the teaching of science and the other learning areas.

Recommendation one has the following implication for the policy makers that would include the Parliamentary Portfolio Committee on Arts and Culture, Science and Technology:

Implication

The policy makers, through participatory mechanisms involving all relevant sectors and stakeholders should aim to strengthen cooperation activities regarding IK, both nationally and internationally, with a view to: sharing and promoting the dissemination of ideas about the meaning of the term IK and jointly addressing the problem of providing an explicit explanation to the question, “What is indigenous knowledge”?

Hoppers (2002:16-18) and Ntuli (2002:65) in their articulations regarding IK in the South African context imply minimum or a lack of support to integrate knowledge systems and to reclaim African indigenous knowledge systems respectively. This apathy probably explains the superficial defining of IK in the revised C2005. Perhaps it also explains some of the interviewees’ perception as to why one ethnic group may readily accept IK in the teaching of science and not another.

Before endeavouring to promote IK in the teaching of science, it is therefore important for teachers to have an understanding of what is meant by the term. An explicit definition outlining the parameters of IK not only informs what is expected of teachers, but it also inscribes the

ways teachers articulate understanding and meaning into their learning programmes.

The grounds for serious commitment from individuals and organizations in civil society (authorities in IK within communities, NGOs, businesses and labour), the scientific, especially the academic community and the policy makers to strengthen national and international collaboration, including the exchange of knowledge and expertise are urgent to streamline the term, IK.

Recommendation Two

The Department of National Education has to extend and improve science education to protect the Earth from further degradation by utilizing IK and WK.

Motivation

Extracts from the Poverty and Inequality Report (1998:97); the 1999 National State of the Environment Report cited in Urquhart and Atkinson (2000:27); the Living Planet Report of July 2002 (Loh 2002:1) and Yeld's article (2002:14) detailed in Chapter One show that the state of the environment in South Africa is still far from satisfactory despite the attempts been made by the democratic South African government to change governance systems in the country to create conditions for sustainability to take effect and for more people to participate in decision making in all sphere of life. Exploitation of natural resources has become imminent threats to the Earth. In short, government initiatives are not sufficient for protecting the Earth. Hence efforts are turning towards the challenging task of finding and defining new paradigms that focus on protecting the Earth from further degradation.

Perhaps an important step forward is the promoting of science education at schools that will go beyond the Western knowledge

system that currently dominates the teaching and learning of science. Science education in the 21st century entails more than learning just information pertaining to the topic, ecology and verifying investigations such as which type of soil has the highest water holding capacity, what would happen if a potted plant growing upright is placed on a window sill etc. To build capacity in conserving biological diversity, management of natural resources, understanding of short-lived natural disasters and long- term hazards of environmental change, improved preparedness and adaptation are areas requiring immediate and special attention in science education. The effectiveness of this call depends crucially on WK and IK being brought close together in interdisciplinary learning areas dealing with links in culture, environment and development.

A respectable body of research has established beyond doubt the usefulness of IK and its potential to contribute to defining strategies to manage natural resources (Lalonde and Morin-Labatat 1993:3; Warren 1991: 4,6,8; Parrish 1999:271-275 and Prakash 2001:3). These strategies could draw from both IK and WK. In this situation neither IK nor WK is considered superior. Both are placed on par. They complement each other. Both are also necessary if learners are to make informed decisions. Therein lies Ntuli's "Principle of Complementary" (2002:57). In some instances just IK is shown to suffice (Lalonde and Morin-Labatat 1993:3; Warren 1998: 4,6,8; Parrish 1999:271-275 and Prakash 2001:3). Seven of the eight interviewees also expressed similar sentiments about the usefulness of IK in the teaching and the learning of science. The above, however, does not imply that all IK is appropriate or correct, or that all traditional societies have sustainable systems for managing their environment. But in general, communities whose livelihood depends on resources in the immediate area are likely to have accumulated through trial and error " a long series of historical observations and practices of relevance to sustainable resource management and conservation of diversity…(Wickham 1993: 28-29 cited in Lalonde and Morin-Labatat 1993:4). On the other hand "there is ample evidence in the form of

environmental destruction…to conclude that in the past three decades of development…have largely failed to address the needs of under-consuming countries" (Wickham 1993: 28-29 cited in Lalonde and Morin-Labatat 1993:4).

The recommendation of utilizing both WK and IK is not just about becoming sensitive to the rights of different cultures and their knowledge systems. Such an attitude will tantalize to reverting to the type of education that merely provides "lip service" to IK. What is needed is not a glorification of the past. The recommendation of including IK is thus not aimed at reviving all traditional practices. Instead it aims at providing learners with the chance to excavate, reflect and revive the technologies behind practices that stood the test of time and are relevant to current circumstances.

Furthermore the world today stands at a crossroad. To decide whether to proceed with modern technology or with traditional ones is a dilemma facing the majority of learners. Modern technology is supposed to make work easier and help achieve maximum returns. But what is apparent is that modern science has also caused extensive damage to the Earth such as chemical fertilizers making soil hard and infertile, residues of harmful pesticides accumulating in water and food supplies causing health problems, eliminating micro-organisms that have tirelessly sustained nutrient recycling over generations and the green revolution in some parts of Africa and Asia (Mwadime 1999:244-245; Warren 1998:11-20; Lalonde and Morin-Labatat 1993:3). Worse, the majority of learners from disadvantaged communities cannot afford modern technology due to spiralling cost of technological apparatus.

What then is needed today is not presenting IK and WK practices as separate curricula (WK at schools and IK at home) but to expose learners to different existing knowledge systems in school curricula that will permit them making informed choices to develop new knowledge on a continuous basis and apply it in a systematic and responsible way to protect the environment and in doing so improve the quality of life.

This is an area where communities around the world are becoming more creative and are opening up exciting new avenues (Easton and Belloncle 2000:4). Local control and parental involvement are also emerging as prominent themes (Fatnowna and Pickett 2002:87-90).

Recommendation two has three implications for the Department of National Education.

Implication One

Concerted efforts should be made to (re) valuate IK

The massive influx of Western knowledge, technology and values that accompanied colonialism and prevailed in the apartheid era in South Africa, contributed to profound social change and often to the dismissal of indigenous form of knowledge as backward, inferior and barbaric. Chapter Three discusses in detail the disdain for IK. This widely held view that IK is an obstacle to development and providing a better quality of life is anchored in the modernization paradigm. Almost universally accepted in the past, this view remains a ubiquitous feature in South Africa as perceived by some of the interviewees.

This view had led in the past to an emphasis on a Western model of education leaving no space for IK. Formal education had thus contributed to the demise of IK by commission as well by omission. In reality, this is still wide spread at present times as espoused by the interviewees who cited Western education and Western lifestyles, as being major obstacles to the inclusion of IK in the science learning programmes. On this note Ntuli (2002:57) contends:

"*The encounter between the West and the rest of us resulted in us losing sense of who we were, what our purpose in life was, and what our ultimate destiny was. Our world-views were partially erased and distorted. Our history was either denied and/or grotesquely distorted beyond recognition. We have to reclaim our history, for the*

reclamation of history is the path that leads to the recovery of national pride, without which no nation can compete in the global market of ideas and products".

In the present context for the above plea to materialize in the teaching of science it is imperative that Department of National Education accord highest priority to (re) valuate IK at all levels, with particular emphasis to the elimination of IK being viewed as a subjugated knowledge system. Steps also need to be taken to indicate that IK is scientific on a comparative basis with WK.

Implication Two

Science teachers and personnel involved in informal science education should have access to continuous updating of their knowledge about the fragile state of the Earth for the best possible performance of their educational tasks.

The political, economic, social, cultural and environment contexts in any country are dynamic hence changes are inevitable. Science teaching needs to urgently address, amongst other changes, changes of the affected components of the earth system. The fragile state of the Earth can no longer be ignored. Survival of all living forms is presently being threatened as discussed in Chapter I. New pathways to appropriate action need to be sought by both young and old and this can only be pursued if the findings of national, regional, and global research are made accessible to science teachers and personnel involved in informal science teaching across the country in clear language, omitting scientific terminology understood only by science academia. Dissemination of these findings as challenging as it may be, is crucial to help prevent the earth from further degradation. The teaching and learning about the causes of air, land, water pollution, deforestation amongst innumerable others and so on and its associated preventive measures are not sufficient to prevent further degradation of the Earth. The effectiveness of science teaching depends crucially on the wide availability of recent research findings.

Implication Three

Elicit IK that relates to the development of science learning programmes concerning efforts to help prevent further degradation of the Earth.

The Department of National Education has a responsibility to communicate in clear language in their policy documents where IK can be utilized. Explanation of these issues and the way in which science teaching can play a role in addressing them should be defined and developed by the Department of National Education in response to the changing educational needs of learners and their communities. New teaching methods, mechanisms to obtain relevant data and the documentation and presentation of knowledge taking into account cultural diversity, intellectual property rights and gender should also be defined and developed. Hence in order to define and develop new curriculum profiles policy makers need to be well advised in IK issues. The best advice drawn from a wide range of the best expert sources is imperative. The knowledge and its sources are very often not documented and are eroding at a rapid rate. It thus becomes necessary to take immediate steps to strengthen the reconstructive task by eliciting relevant IK for school science, document the very complex methodologies of knowledge generation and flow which most of us in South Africa know very little about. This call requires an approach involving partnerships, linkages between many roles players and constant feedback between the players. This is necessary, as one person alone can never achieve it. Knowledge that is social in nature and culturally transmitted typically comes forth in social situations, where people come together to resolve what they perceive to be important problems.

The grounds for serious commitment from individuals and organizations in civil society (authorities in IK within communities, NGOs, businesses and labour), the scientific, especially the academic

community and the policy makers to strengthen national and international including the exchange of knowledge and expertise are urgent to elicit the relevant IK. Networks for human resource interchange both North-South and South-South should be set up. Experts from communities with full participation of women in shaping the agenda for the future direction of eliciting the relevant IK should lead the process. Western approaches that constantly extracts, all that is possible to know about local people and their knowledge and claim ownership of local peoples' knowledge is incompatible in (re) valuating IK. This however does not mean that local communities are not interested in participating in the reconstructive task of refining the revised C2005 or sharing their knowledge with policy makers, scientific academia, and the global community. What communities are saying is that there must be respect for the cultural values of the knowledge and that the rights to maintain these values must be acknowledged and protected in the reconstructive process. Furthermore communities also recognize that IK and WK can complement each other with respect to providing strategies that the community has defined for itself. However, the following criteria must be met:

- The innovators of that knowledge should determine what exactly has to be reported and the mode of reporting.
- The set-up in the academic institutions has to change to encourage contact and exchanges with the generators of the IK because the process of IK generation and use, the close linkage between the knowledge and the knower and the context are very important.

This approach thus borrows ideas from two sources:

- The traditional social structure of many indigenous communities.

- Participatory action research.

The former assigns deliberative roles to the elders, management tasks to the householders and technical ones to the young people in a manner meant to be synergistic and complementary to other knowledge forms whilst the latter entails organizing learning around tasks required to solve a problem (Easton and Belloncle 2000:4). Under these circumstances dialogue between communities and the scientific academia with a view of complementing IK and WK or vice versa can be encouraged and strengthened. Easton and Belloncle (2000:4) cite this approach as “a stimulus rather than an inhibition to the expression of indigenous knowledge”.

It is with the above approach in mind that the Department of National Education needs to develop its networking strategies. Even more urgent is the need to develop a corpus of individuals and organizations in civil society (authorities in IK within communities, NGOs, businesses and labour), the scientific community, especially the academic community and the policy makers to act as catalysts and agents of change. This should lead to knowledge development and ways how to incorporate IK into policy. IT can also provide guidelines on how IK can be recorded and how it can be used in planning, programming and extension of the science curriculum.

Implementing the above approach takes experience and insight that are often in short supply in South Africa as espoused by interviewee 2 and Ntuli (2002:65). The biggest challenge for South Africa is thus to invent ways to change attitudes amongst learned informants in all walks of life and to motivate researchers in Africa to produce articles, books, conference papers for the people of the South. This, however, is easier said than done for it requires the most creative imagination and energy, not forgetting the mammoth task of breaking existing norms in science education teaching and learning at all levels.

Recommendation Three

IK resource centres should be established in the nine provinces in South Africa.

Motivation

WK is reinforced by written sources. Almost all IK is oral. How the knowledge elicited is collected, evaluated and disseminated poses challenges for the Department of National Education. It is therefore important for the establishment of IK resource centres that would serve as nodal points for collecting, evaluating, exchanging information, documenting information, publishing resources, developing bibliographic services related to IK from communities in South Africa and from around the world. It should also aim to strengthen multilateral dialogue between holders of IK, government, NGOs, scientists, academics from schools and tertiary institutions, researchers and the private sector with the objective to mainstream IK in the science curriculum and optimise the benefits of the youth of South Africa to meet the challenges of the 21st century. Recommendation three has two implications for the Department of National Education.

Implication One

The government should budget for the establishment of these centres.

The role of science teaching in this changed context demands the construction of buildings equipped with sophisticated technology to receive information, assess their impact, and promote their use such as through the development of electronic publishing, establishment of virtual research and teaching environments, digital libraries or conventional libraries. The establishment of a programme on Internet science education and training alongside WK should also be considered in order to redress the limitations of South Africa's educational infrastructure and to bring high quality science education to urban and rural locations.

Meeting this demand in developing countries such a South Africa constitutes setting aside billions of rands that the government on its own may find difficulty in allocating. Government should therefore seek funding agencies to ensure that the relevant infrastructure and other costs are adequately covered. Strengthening links with the Knowledge and Learning Centre Africa Region, World Bank hold promises for the establishment of IK centres in South Africa. In Africa the World Bank has supported IK resource centres by improving their capacity to share information. In Cameroon, Tanzania, Ethiopia and Zimbabwe, the project facilitated the capturing of IK through stimulating research into IK practices by local centres. In Burkina Faso and Uganda, the project improved the connectivity and networking capacity of local telecommunications. As a result of this rural community telecenters are now being used to obtain information from local communities and disseminate the knowledge generated to other regions. In Burkina Faso it also highlighted the role of traditional hunters in natural resource management. In Uganda support was given to formulate a national policy on IK and to explore the diversity of IK in the country. In Ghana it supported the use of IK to improve agricultural practices (Prakash 2000:2-3). These cited examples besides endorsing the universality of IK shows the World Bank's commitment in the process of local communities at the regional, national and global levels.

Implication Two

Competent personnel specializing in IK manage the centres.

The database of IK and its practices at the IK centres are not meant to be just a repository of knowledge, but a referral database on IK. The IK centres should play an enabling role in bringing together generators and holders of IK from communities, academics, researchers, civil society, religious bodies, NGOs and businesses to pursue dialogue that should provide input to inform and guide a national strategy to improve and extend science teaching at schools. Creating this channel of communication should enable a two-way dialogue between people well

versed about IK issues and the government departments on a level playing field.

It is envisaged that these centres move beyond informing and guiding government departments. They should be responsible to compile, publish and widely disseminate authentic IK, develop material resources, plan and provide in-service training on a regular basis to subject advisors, teachers and professors.

In the present teaching context, teachers will not be able to manage developing learning programmes on their own. Expecting educators at all academic levels to become researchers to understand multiple epistemologies, possess research skills and interpret the meaning from a variety of perspectives in the present educational context is beyond them. The majority of South African academic educators at all levels are cognisant of the Western way of developing learning programmes because Western education has consistently excluded IK. The curriculum has typically consisted of Western science grounded in a Western modernist epistemology of disciplinary fragmentation and scientific “truth”. Trainee-teacher educational programmes did not and still do not often study this epistemological dynamic, not to mention IK and the different ways of seeing it. Since IK is unknown to most academic educators at all levels, teachers, subject advisors and professors will have to learn the way forward by establishing and securing effective and meaningful partnerships with IK specialists, mainly ordinary people, at the local, regional, national and global level.

Hopefully, these encounters will induce academic educators to see more “broadly”- in a way that keeps in mind what lessons learners from their environment bring to class as these play a very significant role in learning and determining how concepts are learned and how they are applied in daily life.

It is also imperative that administration personnel assisting managers and other key personnel should receive training of relevance to their

work as the effectiveness of the centres depends crucially on competent people working in teams. Greater donor involvement is also necessary. Once again tapping into the wisdom of World Bank's IK researchers who draw mainly from local peoples' knowledge and the Banks' budgetary allocation can hopefully pave a way forward.

Recommendation Four

The revised C2005 be restructured to place IK and WK on par.

Motivation

Although an enormous amount of energy was expended in conceptualising and streamlining the new educational curriculum for the natural sciences, policy makers have failed dismally to transform science education in South Africa. While some attempt has been made to introduce or imply the use of IK in the teaching and learning of science at school in the revised C2005 still has very little access to meaningful and useful science education to improve the lives of the majority of learners concerned. Western knowledge, a one-truth epistemology still dominates curriculum thinking and development.

A close examination of Chapter Four of the Revised National Curriculum Statement Grades R-9 (Schools) Policy and Appendix 1 that relates directly to this research clearly indicates that science still has to be taught and learned from a pre-existing body of knowledge that is definitely Western. A form of Western elitism permeates science teaching. Not once in Chapter Four and in Appendix 1 is the word, indigenous mentioned and only once does the word traditional, presumably implying IK, appear. Furthermore as discussed in Chapter Three the use of IK in the teaching of science in the revised C2005 is portrayed only towards the achievement of learning Outcome three. Thus IK had not been even considered applicable to the other two learning outcomes. The conceptualisation of the revised C2005 had ignored IK being considered as a living body of knowledge. Empirical

data pointing to the sophistication of aspects of IK seem to have evaded policy makers.

Tables 20-24 indicate the possible scope of IK in the revised C2005 at the senior level of the science curriculum in the GET phase. Further research and much deliberation are, however, required to move towards the conceptualisation of a just and inclusive science. In the envisioned, revised curriculum it is advocated that IK is emancipated, developed, integrated with WK and protected to meet the educational, social and cultural needs of the majority of South African learners.

Recommendation four has one implication for the Department of National Education.

Implication

A body of specialists in IK and WK inclusive of women actively participate in reconstructing the revised C2005 in a neutral, noble and altruistic manner.

Operating in a neutral, noble and altruistic manner dismisses the cultural and power-related dimensions of knowledge production. Knowledge of any form will always confront other knowledge forms. When this happens a power struggle ensues hence decisions made in struggles between IK and WK should be viewed as neutrally, nobly and altruistically as possible as these decisions exert dramatic consequences in schools and in society.

In this indigenous-western situation curriculum developers need to analyse what they know, how they came to know it and why they believe or reject it being an integral part of the curriculum.

Recommendation Five

Use locals well versed in IK, especially elders to impart IK at schools.

Motivation

The consequences of our apartheid history have had a profound impact on the science teaching methodologies in school and those being offered to potential teachers at tertiary institutions. During the apartheid era tertiary institutions provided no training that equipped science teachers to effectively draw knowledge from other systems and use in their learning programmes.

Notwithstanding that the curriculum, though valid for individual career development is inappropriate to the educational, social and cultural needs of the majority of learners, the government and the majority of South African tertiary institutions still do not seem challenged to build capacity in personnel that will be effective so that they can effectively engage in using IK in the teaching of science at schools.

In the context of the natural sciences in the revised C2005, with very little recognition of the role that IK could fulfil as essential building blocks for meaningful education, many opportunities are thus being lost to help prevent the Earth being further degraded and for improvements in science education.

In view of the above, the time factor involved in restructuring the revised C2005 and the likelihood that the cash strapped tertiary institutions in the country are unlikely to respond to the changes recommended, the Department of National Education should ensure that IK is (re) valuated by various communication channels to the entire population and promote and support the use of the primary sources of IK in the teaching of science.

Such an approach could help overcome targeting remote schools, finding qualified staff, high cost of delivery services related to IK teaching. Furthermore, it would empower teachers in specific communities to address specific issues relating to science teaching.

More effective community outreach of effective science teaching can be pursued. In the long term it would contribute to more effective and efficient use of scarce IK resources and more affordable and appropriate service provision.

Recommendation five has one implication for the Department of National Education.

Implication

Locals imparting IK at school should be remunerated.

High levels of unemployment, dependence on state welfare programmes commonly characterise “holders of IK” especially in rural areas. While many rural people abandon their rural way of life and migrate to urban areas, significant numbers remain in rural areas without a sustainable economic base and thus are vulnerable to poverty. The use of locals thus targets two main aims: firstly it provided work opportunities for them and secondly it facilitates the teaching of IK at schools by the best suited for the job. A further positive outcome is that it will propose principles that can guide policy makers in their search to restructure in the revised C2005. Funds that are usually allocated to consultants and developmental organizations for advising government should be redirected to local government structures to find such people. NGOs and the private sector can also foster inter-linkages for mutual benefit.

6.5 MODELS EMERGING FROM RECOMMENDATIONS AND THEIR IMPLICATIONS

The generalised and specific models that emerge from the recommendations and implications made are as follows:

Figure 40: General model depicting the use of IK and WK in the teaching and learning of science in schools.

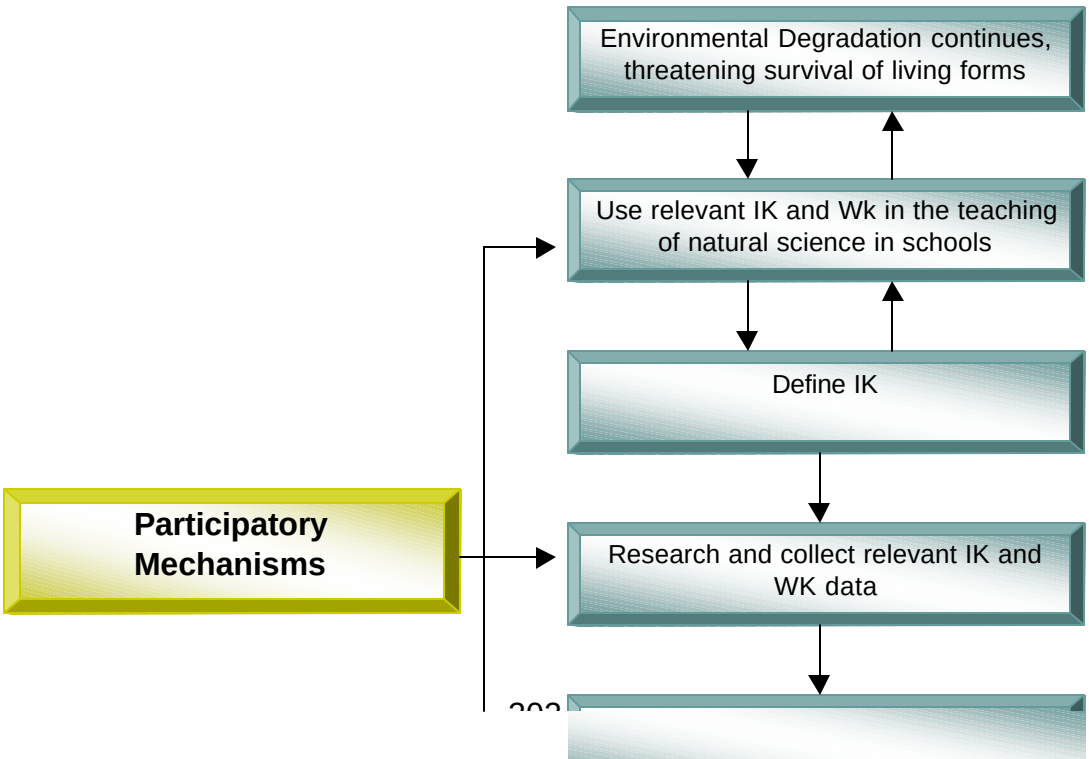


Figure 41: Model depicting the use of IK and WK in the Teaching and Learning of Science in Schools to help prevent further Environmental Degradation.

6.6 CONCLUDING REMARKS

The recommendations made would require a radical re-orientation of school science teaching in context of strengthening and extending the IK base. However, if any progress is to be made in the quest for a better science education, South Africa will have to grapple with such drastic changes. The ultimate goal is to expose learners to the different knowledge systems and facilitate the empowering of learners with a knowledge base to understand and evaluate what science has to offer and to make judicious choices between their IK and other knowledge forms when situation arise. Although this reality may be tricky to curriculum designers in South Africa, it is important to remember that attempts of curriculum development must be seen as a process than a technique or a “quick- fix” or a “cut and paste” method.

Models of education borrowed from other countries can be as oppressive as the past and present South African science curricula. Knowledge of relevance from the community where IK is generated, held and strategically employed must take centre stage in school science curriculum planning. To expect “outsiders” to shape its science curriculum will continue discounting parents’, communities’ and elders’

valuable expertise. This deficit- outlook will be a step backwards in the curriculum designing process.

In concluding it has to be emphasized that if the above truisms are accepted then South African curriculum developers must find their own ways to identify and address the challenges of reconceptualizing its science curriculum to reflect a just and an inclusive science education. The guiding question that curriculum designers ought to always be cognisant of is: Do we contribute to further subjugation or actually redress the power imbalances that exist between knowledge systems? Other crucial questions that must asked are :

- What aspects of IK and WK should science education seek to best prepare South African learners academically and morally for the 21st century?

- Which community should be involved in helping teachers develop learning programmes - rural and/or urban?

- What changes in goals and methods, if any, must indigenous forms of education and formal curriculum undergo if they are to develop collective values effectively?

- Will there be a need to restructure examinations and assessment systems to reflect a knowledge system that is predominantly oral, not easily fragmented and heavily reliant on hands on activities rather than facts, rote memorization and regurgitation?

- Can competing IK and WK prevalent in South Africa be meaningfully integrated?

The above empirical questions require concerted efforts towards generating appropriate answers. Consequently, it is suggested that research attention be directed at unravelling all aspects of IK and WK

and its associated paradigms with a view to begin the process of designing a science curriculum that is just and inclusive. Continuing to ignore this only perpetuates deficit legacies and maintains oppressive knowledge systems.

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APPENDIXES

APPENDIX 1

CORE KNOWLEDGE AND CONCEPTS IN LIFE AND LIVING

Life Processes and Healthy Living	Interactions in Environments	Biodiversity, Change and Continuity
Unifying statement: Living things, including humans and invisibly small organisms, can be understood in terms of life processes, functional units and systems.	*Unifying statement: Organisms in ecosystems are dependent for their survival on the presence of abiotic factors and on their relationship with other organisms.*	*Unifying statement: The huge diversity of forms of life can be understood in terms of a history of change in environments and in characteristics of plants and animals throughout the world over millions of years.*
Life Processes and Healthy Living	**Interactions in Environment**	**Biodiversity, Change and Continuity**
Senior Phase		
❖ Humans go through physical changes as they age; puberty means that the body is ready for sexual reproduction. ❖ Human reproduction begins with the fusion of sex cells from mother and father, carrying the patterns for some characteristics of each. ❖ Conception is followed by a sequence of changes in the mother's body, and during this period the future health of the unborn child can be affected. ❖ Knowledge of how to prevent the transmission of sexually transmitted diseases, including the HIVirus, must be followed by behaviour choices. ❖ Green plants use energy from the sun, water and carbon dioxide from the air to make food by photosynthesis. This chemical reaction is central to the survival of all organisms living on earth. ❖ Animals, including humans, require protein, fat, carbohydrates, minerals, vitamins and water. Food taken in is absorbed into the body via the intestine. Surplus food is stored as fat or carbohydrate. ❖ Animals, including humans, have a circulatory system which includes the heart, veins, arteries and capillaries, and	❖ Human reproduction is more than conception and birth; it involves adults raising children, which requires judgement and values and usually depends on the behaviour of other people in a community and environment. ❖ Each species of animal has characteristic behaviours which enable it to feed, find a mate, breed, raise young, live in a population of the same species, or escape threats in its particular environment. These behaviours have arisen over long periods of time that the species population has been living in the same environment. ❖ All organisms have adaptations for survival in their habitats (such as adaptations for maintaining their water balance, obtaining and eating the kind of food they need, reproduction, protection or escape from predators.) ❖ An ecosystem maintains numerous food webs and competition for food among different individuals and populations. South Africa has certain ecosystems which have exceptional biodiversity. All uses of these areas must be based on principles of sustainable development	❖ Offspring of organisms differ in small ways from their parents and generally from each other. This is called variation in a species. ❖ Natural selection kills those individuals of a species which lack the characteristics that would have enabled them to survive and reproduce successfully in their environment. Individuals which have characteristics suited to the environment reproduce successfully and some of their offspring carry the successful characteristics. Natural selection is accelerated when the environment changes; this can lead to the extinction of species. ❖ Variations in human biological characteristics such as skin colour, height, and so on. have been used to categorise groups of people. These biological differences do not indicate differences in innate abilities of the groups concerned. Therefore, such categorisation of groups by biological differences is neither scientifically valid nor exact; it is a social construct. ❖ Biodiversity enables ecosystems to sustain life and recover from changes to the environment. Loss of

Life Processes and Healthy Living	Interactions in Environments	Biodiversity, Change and Continuity
which carries nutrients and oxygen to all parts of the body and removes waste products. Oxygen, which is provided by the breathing system, reacts with food substances to release energy. *(Links with Energy and Change)* ◆ All living things, including humans, have means of eliminating waste products which are produced during life processes. Water plays an important role in this process. ◆ Water makes up a large proportion of all living things, and their health depends on water passing through them in various ways, using structures (such as kidneys, skin or stomata) which can fulfil this function.	◆ Pollution interferes with natural processes that maintain the interdependencies and diversity of an ecosystem. ◆ Many biological changes, including decomposition and recycling of matter in ecosystems and human diseases, are caused by invisibly small, quickly-reproducing organisms.	biodiversity seriously affects the capacity of ecosystems and the earth, to sustain life. Classification is a means to organise the great diversity of organisms and make them easier to study. The two main categories of animals are the vertebrates and invertebrates, and among vertebrates the five classes are amphibians, birds, fish, reptiles and mammals. ◆ Human activities, such as the introduction of alien species, habitat destruction, population growth, pollution and over-consumption, result in the loss of biodiversity. This becomes evident when more species become endangered, or, ultimately, extinct. ◆ Extinctions also occur through natural events. Mass extinctions have occurred in the past, suggesting that huge changes to environments have occurred. However, these changes occurred very slowly, compared to the fast rate at which humans can destroy plant and animal species. *(Links with Planet Earth and Beyond)* ◆ The cell is the basic unit of most living things, and an organism may be formed from one or many cells. Cells themselves carry on life processes such as nutrition, respiration, excretion and reproduction, which sustain the life of the organism as a whole.

CORE KNOWLEDGE AND CONCEPTS IN ENERGY AND CHANGE

Energy Transfers and Systems	Energy and Development in South Africa
Unifying statement: Energy is transferred through biological or physical systems, from energy sources. With each energy transfer, some of the energy becomes less available for our use, and therefore we need to know how to control energy transfers.	*Unifying statement: Energy is available from a limited number of sources, and the sustainable development of countries in our region depends on the wise use of energy sources.*
Senior Phase	
❖ Energy can be stored in a system as potential energy, either by the positions of the bulk parts of the system or by its particles (atoms and molecules) which have the potential to react with each other and release energy. Examples of potential energy are the stored energy of a compressed spring or the stored energy of particles which could react in a fuel-and-air mixture, or in the food and body of a living thing. ❖ Potential energy can be released as kinetic energy in the motion of parts of the system, either in the motion of bulk parts of the system or in the motion of particles of the system. Examples of the release of kinetic energy are the motion of a released spring or the faster motion of the particles of hot gases when a fuel-air mixture burns, or the body movement of humans and animals. Kinetic energy is transferred to parts within the system and energy is also transferred to the system's surroundings. When energy is transferred, it causes changes in the system and the system's surroundings. ❖ There is an unlimited number of systems which can be made to store or transfer energy. The possible systems include electrical, mechanical (including spring and friction systems), chemical, gravitational, nuclear, solar, biomass, optical (light), acoustical (sound) and thermal (heat) systems as well as human bodies and ecosystems.	❖ Energy sources such as wind, sun, and water in high dams are renewable. Fuels such as coal, gas and oil are not renewable energy sources, because they cannot be replaced. *(Links with Planet Earth and Beyond)* ❖ Development and relief of poverty depends on energy supplies, particularly electrical energy, and the systems to deliver the energy to where it is needed. ❖ Large-scale electricity supply depends on generation systems which use a few energy sources such as burning coal, nuclear reactions, burning gas and falling water. Use of any of these sources has environmental implications. For example, when coal is burned to generate electricity, gases are produced that affect the atmosphere and local and global environments. *(Links with Planet Earth and Beyond)*

Energy Transfers and Systems	Energy and development in South Africa
❖ All physical systems that people use (for example, appliances, vehicles and human bodies) waste some of the energy they receive, and the wasted energy goes to heat up the surroundings. When the energy has gone into heating the surroundings, we can no longer use that energy to do work for us. ❖ Hot objects transfer energy to colder objects, until the objects reach the same temperature. Hot objects transfer their energy, as heat, in three ways: by conduction, by convection and by radiation. These transfers may be useful or wasteful. Wasteful heat transfer can be controlled by reducing conduction, convection and radiation in a system. Similarly, useful heat transfer can be increased by improving conduction, convection and radiation in a system. ❖ All organisms in an ecosystem need energy from other parts of the ecosystem. Energy is transferred from part to part of an ecosystem and each part retains only a fraction of the energy it received. *(Links with Life and Living)* ❖ Light travels away from a light-giving body until it strikes an object. The object may then absorb the light, or refract it or reflect it. Light transfers energy to other objects. *(Links with Life and Living)* ❖ Objects can exert forces on each other, thereby forming a system which can store or transfer energy. They may do so by physical contact or by forces which act through a field. Field forces are the magnetic, electric and gravitational forces. All forces act in pairs, so that if body A exerts a force on body B, B exerts an equal and opposite force on A.	❖ Other electricity-generation systems have smaller environmental impact but may cost more in the short term. Better design of buildings and appliances, and better practices in using energy, can save costs to consumers and lessen the environmental impact of exploiting energy sources ❖ Many people in South Africa use wood for heating and cooking. Plants such as trees can be a renewable energy source if more trees are planted and the soil is managed well. *(Links with Planet Earth and Beyond)*

Our Place in Space	Atmosphere and Weather	The Changing Earth
Unifying statement: Our planet is a small part of a vast solar system in an immense galaxy.	*Unifying statement: The atmosphere is a system which interacts with the land, lakes and oceans and which transfers energy and water from place to place.*	*Unifying statement: The Earth is composed of materials which are continually being changed by forces on and under the surface.*
Senior Phase		
❖ The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The sun, an average star, is the central and largest body in the solar system. ❖ Most objects in the solar system are in regular and predictable motion. The motions of the earth and moon explain such phenomena as the day, the year, phases of the moon, and eclipses. ❖ Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system. Gravity alone holds us to the earth's surface. ❖ The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle.	❖ The outer layers of the earth are the atmosphere, the hydrosphere and the lithosphere. We live in the biosphere, which is where all these layers interact to support life. ❖ Climate varies in different parts of the globe. It tends to be cold in the polar regions and hot in the tropics. Different types of plants and animals are adapted to living in different climatic regions. *(Links with Life and Living)* ❖ The atmosphere is a mixture of nitrogen and oxygen in fairly constant proportions, and small quantities of other gases that include water vapour. The atmosphere has different properties at different elevations. ❖ The atmosphere protects the earth from harmful radiation and from most objects from outer space that would otherwise strike the earth's surface. The atmosphere is the most important factor in keeping the earth's surface temperature from falling too low or rising too high to sustain life.	❖ The planet earth has a layered structure, with a lithosphere, a hot, convecting mantle and a dense, metallic core. ❖ Lithospheric plates larger than some continents constantly move at rates of centimetres per year, in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions and mountain building, result from these plate motions. ❖ Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

Our Place in Space	Atmosphere and Weather	The Changing Earth
❖ Space exploration programmes involve international collaboration in the use of earth-based telescopes (such as SALT in South Africa) and telescopes in orbit. Robotic spacecraft travel long distances to send back data about the planets and other bodies in our solar system, and research is being done on ways to send people to investigate the planet Mars.	❖ Human activities and natural events can slightly change the composition and temperature of the atmosphere. Some effects of these small changes may be changes in annual weather patterns and long-term changes in rainfall and climate.	❖ Many of the organisms in South Africa's fossil record cannot be easily classified into groups of organisms alive today, and some are found in places where present-day conditions would not be suitable for them. This is evidence that life and conditions on the surface of earth have changed through time. *(Links with Life and Living)* ❖ Fossil fuels such as coal, gas and oil are the remains of plants and animals that were buried and fossilised at high pressures. These fuels are not renewable in our lifetimes. *(Links with Energy and Change)* ❖ Mining is a major industry in South Africa, with local examples in all the nine provinces. It is important in terms of the supply of coal for energy, essential raw materials for other industries, employment and earnings for the country. A great number of other industries depend on the mining industry. Legislation controls mining, with regard to safety and environmental effects.

CORE KNOWLEDGE AND CONCEPTS IN MATTER AND MATERIALS

Properties and Uses of Materials	Structure, Reactions and Changes of Materials
Unifying statement: We can classify materials by their properties, in order to establish types and patterns. Properties determine the selection of materials for particular uses.	*Unifying statement: We can modify materials in ways we choose, through our understanding of their sub-structure.*
Senior Phase	
❖ Substances in different states ('phases') have distinct properties such as crystalline structures, or compressibility/incompressibility, or tendency to diffuse. ❖ Dark-coloured surfaces get hotter than light-coloured surfaces when exposed to radiating sources of energy like the sun. Dark-coloured objects radiate their energy as heat more readily than shiny light-coloured objects. *(Links with Energy and Change)* ❖ Some materials are magnetised by electric currents or magnets. Some materials can be electrically charged by rubbing them with a different material. *(Links with Energy and Change)* ❖ Some conductors and circuit components reduce the current in an electric circuit to a significant extent and are called resistors. Resistors can be selected or designed to control currents. ❖ A pure substance cannot be separated into different substances, while a mixture can be separated, usually by physical means. Differences in properties can be used to separate mixtures of different substances (by methods such as filtration, distillation, evaporation, chromatography or magnetism). *(Links with Matter and Materials)* ❖ Specific gases may be separated from the air or produced in reactions, and have many uses in industry and other sectors of the economy. Oxygen, hydrogen and carbon dioxide have characteristic properties and reactions by which we can identify them. ❖ Extracting useful materials from raw materials depends on chemical reactions and methods of separation. ❖ Raw materials, from which processed materials are made, must be mined, grown or imported from other countries. Raw materials that are mined are non-renewable and mining has environmental costs. Growing raw materials involves choices about the use of arable land and water catchment areas.	❖ A particle model of matter can explain physical changes of substances such as melting, evaporation, condensation, solidification, diffusion and heating by conduction. ❖ Many household substances are acidic or basic. Indicators are substances that react with acids and soluble bases to produce products that have distinctive colours. Acids and bases neutralise one another to form salts. Acids have characteristic reactions with metals, metal oxides, hydroxides and carbonates. ❖ Many chemical reactions need some energy to get started; many chemical reactions give off energy as they happen. ❖ Elements are made of just one kind of atom, whereas compounds are made of two or more kinds of atoms in fixed proportions. Elements may react to form compounds, and compounds may be decomposed into their elements. Energy input is needed to break a compound into its elements, whereas energy is given out when elements react to form a compound.

Properties and uses of materials	Structure, Reactions and Changes of Materials
(There are no further core knowledge statements for Matter and Materials in this Phase.)	❖ Oxygen has characteristic reactions with metals and non-metals, forming oxides. Some of these oxides dissolve in water to form acidic or alkaline solutions. Some metals react more readily with oxygen than other metals. Corrosion of iron is an economically important reaction which can be prevented through an understanding of the reactions between iron, water and oxygen. ❖ The reaction of oxygen with food releases energy in the cells of living things. *(Links with Life and Living)*

APPENDIX 2

SECTION A: GENERAL INFORMATION

NOTE: This information is required for classification purposes only. The names of the individuals will NOT be published.

1. Surname (Optional) :…… 2. Initial(s): ……...

3. Title:…… 4. Gender: ……

5. Ethnic Group: ……

6. Birthplace (Area/Country): ……

7. Schools Attended

Area/Country	Urban/Rural

8. Qualification and Institutions

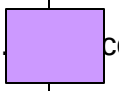
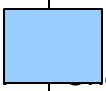
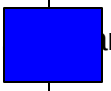
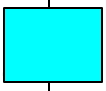
Qualification	Institution

9. Work Experience

	Organisation/Institution and Country	Designation	Year
Current			
Previous			

10. Other Relevant Information: ……...
……
……
……

APPENDIX 3

Code	Category	Colour Code	Rules for Inclusion
1	 ceptable		1a. Upbringing 1b. Pride 1c. Culture 1d. Politics and Overcoming Oppression 1e. Usefulness of IK 1f. Loss of IK
2	 acceptable		2a. Domination by Western Education/Subjugation of IK 2b. Western Lifestyle and Urbanization 2c. Ethnicity and interpretation of concept IK 2d. Intergeneration values 2e. Cultural adherence
3	 nageable		3a. Creativeness
4	 manageable		4a. No/insufficient past/present support and teachers' lack/ insufficient knowledge base 4b. Sensitive nature regarding choice of IK 4c. Personal Cultural Beliefs 4d. Low self-esteem

Code	Category	Colour Code	Rules for Inclusion
5.	Shortcomings of educational stakeholders and learners		5a. Reluctance of elders to divulge information 5b. Shallow elaboration of IK in teaching and assessment 5c. Insufficient insight about the transformation process 5d Personal/ cultural bias 5e. Insufficient insight about IK/WK 5f. Attitude: indifferent, afraid & tired 5g. Language
6	Complexity of IK		6a. Holistic nature 6b. Contextual nature 6c. Undocumented format 6d. Diverse nature 6e. Unstructured, unvalidated nature 6f. Sensitivity
7	Implementation shortcomings		7a. Insufficient resources/data 7b. Lack of a coherent plan to empower educational stakeholders
8.	Intellectual property Rights		
9	Heterogenous classes		
10	Acceptance of IK		

Code	Category	Colour Code	Rules for Inclusion
11	(Re) valuating		
12	tablishing Partnerships		12a. Education Department and Community. 12b. Education Department and Tertiary Institutes 12c. Education Department and NGO's, Corporates and other Government Departments. 12d. Further research: Tertiary Institutes, Education Department, Communities
13	efining C2005		
14	Empowerment provision of resources		
15	Establishment database		

Transcript and Audit Trail of Interviewee 1

Code	Category	Meaning	
1	Acceptable	Comfortable	
2	Unacceptable	Uneasiness, anxiety, apprehension	
3	Manageable	-	
4	Unmanageable	Difficult	

Interviewer:

How would teachers react to the inclusion of IK in the natural science curriculum[Q1]?

Interviewee:

In responding to question one it is actually a two- fold answer depending on who the teacher is. If the teacher is a White or an Indian I would assume, but I won't say definitely, there will be some uneasiness[2] or anxiety[2] regarding the use of the IK system.[2c] There would be generally a tendency of apprehension[2] amongst them because to teach IK you need to know the concepts and you need to know from where IK is coming from. This may pose difficulty because all of us have been seeped into mainstream education and now to start teaching IK it is going to be a whole new area and this is where the[2a] apprehension[2] comes in. I am talking generally, the Black teachers will be more comfortable[1] with this because it is basically bringing their experiences from their background into the classroom[1a].So in terms of how teachers will react I would say that the majority of White, Indian and Coloured teachers will feel very apprehensive[2] because it could be construed as being political. With Black teachers I think that they will be very comfortable[1] because their whole cosmo-vision of life, their spirituality is brought into the class[1c]. This is something they are very familiar and comfortable[1] with. When you ask yourself the question as to why Black teachers are bad teachers-this is the general consensus- you will have to look as to how they were schooled - in a system that they were not familiar with. Now they are in a situation where they will be talking to the curriculum. This will make them comfortable[1]. Given the political landscape that the majority of teachers are Black, I can assume that the majority of teachers will be comfortable[1] with the inclusion of IK in the curriculum[1d]. Regarding the natural sciences I would say that teachers coming from the rural communities will be absolutely comfortable[1] with the inclusion of IK in their teaching. IK expresses itself in the Natural Science curriculum such as lets take a medicinal plant or any other kind of herb and start a discussion in class. A child will come with 100s of uses of that particular plant. They will tell the teacher how to plant it, how to harvest it, etc because that is the experience of life that the child brings. It is a laboratory of life rather than a laboratory of bricks and mortar. So basically the environment is in the classroom[1e] and if that suits the OBE structure then I would say we are moving in the right direction. In this new set-up a child will now be able to tell

you how a clay pot is made. In other words the science of making this pot will be derived- where the clay is found? , the type of clay that should be used, the temperature the clay must be heated at etc. What we are actually talking about is the classification of soil and the thermo-physics involved[1e]. It is like now turning the mirror upside down. Before the scientists used to go in and get the rats to experiment but now the rats are coming to the scientists. So this is the inversion of life that I was taking about earlier[1d].

Interviewer:

What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further[Q2]?

Interviewee:

In terms of the teacher delivering lessons concerning how IK can be used to help save the earth, my comment here is going to be that the teacher needs to understand the context of the IK system. The teacher needs to know that the content is unstructured, uncodified, unvalidated[6c] and it is oral[e]. Most important of all is the fact that it is passed down from generation to generation. In other words it is trans-generational. He needs to understand that he cannot go and cross-reference the information that the child is bringing to the classroom without involving the elders. This also applies to the knowledge that he has. Cross- referencing this with an elder is quite problematic. So unless the teacher understands the context of the IK system[6b] it is going to bedifficult[4] to deliver in the class. I think that his role in the classroom will be more of a facilitator than a teacher knowing all[4a.]

Interviewer:

What are some of the possible obstacles to the inclusion of IK in the natural science curriculum[Q3]?

Interviewee:

In terms of the obstacles, the teacher needs to firstly understand that there is an alternate system of education apart from the western / modern / Euro-centric one. One of the maior obstacles is the acceptance of a knowledge system that has survived 1000s of years[10].

The other obstacle is that teachers are going to face is the issue of intellectual property. I think that this is going to be the most difficult one to overcome. How does the teacher protect the intellectual property that a child brings to class. Consider the knowledge of a medicinal plant that a child might bring, reveal it to the class and then the teacher who is a scientist goes out and discusses this compound with a research institute and this research institute takes it up, goes into the village picks up the plant that for example cures diabetes and starts investigating and if profitable starts marketing it. How does one deal with this? What are the rights of the community? What are the rights of the school? Who owns the intellectual property when learners disclose undisclosed knowledge of the community?[8]

Interviewer:

What are some of the possible strategies that could be used to draw out knowledge from the community/communities [Q4]*?*

Interviewee:

The main strategy is to have joint co-operative partnerships with the community[12a]. This means that IK is held in the community and by bringing your partners from the community you are going to make learning more meaningful. It is like I mentioned earlier, the laboratory of life will be in your classroom.

Interviewer:

From a time factor will the elders be receptive to this partnership?

Interviewee:

You cannot teach IK to learners without prior consent from the community[6f]. That is non-negotiable. When you start evoking information from learners they are going to disclose information that is held by the community[6f]. This may be sacred to the community. So you need to start forming partnerships with the community.[12a] You also need to start working out terms of references with the community such as what is sacred? what is not sacred? There is some knowledge that the community wants to give freely so that the knowledge does not die[5a]. The elders have also come to terms with that. They have to be cool as well. The learners also do not want to learn about IK. 90% of our kids are wearing Nike[5f].They are steeped into an American culture so we have to make IK cool to show them the value of it and that is what the elders in the community have recognized. Because IK within a community is dying, the elders are now very excited[1f] that we are giving them recognition and putting them on par. This is so because they who are professors in their own rights sit next to academic professors in forums[12a]. These elders have the wisdom and this is the wisdom we need to harness and by bringing them into the classroom you will be bringing the laboratory of life.

Transcript and Audit Trail of Interviewee 2

Code	Category	Meaning	
1	Acceptable	Positively	
2	Unacceptable	Oppose	
3	Manageable	-	
4	Unmanageable	Very difficult, battle	

Interviewer:

How would teachers react to the inclusion of IK in the natural science curriculum[Q1]*?*

Interviewee:

You see teaching is basically imparting knowledge from the teacher to the people. More importantly influencing the thinking, the perception and the whole orientation of the people. It is just not teaching the person how to read or write. You want to change the whole orientation in the way the child thinks, sees and analyses things. So the teacher must be knowledgeable. He must understand what he is teaching. He must know the act of imparting the knowledge. So teaching is an art. You must fundamentally know what is that you are supposed to teach. You must also know the circumstances of the people that you teach. When I used to be in university the first day of my class I didn't teach. I created scenes to bring students together, to interact and to talk about issues. The whole idea was that I wanted to have a feel of what type of students I had in the class – how do they think and perceive things, what composition of class do I have? I looked carefully as to how the students even sat in the lecture room and particularly in this country it is very fascinating to see that the Indians group to one side, the Blacks normally sit at the front and the Whites sit at the back. You then begin to ask questions such as: how do you talk to them? How do you get the eye contact so that everyone will understand what you are saying? What is their level of comprehension? What is my level of preparedness for this class?

So you see how teachers are going to perceive the use of IK in their class is going to be dependent on their IK, their teaching skill and their current lifestyle. Practically everyone possesses IK, the extent however will vary depending on their upbringing[1a] and their current life style. The reality of the majority of this country's teachers is that they lead dual lives; they uphold traditional and Western practices[1c]. My perception therefore is that the majority of the teachers will respond positively[1]. They have now been offered an opportunity in the democratic South Africa to talk about their IK[1d] but as much will be too afraid to implement it in their classroom teaching. Afraid because they were not trained in the formal set-up to do this. A minority however would oppose[2] it. These will be mainly the young teachers in urban schools[2b] because they are still not at a stage to appreciate this kind of knowledge and also some of the older ones[2d]. The Western lifestyle is the way to go[2b]. So you see you are going to get a somewhat mixed kind of reaction.

Interviewer:

What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further [Q2]*?*

Interviewee:

This hinges on whether the teachers are trained to be aware of the existence of IK. If they are not trained to know that this knowledge exists such as these are the traditions, these are how parents teach their children at home, this is how they teach their children to behave, this is how they teach children to traditionally count etc. they will not be able to teach it. You can't also appreciate it. I am of the opinion that teachers will find it very difficult[4] to teach this in class because they have not been shown the way[4a].

I can tell you of my father. When my father was alive and we were kids we grew up on a farm and in rare cases when you fell sick you were sent to hospital. When you fell sick my father would just walk into the bush and come with some sort of herb or some root of a particular plant or some stem. He will squeeze water out of it and ask you to drink it or ask you to chew it or he will massage you and you will get well. I never had the time to sit down with the old man and document it because I was not interested and I was not interested because of the way the education system taught me[5f]. They taught me that those were primitive way of treating aliments. If you are sick the first thing you do is to go to the doctor. The old man is dead and I don't know anything[4a]. But what I remember vividly is when two children were playing and got wounded by a panga. They were brought to my father. My father went to the bush got some herbs, put it on the hurt, got some flat raffia bark and bandaged it onto the hurt and five days after they removed it. They were healed[6b]. If it were today we will rush the person to hospital and get some stitches. Now he is gone with all that knowledge and I can't teach it. I don't know it because I was not interested then[5f].

Interviewer:

What are some of the possible obstacles to the inclusion of IK in the natural science curriculum [Q3]*?*

Interviewee:

In the first place do we know enough about IK and if we know what are they?
Lets take some issues:
What is the traditional system of cultures?
What is the traditional system of recognition?
What is the traditional method of medicine?
What is the traditional way to protect resources?
What is the traditional system of taking care of children?
What is the traditional system of giving birth?
What is the traditional method of caring for the environment?[6d]
Let me tell you that I was not born in a hospital. None of my brothers and sisters were born in a hospital. There were 5 of us. We were delivered not by midwives but by the old ladies. How did they do it? How did they cut the umbilical cord? How did they tie it[6d]? Do we know enough of that[5e]? So if we don't know the starting point is that we must go back and try to know more about it[12a]. Once we know what happens in a traditional society and how it is organised then only can we begin analyse it such as this way is not hygienic we have a modern one or if things are not scientific enough we can improve it

or merge both. If you go to Ghana now there is a hospital where there is collaboration between traditional healers and doctors. The doctors are busy studying what one guy claims to be a cure for AIDS. So you need to know this knowledge and document it[15] and merge the two and then train our teachers to also know [14] and accept IK[10] Otherwise we are going to lose IK. We have already lost a greater part of it[1f].

Interviewer:

What are some of the possible strategies that could be used to draw out IK from the community/communities[Q4]?

Interviewee:

So knowing what is existing out there, identifying it[12a], documenting it[15] and then bringing it into the training system of the teachers and from there developing a curriculum of infusing IK with Western science is a way forward[13]. When you teach chemistry or biology you can teach that this is the modern way and this is the traditional way and in this way you can infuse both knowledge systems. You can do this for many aspects such as respect for the environment that your research stresses.

In my house for instance I tell my children that look you have a washing machine, dryer, piped water and everything flowing. So you just come and take out your shirt, put it in the washing machine and it washes. I said I didn't have that. I had to carry a bucket, go to the stream fetch water, come back and wash with my hands, dry it and then use those box charcoal irons. Now we have the modern iron. You must know how to use your hands to wash your clothes. Initially my daughter squealed saying no daddy you are being too hard on us[5d]. I said no, no, no you must do it now. So she started washing some of her clothes. One day I told her to put her clothes in the washing machine and after it was washed I asked for the clothes to be picked up. You could see dirt stuck on the clothes. I said wash it with your hands and see the difference. You need to know that because when you leave this house you may not be that fortunate enough to have a washing machine and a dryer immediately in your house and you got to know what is an alternative way of doing it. So this washing by hand is the traditional way of doing it. So the purpose of infusing traditional knowledge is that it could be called upon as the alternative way[1e]. Maybe the modern way is superior to the traditional knowledge but the traditional knowledge is an alternative in a situation where the modern facilities are absent.

So I think in your research it is necessary to first ascertain what is the modern knowledge. Then you go to the villages or the traditional societies and try to see if you have the comparison or the alternative of the modern knowledge and the traditional knowledge[12a]. Having got that you can come to the teachers and pose questions[14] such as when a child is born how is he/she treated on the first day? I can tell you he is going to say no[4a]. So we are trying to find out the extent of the teachers' knowledge- know whether they know that such things exist. Even if they say that they don't know it what is important is that a discussion occurs and they get empowered so when they are asked to teach it they will be able to do[14] it. Teachers can also ask

students to seek out traditional knowledge just like it happens when a child goes to school and the teacher says something and the child comes home and asks you a question, what did you do about this when you were at school? In this way children will develop interest and traditional knowledge can be imparted, compared[12a].

Interviewer:

Prof, will the teachers in the present context with its numerous demands in the transformation process view this as extra work?

Interviewee:

Now you see I have defined development in a paper that I have presented, as transformation of people and society. Most people and economists construe this to mean movement from the traditional way of doing things to modern way of doing things. But to me that is not transformation. Transformation to me is any process that improves upon the existing[1e]. Whether it is an accumulation of more knowledge, whether it is the development of new alternatives, it a process that ought to give people a variety of choices to expand the scope of activities and knowledge. But the modern way of transforming is making people specialize in a particular direction

Over the weekend we were at a MEXCO meeting trying to put together a Provincial Growth and Development Strategy and people were starting to say that we need to develop the human sector, that the agricultural sector is dying, tourism and that and that… and I said you people must learn history. Go back and read about the history of the more advanced countries. You will see that there is not a single country that started development by not developing agriculture[5c]. The exceptions to this are Singapore and Hong Kong. Singapore and Hong Kong do not have land. They are islands. Why did we have the slave trade? Why were they taken to America? To work on the farms- sugar farms and to develop agriculture. Why in France – agriculture Europe – agriculture. Now when you come here 70% of the people make a living from agriculture. Now you want to develop KZN but you don't want to touch agriculture. You see it tells you the mindset and the loss of focus and the understanding of the issues. Development of agriculture does not necessarily mean you must send 10,000 extension officers or tractors. This is nonsense[5c] ! I will give you an example. IN 1984 Jimmy Carter joined up an organization called SARAGROWA or something like that and started a project called Feeding the Nation. When they came to Ghana they took about 100 farmers, got a piece of land and divided it into two. They gave one side to traditional farmers to plant maize. The other side they developed it by using simple, simple scientific knowledge and planted maize. At the end of it these people had more harvest than the traditional farmers. Now the story is that by no means is the traditional knowledge inferior. The system of farming basically was the same but it tells them what to do in different way. It was just polishing and repackaging. We are not saying that this it is a useless tradition like sending a girl to school as this is a tradition that institutes inequality. We are talking about knowledge that can be improved. This time round it was adding to their traditional knowledge but remember it can also work in the other way. Now how does all of this affect teaching? In our department many civi

servants believe that they must come to work at 7:30 and leave at 4 o' clock[5f]. In my office I tell my workers that they only leave when the work is completed, irrespective of time. Now teachers must also adopt this attitude. Once they are given a syllabus or curriculum and they are told what is to be done they must get on with it[14]. They must identify and recognize both knowledge systems and make the comparison and in the process establish how one can supplement/complement the other and it goes on like that[11]. This is what I said when I started, teaching is an art. But to get teachers to do this you need someone who knows and who will direct them. What I am saying is that C2005 is not enough. There is something missing. What is missing is the traditional aspect of it. Just mentioning use traditional knowledge is not enough[5b]. Obviously they will battle[4].

Interviewer:

Who is this someone that knows?

Interviewee:

You will get somebody who specializes in law, somebody in economics and so on. So you will also get a person specializing in traditional knowledge[12b]. So it should not be considered as additional work. Yes it is an additional subject but it has to be done. It has to be treated like any other subject so that you can give teachers the choice of deciding what is to be done. So the issue of whether it is additional work is neither here nor there. It has to be included as part of the curriculum and if it means being legislated it must be legislated. But you cannot include that in the curriculum if you do not know what you want. So the starting point is to identify what is to be done and how it should be done before you can place IK in the curriculum. You will have to have specialists from the community, education department [12a] and tertiary institutions[12b] to impart this knowledge. People tell me that nurses and doctors don't want to go and work in rural areas. To me that is fine. We have traditional ways of treating people in the rural areas and this may not necessary mean sending doctors and nurses there. Traditional healers could be able to fill that gap if this is recognized and accepted. Why do you need a matron who went to college to train for years when you have my grandmother sitting there and who knows how to deliver a baby. She will do a better job and will do it with passion[1b].

Interviewer:

Prof, what do you feel about having discussions after discussions about doing a particular job and not really get down to do it?

Interviewee:

That is what makes us not do the job because we are afraid of failure -always afraid of failure[7b]. But if you don't do it you will never know if you will fail or not fail. So the starting point is that forget of whether you will be successful or not. Just do it and evaluate it. In South Africa we form committees, write papers, White papers, come back review them, write again and those things never get implemented[5f]. When I see kids just walking along the streets and when I go

to villages, go to Ulundi and see people going hungry it is tragic, it is like committing sin. Go to Bhambanana , the most fertile area in South Africa. The soil is fertile and rainfall good but you just cannot get access to the area. When asked why you are told they are too busy building freeways[7b]. This explains the mindset of decision makers. So we need to change the mindset completely in our whole way of development [14] and transformation. What I wish to do when I will get some money is to set up an organization and have as our basic aim to change the mindset of decision makers. Fearlessly we should go to the cabinet of this country and tell them that you do not know what you are doing[7b]. To do what you need to go to the ground and determine where you will start and from there you will go here, here and… Once this is done you will have a plan and if they don't do it we must take them to court or somewhere, have them replaced or force them to do it. Take Aids for instance in this country. We have all the resources in this country to content with HIV/ Aids within 3 years. People are prepared to give you money to do it and you don't take it. It is criminal! [7b] .
I hope that I will be able to do my bit.

Transcript and Audit Trail of Interviewee 3

Code	Category	Meaning	
1	Acceptable	Embrace, excited	
2	Unacceptable	Astounded, resistance, adamant, against	
3	Manageable	-	
4	Unmanageable	Very difficult	

Interviewer:

How would teachers react to the inclusion of IK in the natural science curriculum [Q1]?

Interviewee:

I think that the indigenous African teacher will embrace[1] it.
Looking at the past and what they used to bring to the classroom was never considered by them to be their thing[1c]. Their upbringing[1a], their culture[1c], their knowledge were prevented from being discussed in class. It was ridiculed and they were seen as being uncivilized[2a].

The mistake that many people usually make is that they think that IK is only African[2c]. It actually does not mean that. Everyone has IK. The other groups who are not indigenous African may therefore initially be astounded[2] and may offer resistance[2] to include IK in their classroom teaching. This reminds me of how a White guy on the panel reacted at National when we writing the curriculum statement for FET. At the beginning this guy was adamant[2] and against[2] IK. In response to his reaction I told him IK does not mean that we

must now start teaching children to become sogomas. It was emphasised that every culture has IK be it the Indian culture, the Euro-centric one and so on and so on. I asked him to imagine a cosmopolitan class and stated that one of the ways you could include IK is by asking the simple question of what is home made remedy in your home of treating flu? You may find that a child coming from a Euro-centric environment will say that my mother uses Vicks. You add some of it to boiling water, position your head over this sauna cover your head and the container with a towel and inhale. Children coming from other environments will present other kinds of remedies. All this brings information that has been passed on from generation to generation. This simple example seems to have convinced him and I am happy to say that this guy now very actively contributes to our discussions concerning IK at National. So if teachers who are not indigenous African understand what IK means they will also embrace[1] it and attempt to use it in their classroom teaching.

At the moment the majority of the teachers have been made to believe that IK is primitive[2a]. What IK really means will have to be understood and once this perception changes the majority of them will embrace[1] it.

Interviewer:

Who is going to change this perception?

Interviewee:

Who else but the education department?[14]

Interviewer:

What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further [Q2]?

Interviewee:

The actual delivery of IK in the classroom is going to be very difficult[4].
We actually tried it. Last year we ran a workshop for Natural science teachers and I said lets try and do this specific outcome that has something to do with IK. I think it was SO8 or SO9. We demonstrated to teachers in the Pietermaritzburg area how flu can be remedied using the turpentine reed. In Zulu it is called isigunga. Prior to this workshop teachers never had any idea how to implement SO8 or SO9[4a].After the demonstration teachers asked for more workshops of this nature in order to embrace it in their classroom teaching.

IK can be easily lost[1f]. It is buried somewhere and it was never allowed to come out. They need to be shown the way[14]. I have not found any resistance[1] with the teachers probably because of my interest in IK. You must also remember that Western knowledge may not be IK of the west.

Interviewer:

What are some of the possible obstacles to the inclusion of IK in the natural science curriculum [Q3]?

Interviewee:

I see training as being the most problematic[7b] because most of the teachers as much as they love to embrace[1] it, will require tremendous support to show them how to go about it. For my Masters I interviewed some children's grandparents. I found that many of the concepts held by these old people correlate closely with Western thinking. There are some concepts, however, that do not correspond at all for example brewing of beer. Fermentation is not related to the activity of micro-organisms. It is the malt and that is it[5d].

The concept of germination also brought a lot of different ideas. I was told that a person has to have a gift to get the best results. This gifted person has the powers to germinate every seed successfully. When questioned whether any other factor such as the use of fertilizer could contribute to the success I was told that they will prove to me wrong. It was the giftedness and nothing else. She told me that when twins planted pumpkin seeds in the same field, the brother's row always produced more pumpkins than the sister's. So you see the idea of formulating a hypothesis and testing it and drawing a conclusion exists in these learners' minds. Whether it is true or not is a different story.

In a similar way many teachers also cling to concepts passed on by the previous generations[5e]. Changing these teachers' perception is going to involve education[11].

An additional problem is going to get teachers accept that everyone has IK[10]. Teachers will have to understand that the use of IK in classroom teaching has to be conceptualised[6b]. Once this mammoth task is tackled I think it is going to be fine.

Interviewer:

Do we have resources to tackle this?

Interviewee:

Yes and no. The education department will have to budget. It is a priority if improvements are to be made in the teaching of science. Written material, books, etc will be difficult to get hold of[7a]. Most IK is oral[6c] and it is part and parcel of life. Texts are skewed towards Western science.Human resources can also pose a problem[7a]. Subject advisory need empowerment. It is challenging. You need people who have the ability and interest to do this[7b]. When you start you will be amazed how many stories will come out. You need to start. You can start using simple ways such as like the workshop we ran.

Interviewer:

Can tertiary institutions not incorporate some kind of support in their teacher training programmes?

Interviewee:

I think it is a very tall order. They are the very people who contest that IK is not science. Very few have the knowledge to see that IK is a science[5e]. Most of them don't even take it seriously.[5f] So if you are now saying that you are going to use these very people with this perception to train teachers you are not going to succeed. If this is to be seen as a strategy then you will have to change their perception and this is not going to be easy. There are lots of this kind of people at university and unfortunately most of them are on the education side. These are the ones that differentiate between pure science and everyday science[5e]. This is quite amazing because your education ought not to do this to you. This reminds me of what happened at a discussion at university when debating the wealth of African indigenous knowledge. A Nigeria doctor told us that if he were to get a fracture, he will ask his wife to buy him a ticket to Nigeria. In Nigeria there is a traditional doctor who will cure your fracture. No medical doctor has this expertise. Now you see we are talking of a medical doctor who has many years of Western science training and who still values the traditional doctor. That is what education ought to do. It ought to allow you to make informed choices[1e]. In my next research I think I will like to consider investigating how pre-service and newly qualified teachers fare as far as IK is concerned. Are the people at tertiary institutions still devaluing IK?

Another amazing thought that I must share with you and this will add weight to why consider training to be the biggest problem is what happened at a Biology Senior Certificate Examination marking centre in Vryheid. Without fail it will rain, thunder and there will be lightning at 5 o' clock in the afternoon and teachers of biology will say that this happens because there is an old man out there controlling the weather. So here you have it, matric biology teachers' thinking in this way! [2e].

In my case I believe that these things complement each other. You don't have to throw away one and embrace the other. You should make use of any good that comes from both.

Interviewer:

What therefore should be the role of the curriculum?

Interviewee:

The curriculum should expose learners to different types of knowledge systems and they should at the end be able to choose the best option. They should not throw away everything because they are now seen as civilised beings.

What else is also amazing now is the exploitation of IK[8]. On one hand we are told that herbs are useless and then you will find the very same herbs in tablet form. See how the Aloe is being utilized now. Everywhere you will see products made from Aloe. Aloe has been our traditional plant. Also look at something else that is very hot now- the African potato. This sort of thing is very bad. These discrepancies need to be addressed and the classroom is an ideal environment provided that the teacher is trained.

Interviewer:

What are some of the possible strategies that could be used to draw out information from the communities / communities [Q4]*?*

Interviewee:

Direct communication is the best[12a]. This can be frustrating but is the only option we have at the moment. I would make the arrangements, wait eagerly to interview the person, drive for hours to get there, only to find that the old man is not there.

Empower teachers to set homework of a different nature[14]. Devise a question or a few questions for learners to pose to members of the family or elders such as how was this done in your days? Why did you do it?

Approach agriculture officers, parks board officers[12c], elders to come to school and help out[12a]. There are simple ways to start. Teachers need support[14]. I am pretty sure that the majority of teachers will embrace[1] the idea of using IK in their classroom teaching. The ones I met are very excited about it.

I should not have been the person you should have interviewed because I am already converted. Out there lots require conversion.

Transcript and Audit Trail of Interviewee 4

Code	Category	Meaning	
1	Acceptable	Extremely receptive to moderately receptive	
2	Unacceptable	Total rejection to vaguely receptive	
3	Manageable	-	
4	Unmanageable	Battle	

Interviewer:

How would teachers react to the inclusion of IK in the natural science curriculum [Q1]*?*

Interviewee:

Teachers will react differently, according to the individuals' exposure to ideas in the past. Personal experience emanating from their upbringing will play a key role in the application of IK in the natural science[1a] curriculum. The broad base will expand from: 1 extremely receptive, to 2 moderately receptive[1], to 3 vaguely receptive to 4 total rejection[2]

Interviewer:

Can you be more specific as to who may be categorised into the 4 groups you have mentioned?

Interviewee:

Stereotypes exist about IK in the school curriculum. Somehow it is conceived by some teachers that Western education paves a way for a better quality of life[2a]. This is regardless of that fact that many non-Whites are strongly associated with traditional culture. To these teachers the application of IK in the natural science curriculum may expand from vaguely receptive to total rejection.[2] This group may comprise largely of Whites teachers who firmly believe that IK is less systematic than Western scientific knowledge [2c]and oppressed non-white teachers who have internalised the colonists' denigrating views of IK[2a].
Fortunately this group does not comprise the majority of teachers. The emergence of Black Power Movement, Black Studies, Afro-American Studies and most important South Africa's democracy have conscientised the majority of teachers about the stereotypes and prejudices[1d]. So I believe that the perception of the majority of teachers will expand from moderately to extremely receptive[1]. These teachers recognize that Western and indigenous systems can complement each [1e] other but how this is going to be implemented in the classroom remains a key problem to many of them.

Interviewer:

What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further [Q2]*?*

Interviewee: In the present context most teachers will battle[4] to deliver lessons related to IK. Thus far, the policy makers have been primarily involved in generating policies. Minimum support is being provided to teachers to use IK in their planning of such lessons by the education department[4a]. Concerted efforts to invent ways in which knowledge systems can be integrated remain a daunting task for all interested parties.

Interviewer:

What are some of the possible obstacles to the inclusion of IK in the natural science curriculum [Q3]*?*

Interviewee:

Lack of a coherent plan to empower teachers to handle the inclusion of IK in the curriculum[7b].

Misunderstanding due to the lack of understanding by the teacher[5e].

Diversity in South Africa poses a serious challenge. It is virtually impossible for any teacher to have a deep understanding of all the IK that learners may bring to the class[9]. Most IK is not to be found in books. Behaviour modelling and listening to folk stories imparts IK[6c].

Fear of not succeeding. Generally speaking people are afraid of failing. Failure is not viewed by many people as being a stepping stone to success[5f]. This could probably be attributed to the past and present socio- economic, socio- political set-up. Lots of things have not changed to empower teachers of not being afraid to try something new.

Maintaining respect for IK and WK. Teachers must be warned against over rating IK. They must not adopt a non- Western stance[5d]. Both systems have wisdom needed to survive today. However, drawing from two knowledge systems without empowerment poses a serious threat to many teachers.

Language barrier. Elders usually play an essential and crucial role in bringing the past to the present. There may be situations where elders because of a language barrier may not be able to transmit the required knowledge[5g].

Compartmentalization of Knowledge- It is difficult to compartmentalize IK into disciplines such as science, geography etc. IK embodies all the disciplines without differentiating one from the other. In the quest for survival everything goes hand in hand[6a]. This means that science teachers have to break up the "survival web" to sift the "science facts". The big question is are they empowered to do this? Will the IK not be misconstrued when not viewed in its totality[5e]?

Finally there is the intellectual property concern. This must be respected. Where money is involved it is a thorny issue.[8] Although seeking knowledge to help save the environment is the duty of everyone, some may still view people eliciting knowledge from them as being not honest and sincere[5f].

Interviewer:

What are some of the possible strategies that could be used to draw out information from the community/communities [Q4]?

Interviewee:

Raise the status of IK[11]. Attempts to make individuals view IK and WK on the same level have to urgently be undertaken by all stakeholders in pursuit of the African Renaissance. IK can no longer be seen as being primitive. This presupposes adequate IK and the awareness of such knowledge[11]. Promotion of cultural identity and empowerment need to be focussed upon[14]. NGOs,

businesses, corporations need to join forces with the education department to drive the initiative[12C].

Enter into a highly participatory process. Plan public forums to exchange information. Encourage teachers and learners interviewing community members[12a].

Encourage "role play" to indicate the holistic nature of IK. This can also be used in situations where there is apprehension to turn the negative to a positive. Successful outcomes can be shown[14].

Provide interpreters for those that are not in a position to communicate effectively because of language barriers[14].

The education department needs to have a coherent plan to empower teachers to handle IK and WK as being complementary, supplementary knowledge systems[13].

Transcript and Audit Trail of Interviewee 5

Code	Category	Meaning	
1	Acceptable	Exciting, will go ahead	
2	Unacceptable	Threatening, resistance, reluctant	
3	Manageable	Naturally creative	
4	Unmanageable	Struggle, difficult	

Interviewer:

How would teachers react to the inclusion of IK in the natural science curriculum [Q1]*?*

Interviewee:

I think that will depend on their upbringing[1a]. I think for a lot of teachers it will be very challenging and quite exciting[1] because they have perhaps in their own families valued the orientations and understandings that they have been brought up with[1a]. I also think there is a lot of ambivalence in many communities. I think particularly in our African communities there are people who go to church on Sundays but they also are fulfilling all sorts of traditional customs and beliefs on other days. It is actually quite well described as polynormativism by Hookerveld who is a sort of developmental sociologist and the only reason why I can remember all of this is because it had such an impact on me. What I am seeing is a lot of ambivalence and people are learning to become comfortable with this. If this is so then there is now a different way of looking at things that may not be threatening. It can enrich part of our lives and it can also enrich our understanding of what we are doing

at the moment[1e] But while this may be so and I am speaking from experience now, I think one of the difficulties in our situation at the moment is that we are moving very rapidly towards the Coca Cola culture and the kind of traditional beliefs of many of our African people have been chucked out[1f] and are leaving us with a bit of a vacuum. People have felt that if they embrace the Coca Cola culture, they've madeit.[2b] So to those people, it will be very threatening[2].

Interviewer:

Will the bulk of our teachers have this Coca Cola culture?

Interviewee:

I think the younger ones will[2d] and I think you will get an intergenerational kind of conflict or disagreement etc.

Interviewer:

What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further[Q2]?

Interviewee:

Well if you are looking at this from a science background and I am now reflecting on the work of a friend of mine at Natal Museum. She is a social worker trained with a honours degree in psychology but she has also done a masters degree in environmental awareness. She is using Natal Museum, a stuffy museum to actually energise thinking around environmental issues. One of the things that quite a lot of museum workers are saying to this kind of effort is that we don't talk about this bird and its food habits and then talk about its significance in Zulu history whether it be part of mythology or whatever. By doing this they claim we are telling half the story.

I think she has encountered a lot of resistance but the children have really got into it. It is quite interesting. They even do a play on the significance of this particular bird etc. So I am saying that I think that those who are naturally creative[3] and naturally wanting to best equip children can make linkages anywhere like biology and the environment and that kind of thing will easily make the change. Energised teachers out in the rural areas are using rivers as their laboratories. I have seen it. Those that are energised will go ahead[3a]. Those that are not energised for whatever reason will struggle[4].

Interviewer:

What role, in the present context should our educational system play to help teachers, even the energised ones to implement the inclusion of IK in some of their learning programmes?

Interviewee:

I think that the educational system needs to make a very big contribution to help those learners and teachers to know who they are without baggage. This must be done in a positive way and I think that this will require a lot of very careful orientation and training and strengthening of people to know who they are because I think it is only when people know who they are can they move in new directions with comfort and not feel threatened[4d].

Interviewer:

So what you are saying is that including IK in classroom science teaching is going to put a lot of demands on teachers and that teachers presently are going to find it difficult?

Interviewee:

It is going to be difficult[4] for teachers and yes it's going to put a lot of demands on them because we have been so moulded by Western thinking particularly in the scientific grounds where the whole kind of way is very black and white as it were and does not allow for grey areas very easily[2a]. I think that this is going to be the challenge and that is why I am very surprised that it is coming from you as a science teacher and not from an arts person or a language person or a history person.

Interviewer:

What are other obstacles to the inclusion of IK in the curriculum[Q3]?

The reality is that all of us civil servants and maybe teachers in particular have been subjected to a huge amount of change in a very short space of time without a real commitment to change management and the building of skills and knowledge etc[5c]. I know for us these things come to us as policy to be implemented[7b] and I think that you may encounter resistance[2] not so much because they don't like the idea but because of just sort of what I call programme fatigue of just always having to deal with the new change[5f]. Ja I think teachers are going to struggle[4]a bit and I also think they have not been taught to think like this[5b]. This is the problem. It is going to require as I was saying shifts in their own thinking which some are reluctant[2] to make and some will be just too tired to make[5f].

Interviewer:

What do you think are some of the possible strategies to help the energised teachers and to help other teachers to attain the energised level that you speak about? In other words what strategies may be used to draw out knowledge from the community or communities[Q4]?

Interviewee:

I think it was in one of the papers that I sent to you, the whole thing about teaching social history[12b]. How do we get to being where we are? What have we gained and what have we lost you know in a very balanced way[11]. I am told that the universities do teach some sort of social history. I say this in the context of social workers because I could see from the Aboriginal social workers of how proud they were that their training equipped them to deal with things like the stolen children whatever in Australia and the huge impact that this has had on modern day Aboriginal family and the alienation of being an indigenous minority caught up in social change[1b]. These social workers were excited about the contributions they could make from their learning which included traditional ways. What problems will emerge and how to respond to these were not beyond them. I actually asked Natal University, are you doing this with social workers? Look at what migrant labour has done to our rural communities. It is throwing up very predictable problems. Are you training people for that?

In the field of social work they are giving people options in Australia. Do you want to go through a Western system or a traditional system for example with delinquency? Do you want to be under the counselling of elders or do you want to go to a reform school? They actually give the kids that sort of option[13].

Interviewer:

So basically what I hear you saying is that our teacher programmes should also have options?

Interviewee:

Ja

Interviewer:

Would you say that it calls for specialist teachers?

Interviewee:

Ja I think that you should really be able to kind of include this in many of your programmes if you want to create the awareness that we have a rich social history[14]. There is some funny little saying that you won't get to where you are going unless you know where you have come from- something like that. They have used it for a lot of young people and I think it would not only energise the teachers, it would probably energise the children as well in the same way that the kind of work my friend is doing in Pietermaritzburg, capturing children's imagination and making them more aware about pollution issues etc[1e]. A lot of this has come from the work that she has being doing of locating many aspects of nature in the history with some of the animals. I think it is how you position it. If you position it as another boring subject like Latin you will …but if you get it informing your history, informing your biology I think it would be very rich[13].

Transcript and Audit Trail of Interviewer 6

Code	Category	Meaning	
1	Acceptable	Happy	
2	Unacceptable	Not believe that it is relevant, not going to do it.	
3	Manageable	-	
4	Unmanageable	Not going to be easy.	

Interviewer:

How would teachers react to the inclusion of IK in the natural science curriculum[Q1]*?*

Interviewee:

I think that teachers were made to believe that their IK is useless especially in the Black world. They were taught in the era where traditional IK was taken to be useless, not applicable[2a]. So I do believe that they may be happy[1] because of the pride that would confront them when teaching IK[1b]. But on the other hand some of them may not believe that it is relevant[2].

Interviewer:

Why will some of them see it as being irrelevant?

Interviewer:

Because that is how they were taught. We were brought up to abandon our traditions by the education system. There has always been a demarcation between the knowledge that you came with and the one presented by the education system[2a].

Interviewer:

Did you really abandon it?

Interviewee:

No! It carries on in your life. You even pass it to your children.

Interviewer:

Are you saying that most of the learners are being exposed to two different curricula that run parallel in their lives?

Interviewer:

Yes. Unfortunately there is no detailed study linking IK and the natural science curriculum for the school level. Interest has only surfaced lately. This, however, brings with it problems. There are so many different tribes, so whose IK do you teach?[4b].

Interviewer:

Can the learning programmes not accommodate the teaching of the IK of the different tribes?

Interviewee:

Yes it can. It depends on the teacher. It depends also on the composition of the class. Today you are going to have a class that is mixed[9]. What I perceive is going to happen is that many of them that will be happy[1] about including IK in their teaching because this is politically correct but whether they can handle it is a different matter[1d]. There are also going to some because of indoctrination that [2a]are not going to do it[2].

Interviewer:

Can you assign groups that may be happy and may not be happy?

Interviewee:

I think the older teachers may see the value[2d]. But I think much more than the age group it is the area where the teacher grew up and now resides. A person from a village might have a different kind of outlook[2e] about IK than someone brought up in a city like Johannesburg.[2b].

Interviewer:

What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further [Q2]?

Interviewer:

I think they have to start by assuming that the child comes with IK. They must find out what these kids come up with and see how these relate to the so called modern science and then start planning ahead[12a]. It is not going to be easy[4].

Interviewer:

If the child does not come up with information, how will the teachers cope?

Interviewee:

This is a political question. The teacher cannot choose one. In the first place you have to identify what can be classified as IK[6a]. In the second place you will have to look as to whether the teacher is able to identify that knowledge as IK. (The child might claim that it is indigenous but the teacher might look at it differently) [5d].

Interviewer:

Will this difference not generate meaningful dialogue between learner and teacher?

Interviewee:

At the end both may progress. It can be seen as a new way of knowledge production if you talk about social constructivism. This will embrace this kind of thought. The problem here is reaching some sort of agreement because in this dialogue who decides what is right and what is wrong. Perhaps it is a kind of situation that lends itself to investigation. How a teacher gets involved is a sensitive issue. Teachers will have to discuss IK that is usable and will not cause conflict in the current situation[4b]. This, teachers will not be able to do on their own until the education system revisits the whole question of assessment. Teachers are now being viewed in terms of the kind of results they produce[7b]. So until the education system rewords assessment procedure they won't take it seriously[13]. For this to take effect you need dedicated teachers who must cultivate a positive attitude towards IK[10] and the education system has to provide tremendous support. [14]

Interviewer:

Besides the ones that you have already mentioned are there any other obstacles to the including of IK in the natural science curriculum [Q3]?

Interviewee:

First of all there is the complexity of IK. Each tribe has its own IK[6d]. In a multicultural classroom you will have a dilemma of choosing what kind of knowledge to transmit[9]. The second one is the attitude of the teachers and the learners toward a particular kind of IK.[5f] I mean as a Black man if you tell me to teach Irish IK, then I will fail. This will also apply to a Zulu being asked to teach Sotho[4b]. Pride is involved here. Asking people to project their own IK could also lead to the creation of competition amongst different people. This could lead to arguments about whose IK is better[5d].

Interviewer:

Don't you think as teachers we should overlook competition and seek to draw out what is best to help learners progress and survive in this world of ours?

Interviewee:

Yes, but that is the utopian kind of situation. In the real world some culture's knowledge will be submerged. Dominance is determined by their competitive advantage in the current economy. If viewed politically when you talk about IK you would imagine that it is Black knowledge that you are referring to. The IK of the White man for instance has evolved into what we see as science and technology today because it was developed. In fact there are arguments that the importation of science knowledge into Africa actually delayed the development of IK[2a]. I mean if people are supplied withy ready-made solutions to their problems they would not care about developing what they already know. They don't care[5f]. It was in the interest of the West that no other knowledge system be recognized. The West will progress as long as they manage to slow down other people[2a]. You see it is money. If you see that another person does not have what you have then you are at an economical advantage. So you see one can argue that there was reason not to make IK evolve because that will bring about competition of knowledge and resources. So the under-developed world is suffering from not having the chance to develop their own IK that they were able to understand. Not having this chance is going to pose problems for classroom teaching[7a]. Let me give you some examples. Today you teach students to build houses. It is a certified course. Culturally a young man knew how to build a house. It is only that the way these houses were built and are still being built in some areas has not been researched to make improvements. There is no further thinking that is going on about the houses that their forefathers built. As soon as I talk about improvement it will mean to buy bricks, iron sheets etc. Look at the pyramids in Egypt. They were never developed further until today when people are going back to say how did these people manage to build this? If there was a continuation of the technology of the pyramids, then perhaps the houses in Egypt will today be looking different. In a similar way things will be different in other parts of the world[5d].

Interviewer:

What are some of the possible strategies that can be used to draw out IK from the community/communities [Q4]*?*

Interviewee:

They obviously need to study, get resources on different cultural groups. They need a lot of information[14]. Unfortunately a lot of it is not written down[6c]. So a lot of it can only be got from word of mouth. You will have to get it directly from people. This will mean that teachers will have to go into the communities[12a]. Teachers will have to write it or record what is being said so that in future they will have a knowledge/data base.[15]

They will also have to call the different communities to school to demonstrate certain things. Which communities are involved depends on the composition of the class[12a]. Perhaps a way to go is to get this IK researched further[12d]. This is going to require a concerted effort by all people not only the Department of Education. Maybe it should become mandatory for schools to

look at the IK of their area[13]. Tertiary institutions being the fertile grounds for investigations have much to do to help find possible strategies for teachers to implement[12d].

Transcript and Audit Trail of Interviewee 7

Code	Category	Meaning	
1	Acceptable	Excited, embrace, positively, happy	
2	Unacceptable	Will not be happy, will not react positively, did not want to pursue.	
3	Manageable	-	
4	Unmanageable	Very, very difficult	

Interviewer:

How would teachers react to the inclusion of IK in the natural science curriculum **Q1***?*

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Interviewee:

Educators will react positively[1] to the inclusion of IK in the natural science curriculum.

Interviewer:

Why will they react positively[1].

Interviewee:

The previous education system through its discriminatory policies corroded IK. The teachers will value the opportunity to impart useful knowledge from their culture[1d] and those pertinent to the lives. It will also assist them to remove myths that learners have about science. Furthermore, it mostly uses hands on approaches and it will make learners have an interest in science[1e]. I say this because sometimes last year in the North West Province we organized workshops that focussed on including IK in science learning programs. Partnerships were established between community members and the education department[12a], agricultural officers, environmental officers[12c], traditional doctors and elders[12a]. They presented to educators invaluable indigenous knowledge that could be used in classroom teaching. Knowledge imparted included traditional ways of controlling pests, traditional ways of enriching soil, uses of plants to cure some common human and animal illnesses. HIV/Aids also featured. These workshops excited[1] those present. After discussions between educators and learning area mangers educators were amazed to see how much of this knowledge could be linked to the specific outcomes and how it be used in their CASS programmes[1e]. It was also

very interesting and encouraging to see that most of the educators could identify with what was being presented. Establishing partnerships definitely accounted for this active participation.

Myths like if you eat kidneys you will age faster were also discussed and questioned. The majority of the teachers realized that this is a belief and this does not really happen. Some, however, felt that they did not want to pursue[2] the matter because something in them kept telling them it was going to happen because many things that elders told them about really happened. Elders according to them should not be defied. They should not be questioned[2e]. They know a lot. Their knowledge had helped them to survive and live happy lives[1e]. While this may be so we have to move forward. So what I am saying is that although educators will hold on to certain myths they are still going to be happy[1] to talk about some aspects of IK during their science lessons. They will feel proud to present to their learners the knowledge that underpins their very existence[1b].

Interviewer:

When you say that educators will react positively, do you mean all educators?

Interviewee:

No the majority of Black teachers especially those who live and teach in rural areas. These teachers in their upbringing[1a] were taught many lessons by their parents and elders that were essential for their survival. The lessons enable them to explore and utilize resources gainfully, sparingly, co-operatively and efficiently. It also helped them to understand the risks and dangers of tampering with the environment[1e]. Many of them especially those out in the rural areas still cling on to them[2e]. The teachers will now have an opportunity to use it in the classroom. In urban areas some teachers have abandoned most of their traditional beliefs and associated IK. The pull towards a Western lifestyle is vogue[2b]. Promises of a better, easier life accompany this choice. These teachers obviously will not be happy[2] to teach lessons involving IK. There are also others that may also not want to include it in their lessons. In the North West Province we have many teachers who come from India. These teachers have a vast reservoir of IK from their culture and may feel that they are not adequately equipped to impart IK pertaining to the learners who are mainly Black. The Whites on the other hand will be happy to impart their stories to White learners only, feeling that it is only relevant to them. Like the Indian teachers they will feel deficient when faced with a class where the majority of learners are Black[2c]. There is still another group that will not react positively[2] because they will not accept change in South Africa. But these groups are a small part of the body of teachers. The majority of teachers are Black and they will react positively[1] as noted in our workshops.

Interviewer:

What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further [Q2]*?*

Interviewee:

I would say it will involve them organizing community members who have the knowledge to assist in the delivery of content[12a]. It will involve educators passing the buck to parents and the learners[4a].

Interviewer:

To this question you have implied the educator as merely being a facilitator who must obtain outside help. In other words the educator cannot cope adequately on his/her own? Am I correct in making this statement?

Interviewee:

Yes just educator involvement would be very, very difficult[4]. You have to remember where we come from. The sort of educational system we have from made us believe that IK is for home use and not for classroom science teaching[4a].
Also this knowledge lies with the elders. It is not documented[6c]. Where then are our educators going to get it?[7a] Many of us felt it was unnecessary to make progress and hence did not bother to obtain such information[5f]. I for one am a victim and it only now that I realize my foolishness. Yes I am saying that teachers are going to find it very difficult to prepare learning programmes of this sort on their own.

Interviewer:

What are some of the possible obstacles to the inclusion of IK in the natural science curriculum [Q3]*?*

Interviewee:

The limited knowledge of the teacher[4a] and the lack of resources. Sometimes raw materials may be difficult to find in the immediate environment[7a].

Another major obstacle I would say is that community members with expertise would withhold information[5a]. Many elders regard the younger generation as being "cash hungry". Knowledge of their forefathers is priceless and under no circumstances will be divulged for public circulation. This will make the make the rich richer and the poor poorer. The injustices of the past are difficult to overcome[8].

The differentiation between a scientific fact and a myth would pose a problem[5e]. Culture influence peoples' thought and the fear of something bad happening to them would deter some educators[5d].

The correlation of a Western science fact and an indigenous fact may be beyond educators. This can be very difficult or impossible for educators to do. This will involve very expensive research that would also probably not resolve easily, even with the best scientists in the world[5e].

Interviewer:

What are some of the possible strategies that could be used to draw out IK from the community/communities [Q4]*?*

Interviewee:

Educators will require enormous assistance from both the national education department and the provincial department[14]. This, however, calls for expert advice being provided to these departments[12]. Local as well as global expertise is a necessary pre-requisite. The services of the men in white lab coats and those without them are a must[12b]. It is time that the top brass listen and learn from the grass roots.[12a] IK has to given its due respect[11].Then only will educators fully embrace it in their classrooms.

Another strategy is for teachers to plan cost effective tasks for learners to do either on their own or in groups. Interviewing elders at home or in the communities about their life styles can provide invaluable information. This will not be too difficult as story telling is one of the methods whereby home education is achieved. Furthermore this is feasible because many of our learners are being care for by elders.[12a]

Seeking corporate funding to arrange exhibitions concerning IK [12c] and using local expertise of community members to present hand on activities at such gatherings would empower the so called educated[12a]. Eliciting the services of the community will obviously require some form of payment. One has to bear in mind that time spent away from whatever community members do daily means money lost and this perpetuates the hardships they endure.

Finally I must say that we educators have a very long road to walk and every small step we take will make us grow stronger to embrace IK with pride[1] in our classrooms.

Transcript and Audit Trail of Interviewee 8

Code	Category	Meaning	
	Acceptable	Positive	
2	Unacceptable	Negative, in opposition, reluctant, oppose	
3	Manageable	-	
4	Unmanageable	Minimal, greatly challenging, wish it away, wash it, resist it, dump it	

Interviewer:

How would teachers react to the inclusion of IK in the natural science curriculum [Q1]*?*

Interviewee:

As far as the educator is concerned, IK is deeply rooted in that particular educator's background as opposed to IK that is in itself considered innate as evolving through the ages as part of survival strategies[1c], human development and human society and culture. I presume that the IK you are researching is different from the Western concept of scientific knowledge as embodied in our mainstream education. The Western concept of a body of scientific knowledge embodies test, compare, verify, retest, reproduce, validate which perhaps makes up 70% what is taught and learnt as scientific knowledge. The other 30% lies perhaps in the innate i.e. IK which to date has not been considered on a Western scale[2a], nevertheless it is there, embodied in instructional objectives of curricula and applied in classroom practice. It is this body of knowledge, which, when it reveals itself to Western scientific thinking is perhaps as scientific and therefore, a vital part of the whole body of scientific knowledge.

It has been shown that groups of tribes people, cut off totally from Western scientific knowledge, have knowledge of medicine, nutrition, conservation measures for natural resources, environmental ethics etc that have allowed them to survive where other's cannot. It is these bodies of knowledge that have become innate, i.e. IK that has allowed them to live in extremely harsh conditions such as the San.

Of more recent, medical researchers and botanists have visited isolated groups of Aborigines in the Northern Territory of Australia where they learnt that the natives have survival mechanisms that encompass a body of knowledge as yet not revealed to the outside world such as when they get cut they would use leaf X over the wound to be an antiseptic and aid in effective, rapid healing, when they have a fever they would eat leaves of Y for the fever to rapidly decline. These scientists, as they followed this group of tribesmen through these remote areas, were astounded at their competence and depth of knowledge, indigenous to them. The scientists realised that IK allows each tribe to adapt to their particular circumstances. All over the world and through out the ages isolated pockets of people have learnt to survive and develop bodies of knowledge in all aspects of their lives[1e]. This is the 30% I first referred to as the innate and what you want teachers and learners to engage with.

The reaction of teachers to the inclusion of IK in the science curriculum will include some being positive[1] and some being negative[2]. Hard to tell exactly who will be positive[1] and who will be negative[2] but wherever educators have not been given the opportunity to study and teach within attainable norms of the Western body of scientific knowledge they will feel deprivation, so to present them with IK will have the effect of them perceiving it as a step backwards,[2a] rather than exploration of new avenues. This will be the first group in opposition[2] to teaching IK. The second group will be educators with all the advantages of access to the best in Western scientific education and school facilities to teach in. While they rigidly pursue curricula, tests and examinations they will be reluctant [2] to be innovators. These educators will constantly compare this new curriculum with curricular across the seas[2a]. They too will oppose [2] IK as a step backwards. Perhaps these two groups

represent 10% of educators; the other 90% having been presented with choices and with proper guidance, structures and support systems will see the wisdom of using IK and will see the inclusion as being positive[1].

Interviewer:

What is your perception about the teachers' ability to use IK as a teaching resource that could contribute toward efforts to prevent the Earth being degraded further [Q2]*?*

Interviewee:

The teachers' involvement is going to call on the resources of the parent. It will be a strength in some cases where parents and the community have much to impart in terms of IK; this too must be properly channelled at school. However the bulk of the learners would be at a disadvantage. I think the teacher's involvement is going to be determined by what the learners bring into the classroom[7a].

Interviewer:

What exactly are you saying?

Interviewee:

I am saying that the teacher's involvement will be minimal[4] because he has not as yet emerged from the trap of his own education. His knowledge of the scientific method has pulled him into a bucket. He can't see over the rim, he is caught. Things have not changed that much to allow him to come to the top of the bucket. Because of their limitations in the area of knowledge they will find IK both difficult to access and impart. In fact IK will prove greatly challenging[4] to most educators to source, sift, test, verify IK to present in our currently accepted classroom practices. Part of the problem arises from the system of education from which the educator comes. Even more problematic is that different educators are themselves at different levels in the attainment of the traditional Western scientific approach[4a].

Interviewer:

What are some of the possible obstacles to the inclusion of IK in the natural science curriculum [Q3]*?*

Interviewee:

Cultural bias[5d], urbanisation[2b] and socio political processes[2a] in South African history, all tend to throw up barriers to the proper exploitation of the rich sources of IK available to us in this rainbow nation.

Intellectual property is another problem[8]. In a Southern African context, besides the well documented survival strategies of the San, as late as the turn of this century found a giant Western pharmaceutical company being challenged by the San in attempts by the former to gain world wide patent

rights over the Hoodiiae plant – a plant that the San have eaten the roots of to stave off hunger. Tests by the company had revealed chemical substances that would prove invaluable in the world wide slimming industry. The body of knowledge developed by the San about limiting food intake for survival is based on ancient trial experience and testing, considered today as innate. This knowledge considered, IK is no less scientific, as the pharmaceutical company had found out by the application of the Western scientific method. The battle over the body of knowledge continues. This example shows the point at which a body of IK meets the demands of scientific evaluation at the same intellectual level[1e]. How each group arrived at this common point is always clouded by time, prejudices[5d], language boundaries[5g], cultural suspicions[5d] and a whole range of social barriers that often preclude the acceptance of IK as belonging to a universal body of knowledge[10]. Such experiences may make communities to withhold IK pertinent to the environment. The element of trust no longer exists[5a].

Severe constraining factors to the successful implementation may also lie in the teacher him/herself: their own baggage of social and cultural bias[5d], their own perceptions of where knowledge comes from and to what extent they can identify with the varied pockets of IK learners bring to the classroom[5e]. These constraints can render sterile the teaching and learning experience. From a homogeneous society it would be much easier to elicit knowledge of IK yet ironically the store of IK can be dramatically narrowed e.g. a teacher from a rural South African school and his/her students can explore IK e.g. Opuntia, the prickly pear because of its entrenched uses by communities over the years[2e]. Yet in an urban school such an example may be quickly dismissed as that alien plant that must be eradicated[2b]. Thus an entire avenue of IK is closed by opposing approaches to a body of knowledge.

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Another problem lies in the fact that IK is so deeply intertwined with culture, folklore and by its anecdotal and often personal nature[6f] it is often difficult to draw out at the level of classroom practise[6a]. So the teacher and the learners are like ships passing each other in the night and another door on IK is closed. Teachers will miss the opportunity to explore the richness of IK embedded in the cultural lives of his/her many students from different cultural and social backgrounds.

Last but not least because IK is evolutionary in nature and belonging to the people[6b], South African schools are faced with an exciting dilemma: the multifaceted society presents endless opportunities to exchange the once hidden pockets of IK and yet by its very nature such a society can be its own worst enemy to explore this knowledge[9] such as a body of knowledge presented in class for exploration may be completely unknown to others in the class and the teacher hence valuable opportunities to teach and learn IK will be lost[5e].

Interviewer:

What are some of the possible strategies that could be used to draw out information from the communities [Q4]?

Interviewee:

Use of books : small specific publication such as those from the Parks Board , Wild Life Society have historical perspective, often folklore and some IK along with the scientific names and writing. A publication such as from Kew Gardens has publication with the emphasis on IK of that particular plant. So if one really looks, books can yield a lot and the teacher can gain a lot of IK.[14]

Interviewer:

How accessible are these books to the bulk of the teachers?

Interviewee:

Publications are available but to make them available will require a national or provincial education initiative. The publications / pamphlets from government and NGO's[14] should provide a toe - hold for educators.

The second strategy is the use of the interview method: First the teacher / learner would have to identify people in the area who have some body of IK knowledge such as a songoma is an interesting starting point for a body of IK. Stripped of the trapping of Western stereotyping i.e. throwing of bones, and other much publicised rituals, a songoma with years of study in community medicine do some amazing medicine and social work. IK affects their practice in a big way. A songoma collects herbs, collects only enough without damaging the plant.
An approach that takes the lid off IK and encourages lateral thinking in science education will reveal mountains of knowledge from these repositories of IK. So interview them![12a]

Interviewer:

Is this not asking too much of the teacher?

Interviewee:

It is asking too much.

Interviewer:

How then are teachers going to get support?

Interviewee:

It is the responsibility of the education system to make it possible, but the content, curriculum for IK must be evolutionary and within the community as the starting point[12a]. Preconceived ideas and perceptions will tend to impose barriers[5d] other than grow the process. There must be structures[13], support services[14] and many educational debates first in place to present some degree of direction to the body of teachers[14]. The outcomes must be researched and evaluated[12d] – the final one being a learner emerging from a

system with a deep appreciation of knowledge of IK and scientific knowledge.

Finally to succeed the philosophical basis on which the objectives for IK are structured must be similar to the philosophical basis on which one teaches Western knowledge[13]. IK must not have a second rate philosophy. In other words your objectives must have the same attainable end[11]. By doing this, both knowledge systems will be elevated thereby bringing them on par and if these bodies are on par then when you seek to address IK you will address it at the level by which you seek to obtain your objectives. You see the hardest thing for the teacher to accept is that this body of knowledge must be brought on to par with Western knowledge[10] and until this happens you can't teach IK at the level you expect to teach it.

In the present context although 90% of the teachers will go for it if properly presented they are going to react with the usual resistance[5f] and either wash it away, wish it away, resist it or dump it on the learner and the parent[4].