

Science and Mathematics Education Centre

**SCIENCE EDUCATION REFORM IN A
POST-COLONIAL DEVELOPING COUNTRY
IN THE AFTERMATH OF A CRISIS:
THE CASE OF RWANDA**

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ABSTRACT

The research reported in this thesis is an in-depth study of science education reform in a transitional society. The society in transition is Rwanda — one of the world's poorest countries — a tiny central African nation adversely affected by major social, political, economic, and ethnic upheaval. Rwanda is faced with the challenge of ensuring rehabilitation after the genocide of 1994 and has adopted the following national goals: implementation of a durable educational policy, eradication of illiteracy, national capacity building in science and technology and reinforcing the teaching of mathematics and sciences.

The objective of this research is to describe, discuss and analyse information on the status of science education in Rwanda, from the perspective of primary and secondary science teachers, students, education personnel and my personal in-field observations and analysis. This research analyses the constraints in the implementation of educational policies and a relevant science education in a climate of social, political, cultural, ethnic and economic uncertainty.

The research used a case study methodology and utilised quantitative and qualitative methods to examine how teachers' and students' knowledge, perceptions and experiences impact on the school learning environment. The study made use of a questionnaire that was administered to teachers and students in Rwanda. English and French versions of a modified School Level Environment Questionnaire (SLEQ) and a modified Teacher Beliefs Instrument (STEBI) were administered to teachers. Two scales derived from the Test of Science Related Attitudes (TOSRA) were adapted for use in Rwandan classes.

The qualitative component of the research made use of interviews, classroom observations, personal reflexivity, historical and curriculum document analysis and vignettes. To enable an interpretation of the quantitative data from questionnaires in a meaningful manner, the socio-cultural, gender and ethnic perspectives of policy makers, teachers and students were examined through interviews and classroom

observations of science lessons. My personal experiences and reflections also were used to understand science education reform in Rwanda.

The qualitative and quantitative findings of the research identified factors that influence the science education reform process and make meaningful interpretations of background, culture and the situation in Rwanda. Document analysis indicated that there is a need for greater access to secondary education. Interviews and science lesson observations indicated that it is necessary to develop a curriculum that is contextually relevant and to redefine science teacher training programmes. The findings of the research identified the constraints, dilemmas and tensions in the implementation of the educational reform process as young and inexperienced teachers, most of whom do not have university degrees and have difficulties in implementing the curriculum effectively. Further constraints included work pressures due to the examination system, an acute, as well as a lack of material resources and finances required to reconstruct and improve educational institutions.

The research investigates the impact of the transition on science education in Rwanda. The research designed to examine the science education reform process in the transitional Rwandan society and economy studied the complex cultural, historical and educational factors that influence science education. Using multiple research methods, this study is an analysis of my understanding of the changes that have taken place in science education, the impediments to these changes and the identification of aspects that may enhance the prospect for future science education reform, especially in the areas of the science curriculum reform, assessment procedures and teacher professional development.

DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

Signed:

Jaya Earnest

Date:

THIS THESIS IS DEDICATED TO

My parents

Maria Dantas, my mother: a teacher by profession and my most
inspiring teacher
and in memory of
Anthony Dantas, my father
who believed in the value of education for his daughters.

Teachers and students

in the
transitional society of Rwanda,
who are resilient, learn to survive against great odds
and have taught me
the true meaning of endurance, survival and courage.

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LIST OF ABBREVIATIONS

ABBREVIATION	THE EXPANDED FORM
AIDS	Acquired Immunodeficiency Syndrome
CASTAFRICA	Commonwealth Association for Science and Technology Education in Africa
CNDP	Centre National de Development des Programmes (National curriculum development centre)
DANIDA	Danish International Development Agency
HIV	Human Immune Virus
IMF	International Monetary Fund
KHA	Kigali Health Institute
KIE	Kigali Institute of Education
KIST	Kigali Institute of Science and Technology
MOE	Ministry of Education
OAU	Organisation of African Unity
SSA	Sub-Saharan Africa
UNAMIR	United Nations Mission in Rwanda
UNDP	United Nations Development Programme
UNESCO	United Nations Educational Social and Cultural Organisation
UNESCO-PEER	United Nations Educational Social and Cultural Organisation-Programme for Emergency Education in Rwanda
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children's emergency fund
UNMIK	United nations Mission in Kosovo
UNR	University Nationale du Rwanda (The National University of Rwanda)

LIST OF KINYARWANDA TERMS

KINYARWANDA TERM	MEANING IN ENGLISH
Interahamwe	The local militia involved in the genocide
Imudugudu	The villagization scheme
Mayibobos	Street children
Ubuntu	Humanity
Umwana	Child
Umwami	King
	The terms listed below have been extensively used in the lower primary (years 1 to 3) science curriculum in Rwanda, which is written in Kinyarwanda.
Gusoma	Books
Intego	Objective
Ibyigwa	Lessons/study or content
Imbonezamasomo	Methodology
Ishuri	School
Ibimera	Something which grows
Amazi	Water
Integanyanyishigo	Lesson planning

CHAPTER ONE

INTRODUCTION AND OVERVIEW

Science education in the broad sense is a fundamental prerequisite for democracy and for ensuring sustainable development. (Declaration on Science, World conference on Science, Budapest, July 1999)

1.0 Introduction

This thesis describes, discusses and analyses the status of primary and secondary science education in Rwanda. As one of the few studies undertaken on the status of science education and education reform in a volatile transitional society like Rwanda, the research has explored a range of factors that affect the reform process by examining the links between science education, economic and national development and the influences of social, political, cultural and ethnic factors. The findings provide some data on the numerous and complex factors that account for the current status of science education reform and the challenges and constraints that affect a transitional society in the implementation of a new science curriculum. This chapter introduces the thesis by providing the background and rationale for the study, discusses the links between science education and economic development, explains in brief the conceptual and theoretical framework for the study, introduces the specific research questions that guide the study, explains the significance of the study and gives an overview of the thesis.

1.1 The Background to the Study

1.1.1 The Personal and Professional Context of the Researcher

My interest in education in developing countries and educational reform in transitional societies is a result of working in countries for the last 12 years where systems of education were being re-established after years of political turmoil. As head teacher of schools in Uganda and Rwanda, I have been part of the reform efforts and have often experienced the

frustrations and the problems associated with the subsequent rehabilitation process. My interest in development education, educational reform and emergency education has evolved over the years and forms part of the background for this study.

I have lived and worked in four different developing countries—India, Kenya, Uganda and Rwanda—where I have had experiences as a teacher, head teacher and teacher educator. I was educated and have worked in India and was always aware of the problems associated with an ever-increasing population, the problems associated with access to education and severe regional disparities in education and employment opportunities. In a country with a billion people, I also was aware that my country, which produces excellent scientists and software specialists in the world, even today has millions of children with no access to primary and secondary schooling (Aggarwal, 2002). Indeed, the problems of child labour and gender inequalities are still widely prevalent. With respect to education, India does not produce statistics as a whole because of severe regional disparities (Mehta, 2002). Even though a competency-based curriculum was introduced in India over 10 years ago, classroom scenarios have not changed with large teacher-centred classes, a focus on rote learning and assessment procedures that test a student's ability to memorise (NCERT, 1998).

I moved to Kenya in 1990, where, in my second year as a school teacher, the country had elections which resulted in a severe economic collapse and a gradual breakdown in the social fabric of life with increasing crime, ethnic violence, an increase in street children and the AIDS pandemic (Ministry of Education and Human Resource Development, 1998). At that time, Kenya already had the support of a number of aid organisations and non-governmental organisations doing work in the areas of primary and secondary education, teacher training, science education and laboratory instruction (Aga Khan Education Service, 1994).

I spent the next four years from 1993-1997 in Uganda as head teacher, rebuilding and rehabilitating a school that had closed down in 1972 during the Idi Amin era. In the midst of gunfire at night, car hijackings and the AIDS pandemic where one in seven adults was infected with the AIDS virus, I witnessed a people dedicated to rebuilding the education system and bringing the same status to Makerere University (a well-known African

Commonwealth University) that existed in the pre-Idi Amin era before 1972. I was impressed with the implementation of school improvement programs, the child-to-child programs (a unique program that forges links between the child, the school and the community) and the secondary science education programs (Ministry of Education in Uganda, 1992). I also witnessed the return of educated Ugandan citizens who had left the country during the period of turmoil and now wanted to be part of the reform.

After my work in Uganda, I spent two years in Rwanda and established a private school comprising nursery, primary and lower secondary classes. I witnessed first-hand a country recovering from the genocide of 1994 and never got used to seeing young armed soldiers on the streets, increasing numbers of war orphans and AIDS orphans, displaced children and the inherent poverty. During my time in Rwanda, the country implemented its new curriculum in September 1998 with a major thrust on science and technology, established an Institute of Science and Technology and an Institute of Education with the main aim of increasing the number of engineers, technologists and secondary science teachers (Ministry of Education, 1998a).

Recently, I returned to Rwanda for a period of three months gathering data for the purpose of the study that forms this thesis. During this period, I worked with a multi-lingual teacher who acted as my interpreter and also spent many hours in discussion with him. He was a refugee teacher who was a survivor of the 1994 genocide and had experienced the war first-hand. He went to great lengths to assist me in my understanding of the pain and helplessness of the people who are affected by war-the refugees, the displaced and people living in areas of long standing political conflicts. This study, which included my personal experiences and reflections, was designed to examine the science education reform process in the transitional Rwandan society with its complex cultural, historical and educational background. To enable an interpretation of data obtained from classroom observations of science lessons, questionnaires, interviews and documents in a meaningful manner, the socio-cultural, gender and ethnic perspectives of teachers, students and policy makers were examined. Using multiple research methods, this study is an analysis of my understanding of the changes that have taken place in science education, the impediments to these changes and the

identification of aspects that may enhance the prospect for future science education reform, especially in the areas of the science curriculum reform, assessment procedures and teacher professional development.

1.1.2 The Education System in Rwanda

Rwanda is one of the world's poorest countries faced with two major challenges - ensuring recovery, rehabilitation and reconciliation after the genocide of 1994, and overcoming the problems associated with poverty and the massive need for sustainable development (Phillips, 1996). Within this context, education is expected to play an important role in social reconciliation, reconstruction and economic development. Subsequently, Rwanda has adopted the following national goals - eradication of illiteracy, universal primary education, teacher training, national capacity building in science and technology and improving the teaching of mathematics and sciences (Ministry of Education, 1998a).

Education is the only factor that is likely to support the sustained modernisation and diversification of systems of production. The role of education in re-establishing and training human resources required for socio-economic development, and promoting peace tolerance (Ministry of Education, 1998b). Current statistics show that only 20% of Rwandan students who complete primary school at Year 6 proceed to secondary school. Rwanda has only 68% of its children attending primary school (Ministry of Education, 2000a).

Prior to the 1994 genocide, Rwanda did not have in place a high quality science teacher-training program. With the establishment of the Kigali Institute of Education in 1998 attempts are being made to develop and implement programs that are in harmony with local conditions and culture as had occurred in Malaysia in the early 1990s (Lee, 1992). However, there were insufficient educators in Rwanda to impart science education to student teachers and hence there was a necessity to depend heavily on science educators from India and Kenya who have no knowledge or understanding of Rwandan society and culture.

Lewin (1990a) and Vulliamy (1990a) both documented that developing countries often fail to take into account the realities in the classrooms, the acute lack of material resources and the

motivation of teachers in their countries in implementing new programs. In referring to his research in Malaysia and Sri Lanka, Lewin (1993) stated that a balance has to be struck between severe budget limitations, import substitution of curricula, technology transfer and the development of appropriate technologies in low developed countries. Four years after the genocide in Rwanda in September 1998, a new curriculum was implemented in primary and secondary schools. The new curriculum had to embody ethnic assimilation, the recognition of cultural differences, and a safeguarding of linguistic and cultural identity. These social issues are crucial in the Rwandan context where ethnicity was a major contributor to the 1994 genocide.

In addition, the issue of the language of instruction is problematic in a country where Rwandese, irrespective of ethnicity, speaks Kinyarwanda, where French is also widely spoken especially in urban areas and in secondary schools during the entire period of Belgian colonization, and the majority of the returning refugees speak English. Consequently, the Ministry of Education in Rwanda has developed a comprehensive plan for the complete restructure and re-organisation of the education system, with the help of the UNDP and UNESCO in 1998, and is in the process of implementing the plan of action and strategies laid out in the policy document. However, the Ministry has to work with inadequate material and human resources that greatly affect the access and quality of the delivery of the curriculum, especially the science curriculum (Ministry of Education, 1998b).

1.1.3 The UNESCO Model for Emergency Education in Rwanda

Immediately after the genocide in Rwanda in 1994, an estimated 800,000 people were killed, two million fled into neighbouring Congo, Burundi and Tanzania giving rise to the largest exodus of human beings in the shortest span in recent times. About one million people returned to the country after being refugees for over four decades (Philips, 1996). In November 1996, two million more refugees returned to Rwanda from Congo, among them were 30,000 displaced Rwandan children. Ongoing political and economic instability has impeded access to regular education for a large number of war-affected children and young adults (Aguilar & Retamal, 1998).

In July 1994, the UNICEF and UNESCO set-up a rapid educational response, both inside Rwanda and within the refugee camps. A Teacher Emergency Package or TEP model was developed and tested on a nation-wide scale in a crisis situation (UNHCR, 1997). The need to normalise children's lives was acknowledged and symbolised by the re-opening of schools and establishing school routines (Ministry of Education, 1998a). The first phase of the rapid educational response was aimed at re-building the almost non-existent infrastructure in order to re-open schools and start re-integrating teachers and students. More than 30% of the previous teaching force had been killed in the genocide. The second phase focused on normalising the education system and reconstituting the infrastructure for educational administration in the Ministry and the prefectures.

Within this second phase was the setting up of a training of trainers system using a cascade approach in order to respond to the urgent training needs of Rwandan teachers (Sinclair, 1999). The cascade approach meant that the trained teachers were required in turn to train their colleagues. From a psychosocial perspective, the trainers also were made aware of the impact of trauma, grief and emotional distress among children, and guidelines were provided for understanding this. Subsequently, a core group of national trainers was sent to the twelve prefectures to train teachers in their local communities. It was particularly noticeable at this stage that only 10% of the trainers were women teachers (Aguilar & Retamal, 1998).

Extreme situations and the daily threat of landmines, cholera, water-borne diseases, AIDS, health and sanitation issues and the degradation of the environment confront populations who are affected by humanitarian crisis, as in the case of Rwanda. These extreme situations were incorporated into themes in the emergency education programme that is imparted to children in crisis areas (Aguilar & Richmond, 1998). Each of these themes discusses the actual cause that created the extreme situation. The emergency education themes are related to science education and can initiate reflections about peace and reconciliation (Sinclair, 1998, 1999, 2001).

1.1.4 UNESCO Project 2000+

UNESCO's activities related to science and technological literacy are being developed through Project 2000+ which is UNESCO's commitment to the promotion of science and technology education around the world at primary and secondary levels. Project 2000+ is based on the philosophy that science and technology increasingly affect an individual's everyday world and enhances his or her literacy by providing knowledge and skills adapted to societal needs. The scope of science and technology learning has strong links with the developmental aspects of science education emphasising the understanding of the nature of science and the need for scientific and technological literacy in relation to local culture and values and the national, social and economic needs of each country (UNESCO, 1993).

UNESCO's efforts in the promotion of basic education for all and scientific and technological literacy for all has been commendable in the last three decades, especially in the developed countries and the newly industrialized countries of Southeast Asia (Kerre, 2001; Lee, 1990; Lewin, 1992). However, for most of the developing countries, and countries in Africa in particular, little progress, if any, has been made due a variety of constraints. At independence in the early 1960s, most African nations were eager to address the issues of poverty, health and education.

Today in Africa, illiteracy is on the rise, children are dropping out of school as they reach the upper grades, there is rising poverty, political instability in more than one-third of African nations, and the continent is faced with the HIV/AIDS pandemic (Kerre, 2001). Rwanda faces similar constraints and challenges and is unable to meet the requirement of basic universal education for all of its population. Throughout the global science education community, the rhetoric of science education for all (Fensham, 2000) is juxtaposed with the reality of science education for the privileged (Bajah, 1999). Science education for all does not have any meaning when in most developing countries, and especially transitional societies; only a minority of students attends secondary school. The rhetoric of science education for all is further discussed in chapter 3.

1.2 Science Education and The Developing World

1.2.1 Science Education, Economic Development and The Developing World

Development is a socio-cultural change in which new ideas are introduced into the social system in order to produce higher per capita incomes and higher standards of living (Bajah, 1999). Political and economic forces have meant that the world is redefining relationships globally and many parts of the world are experiencing conflicts and ethnic violence leading to transitional societies in each and every continent. These changes have contributed towards an increase in displaced and refugee populations giving a new meaning and dimension to emergency education, development education and comparative and international educational research.

Public education, particularly in the sciences, is an important priority in most nations and expectations are that education provides the engine for economic growth and the opportunity for individuals to fully participate in social and economic development (Morris, 1996). Science education can be the active vehicle for disseminating information to policy makers. Science, technology and society communicate and show the linkages in what goes on in educational institutions. Every science education program must address the issues faced by the people in their own environment (Bajah, 1999). The World Conference on Science in Budapest, Hungary, in July 1999 addressed the issues of science education for development, in schools and for the future. Three main themes were identified: Science for knowledge and knowledge for progress; science for peace, conflict resolution and sustainable development; and science in society and for society, with an emphasis on ethics and gender. Within these themes, governments were expected to give the highest priority to improving science education at all levels of schooling, to address the lack of appropriately prepared science teachers and to promote the professional development of teachers and educators in developing countries.

However, research has shown that extensive inputs to educational development in many countries have not produced the intended developmental gains that had been hoped for. One reason for this lack of progress is that educational reform in many developing countries has occurred in contexts where the impact of curricula change is compromised, if not wholly

negated, by the effects of examination systems that made little allowance for changes in educational aims and pedagogical practice (Lewin, 1990b).

1.2.2 The Development-Related Functions of Science Education

In recent years, the term relevance features prominently in official documents in the developing world regarding structural and curricular reforms (Vlaardingerbroek, 1998). Indeed, the notion of relevance is not new; Lewin (1993) recommended that school science education in underdeveloped societies must direct its efforts to meet the basic needs of health, nutrition and clean water. Earlier, Ogunniyi (1986) adopted a similar development-oriented approach:

Although by nature science is universal, the needs of different cultures and economies are not the same...Topics that relate to mechanized farming, control of malaria and tropical diseases, ecological balance, provision of good drinking water, production of food, development of good roads, drought, small agro-based industries, etc., are more relevant to the African setting than many topics that feature in the curricula of industrialized nations. (p.119)

The potential development-related functions of science education are many and varied in rapidly evolving transitional societies, from enhancing rural subsistence-based activities to equipping young people with a skill base applicable to industrial and modern technological contexts. These functions involve the development of attitudes and skills conducive to environmental preservation, the combating of disease, awareness of the AIDS scourge and self-employment after leaving school (Vlaardingerbroek, 1998). Agriculture, population control, food production and nutrition, environmental management, health and sanitation are development-related topics where a wider understanding of science will lead to more informed decision-making and social development of the community at large (Ware, 1992). In this way, science education can be contextualised and linked to the life world experiences of learners. Science education should be relevant to the people living in a particular society, acknowledge the political, social, and cultural factors that affect the population and should be linked to local contexts and issues of sustainability (Kyle, 2001).

1.3 Specific Research Questions

This study is designed to investigate the science education reform process in Rwanda where the major emphasis has been on science, technology and economic development. The study investigated the challenges and constraints in the implementation of a relevant science education program and was guided by four issues of interest. The multiple research methods explored social, cultural, ethnic and political factors that influence the lives of students and teachers in a transitional society like Rwanda.

The first issue of interest was to examine the major influences and the effect of these influences on the education reform process and the implementation of the new science curriculum. Questions 1 and 2 were designed to address the first issue of interest.

- 1) What are the historical and political factors influencing educational change in Rwanda?
- 2) What is the status of the intended primary and secondary science curriculum?

The second issue of interest was to examine the dilemmas and constraints faced by teachers in the implementation of a relevant science education. Two research questions were developed to examine this issue:

- 3) What are the dilemmas faced by teachers in the implementation of a relevant science education program?
- 4) What are the constraints faced by teachers in the implementation of a relevant science education program?

The third issue of interest was the status of teachers and students in the study sample and their perceptions of the new science curriculum and the school environment. Questions 5, 6, 7 and 8 addressed the third issue of interest.

- 5) What is the status of teachers and students in the study sample?
- 6) What are teachers' perceptions of the school environment?
- 7) What are teachers' beliefs about science teaching?
- 8) What are students' attitudes towards learning science?

The fourth and final issue of interest was the effect of social, cultural and political factors on the lives of students and teachers and these factors were discussed through question 9.

- 9) What is the influence and effect of socio-cultural and political factors on the lives of teachers and students in a transitional society like Rwanda?

The design of the research study centered on the above four issues and related research questions. The first issue in the study explored the social and political history of life in Rwanda, the development of education in Rwanda, and examined existing Ministry of Education documents. An analysis of curriculum materials looked at the stated purposes, aims and objectives of the newly developed curriculum documents. This issue was approached at the level of the system. The second research issue investigated the dilemmas and constraints faced by teachers in the delivery of a science education that is contextually relevant to the lives of students in Rwanda. The data for this issue came from teachers, administrators and from reports of the Ministry of Education. The dilemmas of implementing educational reform were constructed from accounts of four key informants, interview data, classroom observations and documentary analysis. The data from interviews and observations were used to interpret themes and patterns at the school level. The target audience for this part of the study was the community of teachers, science educators, and administrators who had contributed to the education reform process.

The third issue provided information and investigated the status of teachers and students in the study sample and their perceptions of the school environment, teacher beliefs and students' attitudes towards the existing science curriculum. The data to examine this issue came from the schools and involved quantitative and qualitative data from teachers and students and observations of science classroom lessons. The fourth and final issue investigated the social and cultural factors that influence the lives of educators, teachers and students; the data comprised vignettes written by me on social, economic and political issues affecting the daily lives of teachers and students.

1.3 The Theoretical and Conceptual Framework for the Study

During my time of living and working as an educator in four developing countries, I was aware of the intense debate about curriculum development. The revolution of science education curriculum development in Africa began in the 1960s when projects that adapted developments from British and American endeavours were being introduced in various parts of Africa (Lewin, 1993; Jegede, 1997). The debate about concerns of various intended and implemented aims of education and curriculum development in developing countries, highlighted by Lewin, also can be related to the Rwandan context. These concerns include contrasting points of view on relevance (how colonially- inherited curricula can be revised or replaced to reflect the new needs of society), on opportunity (where resources for universal enrolment for primary or secondary education are insufficient), and on resources (where human and material resources are insufficient in the country).

According to Bybee and BenZvi (1998), when a new curriculum is being implemented in any country, the curriculum must be complete, accurate and provide the appropriate resources, support for teachers, adequate material and equipment. Part of the responsibility for the full implementation of the science curriculum belongs to the curriculum developers, but the final translation of a curriculum into actual classroom practice is the responsibility of the teacher, which is an essential part of any curriculum development effort. Of necessity, teachers make decisions on unique aspects in the classroom that include students' needs, the students' conceptual levels and developmental stages, the availability of resources; these decisions are also influenced by the background of the science teacher and time available for instruction. In order to be effective implementers of curricula, teachers must understand both the science content and pedagogy; further, they should understand the new curriculum program, the expected outcomes and the assessment strategies (Bybee & Ben-Zvi, 1998)

This study describes the present Rwandan Science Curriculum reform through published material and then examines the translation of that curriculum into action in classrooms in primary and secondary schools and the teacher training college. These dimensions of the curriculum are what Print (1993) describes as the intended and implemented curriculum. The intended curriculum is primarily concerned with the official curriculum materials from policy

papers. The implemented curriculum is concerned with what actually takes place in classrooms. Ideally there is a complete match between the two aspects of the curriculum.

In the context of Rwanda, this study was an enquiry into the education system of a complex society. The decision to choose a research design depends on the considerations of the following points: the nature of the questions, the amount of control available to the researcher and the desired end product. For this research, I used a methodology with multiple research techniques that combined quantitative and qualitative methods typical of case studies (Yin, 1994).

Choice among these methods depends on circumstances within individual cases. In this case study the research is addressed in terms of likely sources of data and possible sample strategies and has a conceptual structure organised around a number of research questions. These are questions on issues revolving around the education reform process and the implementation of the new science curriculum in Rwanda. In this study, issues in Rwanda were complex and also drew links to related common disciplines of knowledge like science education, historical research and education reform. More detail about the choice of case study methodology is explained in Chapter 4.

The research design of a case study can remain flexible throughout the data collection period and these features were consistent with the goals of this research study. Yin (1994) suggested that case studies are the preferred research strategy when the investigator has little control over events and when the focus is on a contemporary phenomenon within some real life context. Yin (1994) defines a case study as an empirical enquiry that investigates a contemporary phenomenon within its real life context, when the boundaries between phenomenon and context are clearly evident, and in which multiple sources of evidence are used. Table 2 in Chapter 3 identifies the relationship between the research questions, the sources, the methods of data collection, the methods of analysis and the type of reporting.

The position adopted by Lewin (1990b) was that there is no dominant research paradigm in education and the set of epistemological, ontological and philosophical assumptions that

shape the nature of the study have to be researched. The researcher makes choices on the basis of the research questions, to select approaches and methods most likely to provide insight and explanation. For this study, I adopted a similar approach of doing research that was not limited to a single research paradigm, nor to a single set of data collecting methods located within one paradigm. As a researcher, I have used those data collection and analysis techniques that offer useful insights and have recognized the epistemological assumptions that accompany them (Lewin, 1990b).

A set of beliefs or frameworks guided my actions in the research process. The framework helped to guide and inform my enquiry and encompassed the following constructs. The moral and ethical dilemma that I had to confront in undertaking my research in Rwanda was that, although I was not Rwandese, I had worked in the country with locals as teachers and students in my school who were predominantly Rwandese. I had lived and worked in Africa for nine years, in countries neighbouring Rwanda and was aware of the education system in East Africa. My children were born in Africa and had a strong connection to the place. My democratic values also were not in harmony with those dominant in Rwanda and it was necessary to work out my position on issues of ethnicity, security, reconciliation, social structure and education policies.

Epistemologically, with respect to the relationship between the inquirer and the known, I had built up a relationship with some people in Rwanda both as a professional and as part of the community. In my school, I spent time talking to my teachers and students, one-third of whom were survivors of the genocide and/or had lost family in the war. I took part in social family functions and celebrations. I also shared in their bereavement when they lost family members to illness or war.

During the study, I developed techniques and processes in relation to the experience of collecting, analyzing and reporting data (Burgess, 1984). In this study I have used an interpretive theoretical framework that combined quantitative and qualitative approaches. I have made use of multiple research techniques, focusing on teachers' and students' perspectives. The quantitative approach focussed on selected variables such as students'

attitudes towards science, teacher beliefs and the school-learning environment. The qualitative approach was more sensitive to the context, and included interviews, classroom observations and reflective vignettes. These approaches are guided by a perspective that sees human action and institutions as social constructions created by people. This case is true of Rwanda where social, political, cultural, ethnic and gender factors have shaped the destiny of this tiny, land-locked Central African nation for the more than 50 years.

During the progress of this research, I became aware of the importance of examining social and cultural factors that might influence the implementation of a new science curriculum in a transitional society. Most importantly, examining socio-cultural factors allows more opportunities for the voice of the people involved in the research (Erickson, 1998). The data from the interviews and classroom observations were used to construct *mini-cases* or *vignettes*, using Polkingholme's (1995) narrative analysis approach, to illustrate the complexity of the change process. As a researcher, I was an integral part of the setting or context that I was trying to understand and represent. Through themes that emerged from the analysis, recommendations are proposed which address the challenges to be faced to meet the constraints in implementing a relevant science education program.

1.4 Significance and Contributions of the Study

Very few studies have examined the Rwandan educational system in Central Africa. The ones that have been carried out are World Bank reports for the purpose of continuity in financial aid. This study also pioneered the use of an instrument to examine the school level environment, student attitudes towards science, teacher beliefs and the development aspects of science education in a non-western country, where English and French are the languages of instruction, but not the students' or teachers' first languages. The study drew on multiple sources of data, such as observations, interviews, empirical data and stories, to provide an in-depth investigation of the effects of the science education reform process.

This research provides information on the status of the education reform process, and identifies the needs and key issues faced by the teachers in the education system of a transitional society, the constraints faced by teachers caught in a dilemma between the

intended and implemented curriculum. The education system in Rwanda has moved from interim during the emergency period of 1994 to 1995, to transitional from 1995 to 1998 when the new intended curriculum was implemented in schools, to an integrated one from 1998 onwards, where the new curriculum has been implemented, the examination system is being streamlined and teacher training procedures are being put in place.

The study also has three levels of significance; the first level of significance is for teachers, teacher educators and administrators in Rwanda. Classroom observations of science lessons and interview data gave insights into working practices, availability of resources, teaching methods and training procedures. The research provides teachers with an opportunity to reflect on their significant role in the implementation of a new curriculum and may help them better understand the constraints under which they work.

The second level of significance is for policy makers in Rwanda and those who have interest in educational reform and responsible for curriculum initiatives. The research is designed to provide an understanding of the perceptions, experiences and responses of all involved in the reform process. The recommendations proposed might allow those implementing science education reforms at a systemic level (the Ministry of Education, the examination board, the head teachers and the teachers) to overcome constraints they face in Rwanda.

The third level of significance is for myself as the researcher and an educator who has worked and has an interest in transitional societies. From a personal perspective, through watching teachers in the classrooms and talking to teachers, I was able to recognise the difficulties of implementing and initiating curriculum reform and understand the complexity of the change process. The issues, constraints and challenges that arose as part of the reform process may enable me to better understand the complex play of factors that affect science education in a transitional society.

The study can contribute to the knowledge about implementation of educational policies and reform in a climate of uncertainty, so as to inform educators, teachers and curriculum developers. As a result of informing authorities of outcomes, the results may be used to re-

align objectives of curriculum programs and teacher education programs to ones that are more relevant and suited to the needs of transitional societies and look at links between intended and implemented curricula.

1.6 Limitations of the Study

Although I had lived and worked in Rwanda for two years prior to the research, I was still an outsider and this fact may have affected the responses to questions during interviews or responses to questionnaire items. African culture in which the element of trust towards outsiders plays a significant part may have affected the responses. At times during interviews, I was often aware that interviewees were cautious with their responses.

Given the practical constraints of a limited time frame, I was unable to pilot test the questionnaires. However, I had used questionnaires that had been validated before in previous studies in developing countries. The questionnaire also had to be translated into French and although specific translation protocol was followed (Brislin, 1980), the meaning of certain words and phrases may have been altered. The level of comprehension and content knowledge of both teachers and students may have negatively influenced how well questionnaire items were understood. These limitations are explained in more detail in Chapter 9.

1.7 Overview of the Thesis

The design, development and findings of this study are presented in eleven chapters. The present chapter has provided the background for the study, the formulation of research issues and questions, the theoretical and conceptual framework for the study and the significance of the study. Chapter 2 provides background information on Rwanda and the context of education in Rwanda including details on the social, economic and population variables that affect life in Rwanda and the status of education and science education in Rwanda. Chapter 3 reviews literature pertinent to the present study on science education and its links to economic development, science education and the developing world, implementation of the intended curriculum, dilemmas in educational reform and examines a socio-political framework for science education.

The design of the study and details regarding its implementation are outlined in Chapter 4. Included in this chapter are descriptions of the research methods and their relation to the analysis and interpretation of data from the study. The chapter also has a description of schools, teachers and students and a description of the survey instrument used for the study. The new primary and secondary science curriculum implemented in Rwanda in 1998 was analysed for content, teaching methodology, assessment and pedagogy in Chapter 5. Chapter 6 deals with seven dilemmas faced by science teachers in Rwanda in implementing the new science curriculum. These seven dilemmas identify distinct difficulties in the implementation of a contextually relevant science education.

Chapter 7 includes a discussion of the constraints identified in the implementation of a relevant science education. Chapter 8 provides a demographic analysis of the teachers and students involved in the study and provides descriptive data on teachers and students in the study. Chapter 9 reports on the findings of teacher and student perceptions of the science curriculum and school environment. Results of the development-related functions of science, the school-level environment questionnaire, the teacher beliefs questionnaire and the test of science related attitudes also are described in this chapter. Data pertaining to the reliability and validity of the English and French versions of the survey instruments administered to students and teachers are provided.

In Chapter 10, I elaborated on my understanding of the complex social, cultural and political issues and factors in the education reform process using stories in the form of narratives, vignettes and mini-cases. The final discussion, conclusions, and limitations related to the findings are provided in Chapter 11. Also included in the final chapter are recommendations to meet the challenges and constraints in implementing a relevant science education program and the implications and contributions of the research.

CHAPTER TWO

THE CONTEXT OF EDUCATION IN RWANDA

Aiding the Rwandans to rehabilitate and reconstruct their society is a politically delicate process that requires commitment and coherence from the international community. It requires a multi-faceted, coordinated effort to not only rebuild economic but also social, educational and political institutions devastated by war and violence. (Johan Erickson, 1996, p 32)

2.0 Introduction

The present study examined the science education reform process in Rwanda and the factors that influence this process. The first section of this chapter provides a narrative historical overview of life in Rwanda before and after independence. The second section examines the various social, political, economic and cultural variables that form the current makeup of society in Rwanda and the effect of these variables on science education reform. A discussion of the constraints faced by the Ministry of Education in Rwanda since the early 1970s in the implementation of an education policy and the current goals of the Ministry of Education leads to a discussion on the issue of bilingualism in Rwanda.

The third section considers the effect of poverty in Rwanda and low developing countries, and the links between poverty and basic science. The fourth section looks at the Model of Emergency Education Response that was used in Rwanda, the related themes of the Emergency Education Program, its link to the Developmental Aspects of Science Education and the Science, Technology and Society themes of UNESCO Project 2000+ to ensure science for all by 2000 and draws links with the Ministry of Education in Rwanda's emphasis on Science and Technology.

The background provided in this chapter seeks to answer Research Question 1: What are the historical and political factors influencing educational change in Rwanda?

2.1 A Brief History of Rwanda

The first section of this chapter gives a brief historical overview of socio-political life in Rwanda. History is an attempt to make the strange familiar-to know not just what happened, but why. In retelling the past we bespeak a perspective, we expose our own values, we seek meaning – to know why, and how this came to pass (Makler, 1991).

2.1.1 Colonisation and Ethnic Division in Rwanda

The history of pre-colonial Rwanda has been passed down through oral tradition and does not give a clear indication as to when the country was first populated. Before colonisation, towards the end of the 19th century, most of Rwanda was a monarchy ruled by a king. Social stratification was based on socio-economic criteria and on the type of work favoured by members of a group. Thus the Hutus tended to be farmers, the Tutsis, cattle breeders and the Twa, hunters and potters, but these were not exclusive categories. The Tutsis were not necessarily dominant nor were the Hutus the subjects. Although pre-colonial Rwandan society was intensely stratified it was not determined by statutory identifications (William, 1995).

The Germans colonised Rwanda between 1899-1916 and after the First World War in 1916, Rwanda was assigned as a trusteeship to Belgium. The Belgians followed a policy of indirect rule favouring the Tutsis and this resulted in political and administrative monopoly in the hands of the aristocratic Tutsi overlords of the Nyiginya clan (Erikson, 1996). It was the colonisers who first used the term 'ethnic' to refer to the Hutus, Tutsis and the Twa at the beginning of this century (Sebahara, 1998). Representing the Hutus, Tutsis and Twa as ethnic groups, the colonial powers shaped their policies accordingly. Thus colonisation brought with it more uniform social relations and a precisely defined hierarchy from coloniser to Tutsi to Hutu to Twa, each successive rung enjoying privileges denied to those of the level below.

The colonisers also established a system of strict ethnic classification backed by compulsory identity cards specifying the holders ethnic group. These compulsory identity cards were introduced in 1933. From then on, all Rwandese had to relate to their respective ethnic group. Thus under European colonisation, a politically motivated policy of ethnic identities was created (Erickson, 1996). It became increasingly difficult for the Rwandese to alter one's social status or ethnic grouping. These cards stating the ethnic origin had still not been abolished by the post-colonial powers until 1994 and they were to play an important part in identifying the victims of the genocide. Thus by the time of decolonisation, at least 50 years of ethnic classification had created an atmosphere of division which was to form the basis of instability in the post-colonial era (Sebahara, 1998).

At the end of the 1950s there was sudden shift, in the trend towards decolonisation, the Belgian trusteeship powers decided to give up their support of the Tutsi monarchy and Tutsis and support the rising Hutu leadership leading to the uprising of 1959. General elections were held in 1961, the monarchy was abolished and a presidential system was introduced and independence from the colonisers in 1962. Independence was followed by heightened ethnic tensions between Hutus and Tutsis causing flows of Tutsi refugees from Rwanda to Uganda, Burundi, Tanzania and the Democratic Republic of Congo (Percival & Homer-Dixon, 1995).

Political power remained in the hands of the Hutus until 1994. Many refugees from 1960s and 1970s were categorically refused entry back into Rwanda during 1962 and 1994. In 1994, ethnic difference was considered an accepted fact in Rwanda especially at the level of official policy. Nevertheless, in everyday life Hutus and Tutsis spoke to each other, they lived as neighbours, mixed marriages existed and they were thousand of children born of these mixed marriages (Uvin, 1996).

2.1.2 The Land of a Thousand Hills

The next three pages are paraphrased from 'Land of a Thousand Hills: My Life in Rwanda' by *Rosamond Halsey Carr* and *Ann Howard Halsey*, published in September 1999. When Rosamond Halsey Carr, an American, arrived in Africa in 1949 as a young woman, she did not know that she would spend the rest of her days in Rwanda. She witnessed half a century of political violence, the decline and fall of

colonialism, wars fought for the independence of African states and constant conflicts between the Hutus and the Tutsis. Finally, after having been caught up in the maelstrom of the 1994 genocide, Rosamond Carr returned to her destroyed home in Rwanda and transformed her plantation into an orphanage for more than 200 children. Her book gives a poignant memoir and an accurate portrayal of life in Rwanda.

Rwanda, a small landlocked country in Central Africa, is called the land of a thousand hills or in French Mille Collines. Rwanda lies just south of the equator at the height of five thousand feet and enjoys a cool climate most of the year and is bound on the west by Zaire, on the south by Burundi, on the east by Tanzania and on the north by Uganda. The southern region is scattered with lakes and dense forests, to the east are the Akagera national park and the Akagera River. The northern region is dominated by the lofty peaks of the Virunga volcanoes, encompasses some of the most fertile land in all of Africa and is home to the world-renowned mountain gorillas.

Rwanda in 1949 was a land of beauty endowed by nature: a wilderness where people and animals lived in harmony untouched by the outside world and its landscape was a tapestry of a thousand peaks and valleys. Shepherds led their cattle to drink at lakes, elephants began to migrate towards the watering holes to drink and bathe. Time was told by the sun and the moon was the calendar. A house could be built in a few days made from trees and bamboo gathered from the forests and roofed with grass. The markets were social places and trading centres where barter was common. The southern region of Rwanda is scattered with numerous lakes and dense forests. In 1950, there were coffee and tea plantations in Rwanda and groves of orange, lime and grapefruit trees grew next to coffee plantations. The steep hills were terraced with crops; the valleys were pastures for long horned cattle of the Tutsis. Bougainvillea and climbing roses grew in abundance and banana groves flourished on countless small fertile farms. (See Appendix A for a photograph of the hills of Rwanda.)

Rwanda's three ethnic groups - the Tutsi, Hutu and Batwa - were easily noticeable by their physical characteristics, their mode of dress and their station in society. The Hutu whose name translate to mean cultivators are of

the Bantu stock and make up approximately eighty-five percent of the population. The Tutsi are the tribe of the feudal kings of Rwanda and make up twelve percent of the population. They are a tall nomadic people who are traditionally cattle herders and warriors. The remaining two percent are the Twa pygmies who are hunters and potters and collectively they are known as Banyarwanda - the people of Rwanda.

Following World War I, Rwanda was assigned to Belgium as a trusteeship by the League of Nations. The Belgians and the Tutsi ruled side by side until the Hutu rebellion of 1959, when the Tutsi monarchy was abolished. Vast numbers of Tutsi fled to neighbouring countries, setting the stage for ethnic enmity in the decades to follow. The hillsides were scattered with the burnt remains of Tutsi homes. The destruction was massive: blackened hillsides, with most of the crops destroyed. The Hutu by their sheer numbers had dismantled the feudal monarchy in Rwanda and were faced with the prospect of creating a new government, but most of the Hutus were lacking in skills, experience and education necessary to lead a country.

Rwanda was declared a republic in January 1961 and became an independent country in mid 1962. In 1973, a Hutu by the name of Juvenile Habyarimana came to power in a bloodless coup and was to rule Rwanda until he was assassinated in 1994. Throughout his twenty-one year presidency the majority of the population enthusiastically supported him. Reforestation projects, preservation of national parks and wildlife conservation became a national priority. This peace was not to last, in the late 1980s decreasing coffee prices created a sharp economic decline in Rwanda as coffee is Rwanda's main export. By 1990, the government had devalued the Rwandan franc by more than 60 percent and imposed a 10 percent sales tax on goods and services.

The 1980s brought the AIDS epidemic to Rwanda. The exceptionally high rate of AIDS infection throughout Central Africa has been spread predominantly through heterosexual contact and unsterile medical practices. The percentage of population HIV positive grew significantly and men, women and children were dying at an alarming rate throughout the country.

October 1990 was to be the start of a three-year civil war between the Rwandan army and the Ugandan backed English speaking Tutsi rebels. Three years of civil war left 6500 Rwandans dead and displaced more than a million people. The war caused massive destruction of the national parks and wild life was slaughtered. The natural habitat of the mountain gorillas was destroyed and the veterinary research centres in the volcanic mountains were destroyed. Farmers from Rwanda's most fertile region were forced to abandon their fields causing a severe food shortage and mass starvation. Squalid displacement camps sprang up where refugees lived off emergency supplies and stripped the forests for shelter and firewood. The displaced, wounded and families who had lost loved ones were filled with bitterness at the devastation to their country, their homes and the insecurity of their situation.

On April 6, 1994, a plane carrying President Habyarimana was shot as it descended into the capital Kigali. With the assassination of the President the country dissolved into a state of anarchy and terror. Extremists Hutu militia groups using guns, machetes, axes slaughtered Tutsis and moderate Hutus. Within two weeks there were food shortages, drinking water became scarce, sanitary facilities were non-existent, power supplies cut, chaos reigned and the air was thick from burned out villages and the stench of corpses. Within two months, two million Rwandans had left their homes for refugee camps both in and outside Rwanda. Tutsis fled in fear of their lives and Hutu fled in fear of retaliation. On the July 4, 1994 the Tutsi rebels gained power in Rwanda. This caused the greatest mass flight of people in modern times. Two million Hutu fled across the borders into Burundi, Tanzania and Zaire within a few days. The vast majority of those that fled were innocent of any wrongdoing. (See Appendix B for a chronology of key events in Rwanda.)

Today Rwanda is a country struggling to reconcile its traditional way of life with a new Africa at the dawn of the 21st century. Much has still remained the same in Rwanda. Many villages still have no electricity or telephone. Food is still prepared on a wood-burning stove or with charcoal in many homes. The only light in the evening is candlelight and kerosene lanterns. The chairs are African-made, laced with hide strips. Straw mats and animal skin rugs cover the floors. It is a land of immense pain and hope, beautiful people and endowed by nature.

2.2 Background Variables to the Study on Rwanda

Following the above brief history of Rwanda from 1949, this section deals with the background variables that have impacted on Rwanda before and after the genocide. Rwanda is one of the world's poorest countries and being landlocked (see figure 1) Rwanda's economy is directly dependent on its neighbours. After the horrific genocide of April 1994, the country is currently faced with two major challenges - ensuring recovery, rehabilitation and reconciliation after the genocide of 1994, and overcoming the problems associated with poverty and the massive need for sustainable development. A chronically poor country before the genocide, the events of 1994 led to a catastrophic rise in poverty with 70% of the households below the poverty line in 1997 (UNDP, 1999).

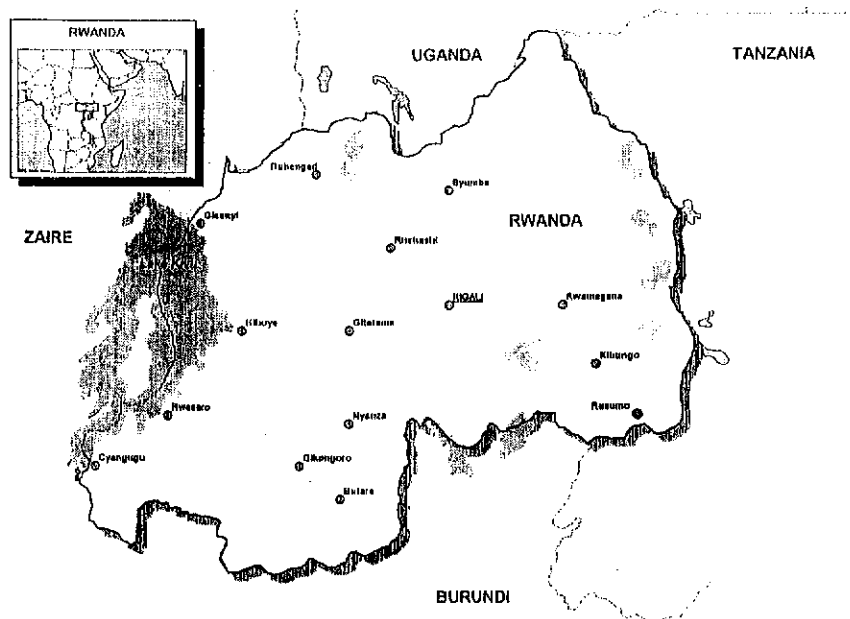


Figure 1: Map of Rwanda and its neighbours

2.2.1 Political Divisions and the Way of Life

Rwanda is divided into twelve prefectures, each of which is administered by a prefect or mayor who is appointed by the president (Ministry of Education, 1997a). The prefectures are further divided into sub-prefectures that are divided into communes. Communes are further divided into secteurs, which in turn are divided into cells. For most administrative matters, sub-prefectures are rarely noticed and only prefectures and communes are considered. There is an Inspectorate of the Ministry of Education in each prefecture.

The principal cities in Rwanda are Kigali, the capital, and Butare, the city which has the only university in Rwanda, the National University of Rwanda. Most Rwandans live in round grass huts in farms scattered over the country's many hills. The Rwandan diet consists mainly of raw bananas, sweet potatoes, beans, peas, millet and fruit (UNICEF, 1996). Beer and milk are important beverages. However, meat is in short supply and is unaffordable by the majority of the population; thus protein deficiency and malnutrition is a serious problem among children and women (UNICEF, 1999a). Central to society in Rwanda is family life but this has been affected by the civil war, the genocide, and subsequent economic and political factors (Phillips, 1996).

2.2.2 Population and Ethnicity

The war and genocide in 1994 killed as many as 800,000 people and almost half of a population of 7.7 million people was displaced. More than two million refugees fled into neighbouring countries and one million become internally displaced (Phillips, 1996). This enforced movement of people paralysed the country's socio-economic infrastructure and disrupted cultural values; as such, nearly 53% of the population is illiterate and 11% of the rural population and 12% of the urban population over 12 years of age is estimated to be HIV positive. The secondary school enrolment rate is 20% of the primary school students, which accounts for only 3.8% of the population, being the lowest in Africa (Phillips, 1996).

The population of Rwanda is 94% rural and comprises three ethnic groups: the Hutu (85%), the Tutsi (12%), the Twa (2%). The official languages are Kinyarwanda (a Bantu language) and French. English also is recognised and widely spoken after the genocide as many of the refugee returnees from Uganda, Kenya, Tanzania, South Africa and the developed world spoke English. A variety of worship forms are pursued with Christianity accounting for 75%, Islam 9% and traditional worship forms being practiced by 17% of the population (Phillips, 1996).

In Rwanda, the Ministry of Education and the Ministry of Reconciliation have implemented plans to ensure that both the ethnic majority (Hutu) and ethnic minorities (Tutsis and Twa) are involved in the reform process (Ministry of Education, 1998b). Within this context, education is expected to play an important

role in social reconciliation, reconstruction and economic development. A broad goal is to integrate people who have many different histories, stories and traumatic experiences.

2.2.3 Gender

Women constitute 54% of the total population in Rwanda and 34% of the households, which are among the poorest, are female-headed. Many of the women are genocide survivors, struggling with multiple burdens of being breadwinners, dealing with death and 30% have been victims of sexual abuse (Reindrop, 1998). In the Rwandan Government, fewer than 10% of ministers are women and nearly all these positions are urban; consequently, female government representation at the community level is almost non-existent. Nevertheless, the government, with the help of the United Nations and non-governmental organisations, is ensuring that women are fully involved in the development process by increasing measures to support education and training. Women also are being enskilled through income-generating and capacity building activities by being given small loans for pursuing agricultural activities, poultry farming and animal husbandry (Phillips, 1996).

2.2.4 Overview of Social Indicators

There has been deterioration in Rwanda's social indicators since the war. The genocide subjected people to systematic terror, fear and mistrust so that links and relationships of mutual interdependence between families and households, that historically acted as safety nets, have been shattered (Phillips, 1996). The civil war and culminating genocide of 1994 greatly disrupted the ethnic and geographic distribution of the population and caused massive numbers of deaths. The genocide contributed to a dramatic increase in poverty, the proportion of households below the poverty line rose from 53% in 1993 to an estimated 70% in 1997; since then the country has been slowly recovering and the 1999 estimate has been 65% still living in poverty. Health indicators are poor and there are exceptionally low levels of secondary and tertiary enrolment. The school dropout rate is 16.8% (IMF, 2001).

The deterioration in health indicators is mainly due to the high level of malnutrition, the prevalence of malaria and AIDS. Rwanda has a high rate of population growth at 2.9% per annum and is one of the most densely populated countries in Africa; 49%

of the population of Rwanda is below the age of 15 years (International Monetary Fund, 2001). Notwithstanding these data, most social indicators show that Rwanda compares favourably with the Sub-Saharan Africa (SSA) average literacy rate, gross primary enrolment, access to safe water and sanitation.

The life expectancy and infant mortality rates are somewhat less favourable, partly due to the high level of malnutrition and the high cost of healthcare (see Table 1). The low-income levels of the population aggravate the common person's accessibility to social services, especially in the rural areas, and there are also wide disparities in the provision of social infrastructure across regions in the country (International Monetary Fund, 2001).

Table 1: Social Indicators comparing Rwanda and Sub-Saharan Africa (SSA) (International Monetary Fund, 2001).

Social sector comparisons	Rwanda	SSA average
Life expectancy at birth (years)	49	51
Literacy, % of population aged 15+	48	43
Combined first-second-third level enrolment ratio (%)	43	44
Gross primary enrolment (1996/97) %	80	75
Access to safe water (% of population)	66	45
Access to sanitation (% of population)	86	37
Infant mortality rate (per 1,000 live births)	131	91

2.2.5 Legacy of the Genocide

The demographic structure of the whole population of Rwanda changed as a result of the genocide resulting in a severe shortage of adult males, a high proportion of orphans, and 21% households being headed by female widows. There are 65,000 child-headed households in Rwanda today and 130,000 people are in prison awaiting trial for genocide related crimes (International Monetary Fund, 2001). The experience of violence has traumatised a high proportion of children with 96% of children having witnessed violence and 80% having witnessed death (International Monetary Fund, 2001).

2.3 The Ministry of Education in Rwanda

A brief history of the Ministry of Education in Rwanda and the existing system of education are the focus of this section. There have been three major education projects in Rwanda since the mid 1970s. The first project dealing with general education and increasing access to primary schooling in Rwanda was implemented in 1977 and completed in 1983; the second project approved in 1982, supported secondary education. The third project, approved in 1986, included assistance for improving the quality of primary and post-primary education and management capacity of each of these education sectors. (See Appendix C for secondary and tertiary enrolments 1980-1987.)

At the completing of the third education project, in December 1991, research showed that the length of primary education, the excessive vocational orientation of the seventh and eight year of primary and lower secondary were problematic in terms of cost-effectiveness and relevance (World Bank, 2000). By the end of 1991, just before the start of the civil war, primary enrolment rates had reached 62% but the number of qualified teachers, the provision of textbooks, and the length of class time remained low. Explosive population growth in the 1990s necessitated building schools to accommodate the fast growing school-aged population, which diverted resources from teacher training, procurement of classroom material and the quality of the education imparted (Ministry of Education, 1998a).

The modern Rwandese education system has been subjected to many reforms since its birth in 1908, but the original conception of the system has not changed. The education system is selective, distinguishing between education for trades, which consists of preparing the majority of the people to play their role in a traditional society, and the training and development of an educated elite capable of supervising the rest of the population. This distinction has often contributed to an image of the Rwandese school that education was a matter of dichotomy between the masses and the elite. The recent restructuring of the education service, with increased enrolments at the primary level as well as at the secondary level, is a fundamental and timely action to increase access to education (Ministry of Education, 1997a).

Primary education lasts six years. Education in the first three years is devoted to reading, writing, learning languages and basic mathematics; the next three years are for general or basic education and culminate in a national examination at the end of Year six when students are 12 or 13 years old. Secondary education also lasts six years. Education in the first three years of secondary education constitutes the orientation cycle or common core (*tronc commun*), which aims to reinforce general knowledge, as well as to develop forms and methods of working and thinking. The second three years of secondary education are made up of streams that are divided into general education, teacher training, and technical and vocational education. General education consists of two streams—scientific (Mathematics, Physics and Biology) and literary (Arts and Humanities). Teacher training consists of primary, technical and artistic teacher education. Technical and vocational education is composed of a dozen sections which include agricultural subjects, nursing and para-medical subjects, economics, commerce, accounting and secretarial studies (Ministry of Education, 1997f).

The devastating situation after the genocide and the complex political and security situation of the post-conflict situation caused a complete close down of the infrastructure in the country and all schools, hospitals and industry ceased to function. The immediate education aim was to rehabilitate the schools and allow students to return to schools, which often were the only safe places in many communities. While the war caused destruction of infrastructure and resources and displaced personnel, there was an overwhelming commitment to restoring access in a post-conflict situation (World Bank, 2000). The transitional Government of National Unity, sworn in, in July 1994, decided to reopen all primary and secondary schools by January 1995 as a means of healing and reconciliation after the genocide. Subsequently, a post-conflict emergency education program was implemented (Ministry of Education, 1997a). (See Appendix D for damaged literacy centres.)

The main objective of the government in Rwanda has been to expand access to and improve the quality of primary education and to attempt to improve access and equity among all prefectures in Rwanda. Although the government has tried to improve the quality of education, this has proved a difficult task; only 22% of the student population completes primary education, about 40% of the teachers are

qualified and have been provided with teaching material (International Monetary Fund, 2001). There are insufficient books and resources for the students in the whole country. Trends from statistical data for the period 1992-1997 showed that the proportion of qualified teachers fell from 57% to 32.5%. Illiteracy rates have continued to rise in Rwanda and estimates in 1997 reached 48% of the population (International Monetary Fund, 2001; World Bank, 2000). (See Appendix E for statistical data on school enrolments 1990-1997.)

The current government in Rwanda regards science as a national project for the achievement of national development. Education is the only factor that is likely to support the sustained modernization and diversification of systems of production in this land-locked country (United Nations Development Programme, 1999). A new curriculum implemented in 1998 was designed to ensure universal primary education and improve science and technology in an environment severely constrained by financial, human and material resources. These constraints are further exacerbated by the fact that during 1996 and 1997 the government has drastically reduced funding to government schools, resulting in further difficulties for schools, teachers and students (Ministry of Education, 1998a). (See Appendix F for Education Performance Indicators.)

Rwanda now has adopted five national goals - eradication of illiteracy, universal primary education, teacher training, national capacity building in science and technology, and improving the teaching of mathematics and sciences (Ministry of Education, 1998). Thus the government in Rwanda has reinforced the awareness that education is no longer a matter of dichotomy between the masses and the elite but that the acquisition of knowledge by the majority provides opportunities to improve their life (Ministry of Education, 1997a).

2.4 Bilingualism in the Rwandan Curriculum

Rwanda is fortunate to have only one local language, Kinyarwanda. However, as the country is otherwise split between French and English for conducting business, it is imperative that the curriculum policy clearly articulates the mandatory inclusion of French and English, in addition to Kinyarwanda, in the curriculum from pre-school

to higher education. The Curriculum Development Centre mandated that bilingualism is introduced at all levels of education for many practical reasons, the main being to cater for the future needs and challenges of all Rwandan citizens while creating and enhancing linkages regionally and internationally. In present day Rwanda, returnee children have come back with their parents from a variety of backgrounds and countries and can communicate in two to three languages (Ministry of Education, 2000a).

Kaplan and Baldauf (1997) define bilingualism as an individual phenomenon where a single person immersed simultaneously in two or more language communities. A bilingual person may be fluent in two languages but tend to heavily favour one of them or be less fluent in the other. Thus bilingualism can be defined as the ability to speak, understand, read and write in two languages at a level where exchange of communication is permitted, sequential or simultaneous. Bilingualism is advantageous to children who can function effectively in two cultures; in so doing, these children have a wider and varied range of experiences enabling them to acquire an extended range of meaning, values and modes of thinking. Bilingual children also are richer in their thinking (Baker, 2001).

The rationale for language acquisition can be organised under three main areas: ideological, international and individual (Baker, 2001). The ideological rationale, especially in the case of Rwanda, is that the learning of second languages continues along side the survival of small and minority languages. The availability of second language instruction thus attempts to preserve and maintain the existence of these languages. In the Rwandan context, there was need for harmony, unity and reconciliation among the population. The government of Rwanda also accepted the fact that there are languages, which are the *lingua franca* of the social, political, economic and educational world, such as English and French, which are considered by the United Nations as major languages. As a result, countries with a population that have facilities in these languages seem to welcome economic activity as well as new knowledge, skills and understanding. For individual reasons, acquiring a language will permit a person to understand other peoples' cultural background. Culture and language are also inseparable; losing one's language can cause loss of

cultural identity and history. Thus culture and language cannot be separated and are inter-related (Jiang, 2000).

The inter-agency collaboration of UNICEF and UNESCO immediately after the genocide in 1994 initiated work on the translation and adaptation of the Teacher Emergency Package teacher's guide and other educational material into Kinyarwanda. Specific teaching packages of the emergency themes were integrated into the basic literacy and numeracy core of the Teacher Emergency Pack (Aguilar & Retamal, 1998) and these themes were also translated into Kinyarwanda. Most children in Rwanda are multilingual as they speak Kinyarwanda at home, learn French and English in school, as well as speak Kiswahili that is locally spoken in most parts of East and Central Africa.

2.5 The Relationship between Poverty and Development

On a daily basis, poverty seriously affects the quality of life of millions of people in developing and low developing countries, mainly in Latin America, Africa and Asia (UNDP, 1999). The United Nations Development Program defines poverty as not having sufficient resources to ensure a minimum, nutritionally adequate diet or to obtain essential non-food items. These resources may include the economic resources of land, labour, capital and enterprise. The World Bank supports the definition and provides strong images of poverty: "Poverty is hunger. Poverty is lack of shelter. Poverty is being sick and not being able to see a doctor. Poverty is not being able to go to a school. Poverty is powerlessness, lack of representation and freedom" (World Bank, 2001 p. 4). All these images of poverty are related to food, shelter, environment, health, education and lack of social access and can be linked to basic science education.

At a national level, poverty can cause political instability and civil unrest that can have regional and global implications. In developing countries in the past 10 years, food production has increased by more than 20%; in the past 20 years, the combined primary and secondary school enrolment of girls has increased from 38 % to 68 %; in the past 30 years, the infant mortality rate has been more than halved from 149 per thousand live births to 65 per thousand live births and population with access to safe

water has almost doubled from 36 % to 70%. Although all indicators show increase in food production, education enrolment, access to water and sanitation and lowering of infant mortality, poverty is on the rise in most of the developing world and the link between poverty and development is indeed a complex one (World Bank, 2000).

2.4.1 Poverty in Rwanda

Poverty is a chronic, structural problem for Rwanda but war, genocide and displacement have contributed to the deepening poverty experienced by even more Rwandans (International Monetary Fund, 2001). Poverty serves as one of the primary contributors to the inequitable social distribution of knowledge and the inequitable access to knowledge in many countries in the developing transitional world and especially in Rwanda. As one of the world's poorest countries, Rwanda has an inherited legacy of inequalities, unequal development, distribution and access to education and educational resources (Reindrop, 1998).

According to the International Monetary Fund (2001), Rwanda today faces a major environmental, food and shelter challenge due to its increasing population. Some parts of the country are plagued by persistent droughts and water supply in general is a particularly acute problem in most parts of Rwanda. Water resources need to be conserved and better managed, the soil fertility rate has been declining sharply in the last decade, soil erosion is progressing rapidly, there has been extensive deforestation due to war coupled with increased use of wood as fuel, marshlands are under severe pressure to be reclaimed as farmland or development projects. Insurgency and insecurity in some parts of the country combined with the influx of returning refugees makes shelter a major problem, with 25,000 households in 1998 living under plastic sheets and others in damaged or illegally occupied houses (International Monetary Fund, 2001). (See Appendix G for the international development targets for Rwanda.)

In 1997, the Human Development report of the World Bank had only one other African country ranked lower than Rwanda in terms of human development. Among the poorest in Rwanda are those households that lack arable land of less than 0.2 ha per household and will thus be unable to meet their minimum household needs, and those who have reduced access to gainful employment. Post-genocide, the

households most likely to fit the profile are female and child-headed households. For the estimated 65 000 child-headed households many endure poverty, neglect and abuse and lack access to food, water, sanitation and education (Reindrop, 1998).

2.4.2 Inequality between the Sexes and Poverty

Peculiar to Rwanda is genocide-related poverty. Various studies conducted on poverty in Rwanda (e.g., World Bank, Poverty Note on Rwanda, 1998) show that the social groups that are most affected by poverty are women-headed households, child-headed households, prisoner-headed households, unemployed and unskilled youth, seasonal/casual labourers, the elderly, the disabled, and segments of the urban population. Poverty is largely a rural phenomenon where the groups that are most affected by poverty are especially those headed by widows. Urban poverty is also on the increase, as large numbers of people migrate to the city. Many of these women are genocide survivors struggling with multiple burdens of being the major breadwinners, fostering orphan children and dealing with the trauma of bereavement or sexual abuse (Reindrop, 1998).

Inequality and discrimination between men and women in Rwanda has increased women's vulnerability to the consequences of poverty. Women in Rwanda do two-thirds of household agricultural work as well as having responsibility for preparing food, collecting water and wood. Yet, despite being the principal cultivators in small land holdings, women have no rights to the land that they cultivate. In most societies, women are more likely to be poorer than men, primarily as a result of the huge roles they play in the lives of their family and community. Women in Rwanda have been marginalised in terms of access to education, extension and other technical services. Recently, the government has committed itself to eliminating discrimination and has introduced measures to increase and support education, training and access to justice (Reindrop, 1998).

In 1997, the Rwandan Government established a Victims of Genocide fund aimed at helping widows, orphans, unaccompanied minors, sexually abused women and the elderly (IMF, 2001). This fund helps the target groups in building sustainable livelihoods through education fees, healthcare, social rehabilitation, housing and income generating projects. Poverty can be alleviated when all people are working

equitably and to their maximum potential. Experience shows that rising female literacy rates lead to rising female health and well-being (UNICEF, 2001). A woman or female child who can read can learn more easily. As a better learner, she can gain knowledge to better care for herself and her family. Investing in literacy means empowering the individual woman or girl who attends literacy classes as well as helping society redress a legacy of inequality between women and men (UNICEF, 2001)

In short, people have a far greater chance of working their way out of poverty if they eat well, are of good health, are educated ideally beyond primary school level, live in a community with adequate basic services such as safe water, and live under a fair and stable government (IMF, 2001). Improvements in health, education, infrastructure, agriculture and government are the keys to helping people emerge from poverty. Food production, infant mortality, health and water are linked to basic science education (UNICEF, 2001). (See Appendix H for Student Enrolment Rates by Gender.) In chapter 11, I have tried to address the challenges to science education by suggesting some recommendations that may help a transitional society like Rwanda.

2.6 The UNESCO Model for Emergency Education in Rwanda

Ongoing political and economic instability impede access to regular education for a large number of war-affected children and the UNICEF, UNESCO and UNHCR organizations try to address the problem of access to education and health of the displaced and refugee population so as to bring some semblance of normalcy to their lives. For UNESCO, an educational emergency is a crisis situation created by conflicts or disasters which have destabilized, disorganized or destroyed the education system, and which require an integrated process of crisis and post crisis response (UNESCO, 1998). For UNICEF, emergencies include natural disasters like floods and drought, human-made crises such as civil-strife and war and silent emergencies like extreme poverty, HIV/AIDS (Pigozzi, 1999).

In July 1994, inside Rwanda and within the refugee camps, the UNICEF and UNESCO set-up a rapid educational response. The strongest reasons for supporting

organized activities, such as education early in an emergency situation, are to lessen the psychosocial impact of trauma and displacement and to protect at-risk groups. The disruption and insecurity inherent in refugee and crisis situations were existent in Rwanda due to the civil war and the genocide can harm children's physical, social, cultural and intellectual development. A UNICEF survey in 1996 of Rwandan children showed that a very high percentage of the sample had witnessed someone being killed or injured during the 1994 genocide (Sinclair, 1998, 1999, 2000).

As soon as a food distribution system is in place in a refugee camp or is available to the displaced population, an integral part of emergency response is the introduction of education for promoting the recovery and the well being of children and adolescents who have suffered losses, displacement and other horrific experiences (UNHCR, 1997). Rille (1995) describes Rwandan refugee children in Goma sitting on hard volcanic rocks in front of refugee teachers with neither teacher nor student having any materials, not even slates, chalk or blackboards. Such images encapsulate the rationale for education as a humanitarian and peace-building response. The UNICEF and UNESCO response in Rwanda included support for the rapid restoration of schooling as a means to educate children, as well as training teachers to understand the effects of trauma (Aguilar & Richmond, 1998).

A Teacher Emergency Package (TEP), developed in Somalia in 1993, was introduced in refugee camps in countries bordering Rwanda such as those in Tanzania, which permitted the re-establishment of schooling in October 1994 with 58,000 Rwandan students in 40 refugee schools by March 1995 (Aguilar & Richmond, 1998). A distinguishing feature of the TEP is the inclusion of a teacher's guide and other printed material such as cloth wall charts and small wooden cubes. Where possible, the TEP also includes and is accompanied by supplementary survival messages or the emergency education themes (Aguilar & Retamal, 1998). (See Appendix I for pictures of the TEP in action in Rwanda.)

The emphasis in the TEP approach for Rwanda on introductory literacy and numeracy meant that the package was only appropriate for lower primary classes. Because there were a considerable number of displaced students who were attending upper primary classes, the TEP alone was not adequate to address the educational

needs of all the refugee student population. The Teacher Emergency Pack is also called a 'School-in-a-box' according to the UNICEF-USA report (1999b):

It is estimated that over half the world's refugees are children. With just a box and a bag of materials, the teacher and children can set up a simple classroom almost anywhere. (p. 1)

UNICEF, in collaboration with UNESCO, was reaching teachers in Rwanda and children in the refugee and displaced people camps by delivering the 'School-in-a-box' or TEP to them. These TEPs are designed to bring teaching supplies to places where there are no schools. Each TEP is a big blue tin trunk with a cloth sack and contains basic things needed to create a simple classroom. The basic things included activity guides, slates and chalk, blackboard paint, pencils and erasers, exercise books, storybooks, record and attendance books and small games. A feature of the TEP approach has been the provision of at least two days initial training for teachers from the refugee and displaced people camps on the use of the teacher's guide and the TEP material (Sinclair, 2001).

With one TEP and the initial training provided, a teacher can hold classes for about 80 children a day. A detailed plan for the teacher is included with a simple emergency curriculum (UNICEF, 1999a, p.2). Around the basic core of literacy, numeracy and recreation subjects are the emergency education or supplementary survival themes which link the cause that creates the crisis and the effect of the crisis. These themes often are crucial to heighten awareness among affected populations, especially children and youth who have been victims of armed conflict (Aguilar & Retamal, 1998).

The first phase of the UNESCO and UNHCR education program in Rwanda was aimed at re-building and re-opening severely damaged schools and establishing school routines as well as re-integrating teachers and students. A major problem is a lack of teachers because about one-third of the teacher population had been killed in the genocide and many had also fled the country. The next phase of the education program, focused on normalising of the education system by establishing educational administrative structures with the ministry and the prefectures in Rwanda. Within

this phase a cascade approach that uses the skills and training of a few trained teachers to train other colleagues and teachers was established (Aguilar & Retamal, 1998).

Throughout the 1990s there has been a growing awareness of the need to convey information to crisis-affected communities in transitional societies throughout the world such as Somalia, Afghanistan, Bosnia and Rwanda, on themes relevant to health issues like cholera and polio awareness, sexually transmitted diseases, HIV/AIDS, acute respiratory infections, water and sanitation and issues related to landmines. Cholera and water-borne diseases are the main killers in crisis situations of refugees and displaced people (Aguilar & Retamal, 1998). The legacy of landmines remains long after the war has ended and landmines do not discriminate between soldier, farmer, women and child. These themes should enable all individuals, including children, and the communities to gain an awareness of their environment and society and thus acquire the knowledge and skills that will enable them to act collectively to solve their environmental, health and sanitation problems.

Each of the themes highlighted below in Figure 2 has links to science education, especially the development-related aspects of science education and together they have an impact on the daily lives of the people of Rwanda. The developmental aspects of science education help provide knowledge and skills adapted to societal needs. These developmental aspects and emergency themes have the potential to promote critical thinking abilities and sense of civic responsibility and motivate students towards scientific and technological studies and careers (UNESCO, 2001).

Through the emergency education themes, it is possible for teachers and students at both primary and secondary levels to discuss issues that affect Rwandan society and to talk about conflict resolution, reconciliation and peaceful co-existence. Issues and applications such as nutrition, health, water and sanitation and healthy living are used to motivate students to learn science and to think scientifically. The content of the emergency education themes constitute the foundation for developing knowledge about extreme situations that exist in refugee and displace populations. The various emergency education themes shown in Figure 2 have been incorporated into the new curriculum implemented in schools in Rwanda (Ministry of Education, Curriculum

documents, 1997b to 1997f) and these have been discussed in more detail in Chapter 5.

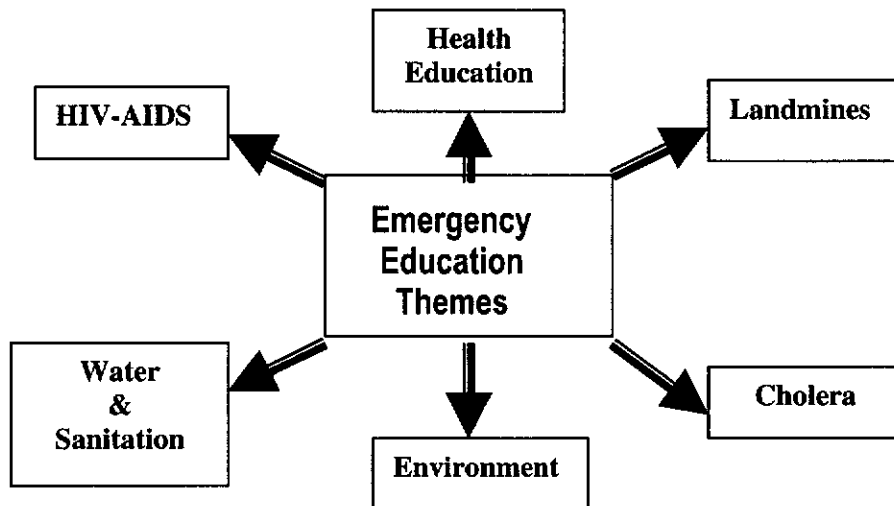


Figure 2: Emergency Education Themes (modified from Aguilar & Retamal, 1998, p. 34)

On a global scale, in 1990 at the United Nations World Conference in Thailand, there was unanimous agreement for the adoption of the World Declaration on Education for all, to address globally the basic learning needs of all children, youth and adults. In the 1980s, various initiatives began to change the goals of science education to make them more aligned with the individual needs of each country and the needs of the society in those countries. Over the past decade, UNESCO has promoted and developed Science and Technology Education (STE) as well as Technical and Vocational Education and Training (TVET). Project 2000+ was launched in 1993 and is the main channel through which the UNESCO programs relating to scientific and technological literacy are developed. (A note about Project 2000+ has been included in Appendix J.)

2.7 Summary of Chapter 2

In response to the first research question that identifies the historical and political factors affecting life in Rwanda, the discussion in this chapter has examined the factors impacting education reform. The first section of the review gave a background to the complex interplay of variables in Rwanda, the social indicators currently existent in the country, and provided the context for the study. The second section examined the role of the Ministry of Education in Rwanda and took into

account the various education projects implemented in Rwanda including the goal of bilingualism.

The third section focused on poverty and its effect on development in the Rwandan context and acknowledged that women and orphaned children in Rwanda are the major victims of poverty that has become chronic and endemic after the genocide. The fourth section of Chapter 2 described the Emergency Education Program introduced in Rwanda in the refugee and displaced persons camps by UNICEF, UNESCO and UNHCR. The Teacher Emergency Pack and the generative themes are discussed in this section. The chapter has addressed Research Question 1. The next chapter reviews the background literature pertaining to the study.

CHAPTER THREE

LITERATURE REVIEW

The challenge of curriculum reform in the developing world, and especially in Africa, lies in improving the quality of education in mathematics, sciences and technology and incorporating the potential development-related functions of science education in rapidly evolving transitional societies. Such reform will involve changes from enhancing rural subsistence-based activities, to equipping young people with a skill base applicable to modern and industrial technological contexts and the development of skills conducive to environmental preservation, combating of disease and self-employment. (Vlaardingerbroek, 1998)

3.0 Introduction

This chapter aims to review and critique literature relevant to the present study. Specifically, this chapter sets out to provide the background for answering the research questions related to science education in Rwanda. The first section reviews literature pertaining to the development of science and technology in Africa, leading to a discussion on the development-related functions of science education and the link between science education, economic development and national development. The second section deals with the issues relating to curriculum reform in the developing world, the issues in the effective implementation of the intended curriculum and the constraints/dilemmas/tensions encountered in educational reform and use of multiple perspectives to analyse curriculum implementation. The third section looks at a socio-cultural framework of curriculum reform and the contemporary notion of science for all. The final section of the chapter discusses the psychological constructs and related instruments used in the study. The chapter concludes with a summary.

3.1 Science Education for Development

3.1.1 Science Education Reform in Africa

The decline and fall of colonialism in Africa, the emergence of the new and struggling African states has had a profound impact on the lives of the common people (Carr & Halsey, 1999). Subsequently, since their independence in the late 1950s and 1960s, most African states have become acutely aware of the importance of science education as a means to scientific and technological development. Within the continent, the two major declarations adopted by the African heads of state and government were the Lagos Plan of Action (1980) and the African Priority Program for Economic Recovery (1986). Both of these declarations in the 1980s have called for sustainable development based on self-reliance in science and technology applications (Husen, 1983).

Like other developing regions of the world, Africa has been eager to develop its scientific and technological power and to attain a measure of self-reliance in the production of goods and services. This goal was evident from the resolutions, from workshops on science and technology sponsored in the past three decades by African governments and professional bodies (Oginni, 1996b). The Dakar conference of 1974, nearly three decades ago, showed that many African states had made an effort towards the formulation of policies that would help them achieve scientific and technological progress.

A dominant theme since independence of most African countries has been that, without a minimum science and technology base, there can be no breakthrough in the economic development of Africa (UNESCO, 1987; OAU, 1981). Most African countries have expanded their educational facilities by investing in curriculum development centres, science and technology institutes, national examination boards and curriculum research and evaluation units. The CASTAFRICA II summit held in Tanzania in 1987 noted several factors that have affected the development of science and technology education in Africa. These factors include the rapid deterioration of the environment, the increase in the rate of pollution, population growth, the increase in AIDS-HIV, rise in infant mortality, the external indebtedness, the consequent policies of adjustment, unsuitability

of development policies and the poor management of resources (UNESCO, CASTAFRICA II, 1987).

Post-independence reform efforts carry promise and optimism. Yet they require immense investments with regard to the development of expertise in order to reach fruition. With the hope of a brighter future, countries in Africa have often chosen to invest heavily in science, mathematics and technology education (Mckenney, 2001). Although most nations in the sub-continent have taken steps to increase science and technology capacity in their country and develop curricula believed to be more relevant to the needs of the people, there have been no efforts to increase access to secondary education and to change the examination system (Ogunniyi, 1998). Science today is taught at primary and lower secondary education in most of Africa; however, as mentioned before access to secondary education has not increased especially in Sub-Saharan Africa.

3.1.2 Science and Technology as a Means for Solving Societal Problems

The importance of science and technology to society and the environment is demonstrated by Ogunniyi (1998), who declared that a country that is not considering constant improvement in science and technology is running the risk of being obsolete. Ogunniyi (1998) also pointed out that very little concern is shown about possible socio-cultural tensions created through the application of science and technology especially in Africa. He expressed the changes that are experienced by the African child of today and the realities of the environment in which he or she lives and the expectations bestowed upon him or her in the following manner:

The African child of today is not the same as the African child of the century ago especially with respect to knowledge. In a significant way his/her worldview is being influenced by science and technology. As an individual his /her thinking processes, creativity, desire to attain excellence, receptivity to Science and Technology and his/her career opportunities have widened dramatically. The community in which he/she lives is also undergoing significant changes with respect to values and interests. (p. 39)

Ogunniyi (1998), attributes the economic failures of most African countries to the lack of development in the endogenous scientific and technological human power and further emphasises that without this crucial ingredient the much envisaged socio-economic progress will remain a mere dream. Asouzu (1998) also asserts that:

If the African situation is taken as a case study, then within the African context the search for scientific answers to challenging problems does not always seem to have yielded commensurate results comparable to what is obtained elsewhere. And indeed it is relevant for everyone to ask why there is this kind of discrepancy in tangible results in comparison with other countries. (p. 1)

Many African science educators have acknowledged that certain questions related to scientific progress and development in Africa are very sensitive and touch on the pride of an African. Speculating on answers as why science enquiry within the African context has not been on par with other developing partners, Asouzu (1998) says:

Africa is heavily dependent for almost all her advanced needs. Moreover echoes of scientific development from Africa are very scanty and insignificant to be relevant. Recycling of old and new knowledge as is practiced in many parts of Africa, even in institutions of higher learning, can hardly qualify for direction in serious moves to scientific advancement. (p. 4)

However, political independence in Africa cannot be equated to economic and scientific or technological progress. The situation in most of the African continent has in reality worsened as a result of internal political strife, poor leadership and mismanagement of resources (Oginni, 1998).

3.1.3 The Development-Related Functions of Science Education

Yoloye and Bajah (1981) state that the process of curriculum development is perhaps the most remarkable change that has taken place in African education systems. In the

developing world, national and international leaders look to the education system to alleviate the basic problems in their societies including unemployment, overpopulation, poor sanitation, fuel shortage, water adequacy and quality, shelter, and health care (Lewin, 1993). An education in science should enhance each developing country's capacity to find ways to provide crucial essential services that are environmentally sound, socially equitable and economically affordable (Kyle, 1999).

As mentioned in Chapter 1, Oginni (1986) recommended a similar development-oriented approach, more than 15 years ago. Agriculture, population control, food production and nutrition, environmental management, health and sanitation are a few of the areas where a wider understanding of science will lead to more informed decision making and social development of the community at large (Ware, 1992). Ecologically sustainable development also is important if poverty is to be alleviated in the long term because a healthy and well-managed environment benefits its current residents and, over time, benefits future generations (UNESCO, 2001). Science education can play a role in identifying and strengthening the basic knowledge required in areas such as health, nutrition and the provision of safe drinking water (Hegarty-Hazel, 1995).

According to Urevbu (1990), African countries need to make a choice of science and technology at three levels: the simple village level using local material and low-skilled manpower such as ox ploughs and natural energy sources; the intermediate baseline level using widely available locally manufactured gadgets such as pumps, stoves, electrical gadgets; and the advanced technology level that makes use of imported material. In many African countries, the replacement of the hoe with the tractor imported into the country rather than the ox-drawn plough has met with failure, as there is little technical expertise available for maintenance of equipment. Adu-Ampoma (1980) in the early 1980s emphasised that science and technology needs to be seen as a way of life. When so appreciated, science and technology education can make a contribution to health and nutrition, agriculture and training of personnel in developing countries.

In the domain of science, mathematics and technology education, there have been various developments such as new curricula, new subject syllabuses and a call for more learner-centred teaching (McKenney, 2001). Yet many countries in Africa have to make do with an unqualified and under-qualified teaching force. This already grave problem can be compounded when education reform demands the inclusion of subject matter completely new to practicing teachers and/or the adoption of a new and unfamiliar teaching methodology (Caillods et al., 1996).

Science education ought to be contextualized and linked to the life world experiences of learners. Hegarty-Hazel (1995) calls on all science educators to include and acknowledge individual experiences and expectations, societal needs, in addition to gender, ethnicity, and culture of the learner in the science curricula of developing countries. Science, technology and society communicate and show the linkages in what goes on in educational institutions. Every science education program must address the real issues faced by the people in their environment served and the issues that affect human beings in a particular society (Bajah, 1999). Two African countries that have made notable changes to contextualise their school science curricula are Zimbabwe and Ghana. The Zimbabwean Core Science Curriculum is still examined by Cambridge University but has a local orientation to all its science strands based on the science of local agriculture, energy use, mechanical systems and community life (Whittle, 1992). Yakubu (1992) reported on the Ghanaian project to develop teacher resource materials related to local industry and probing societal attitudes towards science and indigenous technology.

The 1970s, 1980s and 1990s were a time when Kenya and Uganda, the neighboring East African countries of Rwanda, faced political and economic difficulties. During that time, the whole African continent was experiencing political changes toward multiparty governments and both Kenya and Uganda, along with Burundi, Tanzania and the Democratic Republic of Congo, were home to thousands of Rwandan refugees.

In the 1960s, Uganda had one of the best education systems in Africa. However, the political upheavals and economic mismanagement of the 1970s and early 1980s wreaked havoc on the education sector. Infrastructure was destroyed, materials were not available, and resources were diverted. Teachers were poorly trained or not trained at all. Many had left the teaching profession and joined the private sector. Teachers in the rural areas moved to urban centres in search of better pay (Shindu & Omulando, 2000; USAID/SUPER, 1997-2000).

Between 1993 and 2000, the government of Uganda overhauled its primary education system. The key to success was a partnership between the American international aid agency (USAID) and the strong resolve of the political leaders. USAID (Uganda) was a leading partner in primary education reform in Uganda, and a central part of USAID's program was support for the Teacher Development and Management System (TDMS). TDMS is an innovative program for quality enhancement in the primary education sector. The TDMS strategy has decentralized teacher-training activities from the traditional pre-service fixed-site primary teacher's colleges (PTC) to the peri-urban and rural villages. USAID funds were used to establish 549 learning resource centres throughout the country. The teachers are now using these centres to meet with their tutors and for developing teaching aids using locally available materials. In addition to supporting the professional development of classroom teachers, TDMS has also enhanced the management and leadership skills of over 20,000 head teachers and school inspectors (USAID, 2001).

Since independence, Kenya has had several commissions that have proposed ways of reforming the educational system. In 1964, the Ominde Commission was set up to make the changes in the educational system and its main focus was secondary education. The Gachathi report of 1976 emphasized the provision of free primary education. The report also noted that there was a need to integrate secondary education with the non-formal sector in order to take care of school dropouts. This report called for the need to introduce more technical subjects in secondary schools. The 8-4-4 system was launched in January 1985 and emphasized vocational subjects, with primary education lasting 8

years, secondary education 4 years, and tertiary education another 4 years. It was assumed that this new structure would enable school dropouts at all levels to be either self-employed or to get employment in the non-formal sector (Rharade, 1997).

Thus with a conducive policy environment and political will from the government and the Ministry of Education in Kenya and Uganda, education reform focused on examinations and curricula, science education, textbook printing and supply, financial resource flows, sustainability and, most importantly, teacher recruitment, training and retention.

3.1.4 Science Education and National Development

Since the Second World War, many nations around the globe have come to associate high investment in science, mathematics and technology education with economic growth (McKenney, 2001). Caillods et al. (1996) conclude that investing in science education is a necessary condition for economic growth. Lessons can be learned from Korea, Taiwan, Hong Kong and Malaysia who have enjoyed rapid economic growth in recent decades. In addition to sound macro-economic policies, these countries have made substantial investments in education and training in general and science and technology in particular as a major contributing factor to their economic growth (Calloids et al. 1996). Although the causes for these developments are multi-dimensional and complex, there has been a strong and sustained commitment to science and mathematics education in these countries.

The World Conference on Science in Budapest in Hungary in July 1999 addressed the issues of science education for development, science education in schools and science education for the future. Three main themes elucidated were: science for knowledge and knowledge for progress; science for peace, conflict resolution and sustainable development, and science in society and for society, with a special consideration on ethics and gender. Within these three themes governments were expected to accord the highest priority to improving science education at all levels through their Ministries of Education.

One task was to promote the professional development of teachers and educators and address the lack of appropriately prepared science teachers in their countries. Another task was to develop new curricula, teaching methodologies and resources in response to the changing educational needs of societies. The governments were to provide basic science education to all and opportunities for lifelong learning in the sciences. Even though these themes and expectations were stated in most policy documents, in most developing countries there was, and still is, no consensus among nations on how to structure courses that will provide quality science education to all students. Nevertheless, the participants in the Project 2000+ Forum believed that scientific and technological literacy are essential for achieving responsible and sustainable development (UNESCO-Project 2000+; Paris Declaration, 1993). Similarly, science education experts have made the following statement:

Governments that are interested in laying the groundwork for a more technically oriented economy should place heavy emphasis on Mathematics and Science. These subjects are relatively inexpensive to teach and are likely to promote economic growth more efficiently than in-school vocational education. (The World Bank, 1998, p. 62)

Despite these good intentions, there is a widespread lack of understanding of the complexities of implementing successful educational reform and no African country has ever achieved widespread scientific literacy. Across the world, there is a recognized relationship between quality research and development in science and technology and economic stability and growth (Ware, 1992). In many countries, this recognition has resulted in additional efforts being made to support science and technology education at all levels because this can lead to a scientifically and technically skilled labour force and such skilled personnel enable economic progress in low developing countries (Drori, 1998). Science and technology often have been perceived as the driving force behind the economic development of industrialized countries. Many developing countries invest heavily in science education to strive for socio-economic development (Lee, 1999). The

Indian Education Commission as far back as the 1960s acknowledged that economic development, welfare and security are all closely dependent on the extent and quality of education (Kothari, 1970).

The science for development model put forward by Drori (1998) works on the assumption that a government envisions science education as a systematic programme for national development with a scientifically and technically skilled labour force that enables industrialization and in turn economic progress. The leaders in Rwanda have acknowledged national capacity building in science and technology and improving the teaching of mathematics and sciences as a national goal. The government is trying to ensure that an education in science will facilitate development, environmental sustainability and enable the young to change, transform and work collectively to create a better future (Ministry of Education, 1998). How does this become a reality and is to have any meaning if only 20% primary school leavers attend secondary school? It needs to be emphasized that the expectations as to how much a scientifically literate population can reshape any given society tend to be too optimistic (Ware, 1992).

3.2 The Science Curriculum

With this background of science education in Africa and the links between science education and development, the next section deals with curriculum issues, the institutionalisation of the curriculum in developing countries, and issues related to the intended and implemented curriculum.

3.2.1 The Institutionalisation of Science Education

Many developments in science education that have potentially influenced today's teachers include viewing science as enquiry, as a process of developing and testing hypothesis and as problem solving, in addition to the more traditional views of science as acquiring knowledge and understanding science concepts to explain the events in the world around us (Hodson, 1993). Contemporary issues in science education now include social awareness of the impact of science and technology, information sciences, science-related vocational roles, preparation for further education and contending with current

technology. However, a problem exists in that all of these issues are included in a curriculum that is already crowded with concepts, facts, processes and skills (Black et al., 1998).

As explained previously, many developing countries promote science education in the hope of promoting economic development. Subsequently, strong societal support and resources need to be mobilized to advance the teaching of science in schools and in higher education institutions to promote a scientifically literate society and to produce manpower to meet the economic needs of society (Lee, 1992). Such support and resources result in the institutionalisation of the curriculum (Lee, 1992; Lewin, 1993). The institutionalisation of curriculum development has meant that most developing countries have localised their science curricula and have accumulated direct experience of the difficulties of implementing changes in teaching and learning practices (Lee, 1992). However, in several countries existing science syllabuses were retained or only weakly modified to remove some of the more obvious distortions inherited from colonial administrations (Lewin, 1993).

In many under-developed and developing countries national curriculum facilities began to be established with external assistance and aid, many supported by UNESCO and bilateral donors. Many of these projects were derivative of what was thought to be good practice in industrialised countries (Lewin, 1993). Secondary science curriculum development effort took the major share of curriculum development effort in countries like India, Malaysia and Sri Lanka with primary curriculum development the poor relation. In these countries attention was focused on design of written material like textbooks, workbooks and teachers' guides. Examination and assessment systems generally changed more slowly than the curricula (Lewin, 1993).

What has occurred in Rwanda is a major thrust on science and technology by the government in power. The period between 1996 and 1998 resulted in four higher education institutions being established and restructured to meet this goal. The Kigali Institute of Science and Technology was established in 1997 to produce engineers,

technologists and managers, The Kigali Institute of Education was established in 1998 to train graduate teachers especially in mathematics and science. The Kigali Health Institute was restructured to meet the para-medical needs of the country in the area of health workers, nurses and laboratory technicians. The Institute for Agricultural Sciences also was restructured in order to produce better crop scientists, wildlife technicians and food technologists (Ministry of Education, 2000a).

3.2.4 The Intended and Implemented Curriculum

Among the many abstract concepts in educational literature, curriculum probably is among the most elusive (Jackson, 1992). As a field of study, “it is tantalizingly difficult” to know what curriculum is (Goodlad, 1994, p.1266). A definition of curriculum, that is generic, but more informative, is that ‘the curriculum refers to the content and purpose of an educational program together with their organization.’ (Walker, 1990, p.5). The conceptual work of Goodlad (1994) differentiates between various curriculum interpretations of curricular activities (the design and development, the implementation and the evaluation): at the system level or the macro level where policies are created; at the institutional or school level where the policies are implemented; and at the classroom or micro level where the curriculum is achieved.

According to Print (1993), curriculum representations can include the intended curriculum, which is the basic philosophy of the curriculum as elaborated in a curriculum document, the implemented curriculum, which is the actual instructional process in the classroom and is often referred to as the curriculum-in-action, and the achieved curriculum which is the resulting learning outcomes of the students. This typology of curriculum representations is instructive for analysing the outcomes of numerous curriculum innovation efforts in science education, especially where curriculum reform is aimed at reducing the incongruence between the new intended curriculum, the implemented curriculum and current student learning. Too often science education reform has failed to affect classroom processes or the implemented curriculum (Print, 1993). The curriculum addresses questions about why something should be learned in school (aims and objectives) and about what is considered important to be

learned in a certain society (content). These aspects are the intended curriculum. The curriculum that addresses questions about how different learning objectives can be met in schools with regard to the development of knowledge, skills, and patterns of behaviour as a result of specific teaching and learning strategies refers to the implemented curriculum.

A range of representations adapted by Van den Akker (1988; 1990) also illustrates curriculum evolution. This typology begins with the designers' intentions (ideal curriculum), then proceeds to their written form (the formal curriculum), moves on to the interpretations made by the users (perceived curriculum), the way it is actualized in the learning setting (operational curriculum), then looks at the way it is experienced by the learners (experienced curriculum) and concludes with learner achievement (attained curriculum). The curriculum also addresses the effectiveness of learning processes through assessment and evaluation of students' achievements in different areas (achieved curriculum) (United Nations Mission In Kosovo, 2001). Within the context of the present study, the research has looked at the intended and implemented curriculum in Rwanda, as these were the most appropriate within the Rwandan context.

Klein (1991) describes nine essential elements of curriculum: goals, objectives and purposes, content, materials and resources, activities, teaching strategies, evaluation, grouping, time and space. The anticipated and actual outcomes of teaching and learning are reflected under the concept of the nine essential elements of curriculum goals and objectives. Content refers to those facts and ideas, concepts, beliefs, attitudes and skills with which the students interact as they experience a curriculum. Materials and resources are the objects, people used to facilitate the learning process. What students do when they engage in the process of learning falls under the heading of activities.

Teaching strategies are defined as the role taken by the instructor or teacher in order to facilitate learning. Procedures for determining what the students are learning and have learned are forms of evaluation. Grouping refers to the processes and the results of determining the clusters of pupils that facilitate the learning process. Time is a

fundamental aspect of the curriculum when allocated on a formal or informal basis. Finally space refers to the design and use of the physical learning environment, such as classroom, school or shade of a tree. In this research nine essential elements: the objectives of the curriculum, the curriculum content, materials and resources, teacher beliefs, student attitudes, teaching methodology, evaluation and the physical learning environment are discussed in Chapter 5.

The intended curriculum may be defined as the outcomes that curriculum developers wish learners to achieve as a result of participating in the curriculum. Curriculum intent incorporates the various forms of aims, goals and objectives found in curriculum documents, which together provide directions that can be achieved by learners as they interact with the curriculum (Print, 1993). Aims are broadly phrased statements of curriculum intent developed at the system level usually by the Department of Education. Goals are precisely worded statements of curriculum intent, derived from aims, that are usually phrased in non- technical language and directed towards student achievement by emphasising content and skills. Objectives are specific statements of curriculum intent, that is, what students should learn through interaction with this curriculum and are expressed in terms of changed learner behavior. Objectives also may be seen as working statements whereby educational institutions translate goals into specific statements of educational intent (Print, 1993). The curriculum is thus one of the most important means for the assurance of quality education for all citizens and for equitable education provisions for every member of society, regardless of sex, ethnicity, social position or other differences.

Science education since the 1960s has led to new conceptions of curriculum development. Many societies recognise that science is not divisible into teaching and learning science in a simplistic way and are attempting to assist teachers to see that the teaching of science concepts needs to be related to the way that learners and teachers conceptualize the phenomena. Similarly, it is important for curriculum developers to take into account the contexts of the curriculum and its materials and its subsequent implementation in classrooms. Classroom and school contexts in which the science

teacher works are important features of the curriculum implementation process. Science teachers need to be brought into association with curriculum developers for the sharing of ideas information and experiences so as to bring about changes in their behaviour and in the learning of their students (Fensham, 1988).

Over the last few decades, in many countries of the world, the development of curriculum frameworks has been documented as a recent trend in curriculum reform. A curriculum framework stipulates the parameters that should be considered when setting curriculum goals and contents, when choosing learning methods and materials and for assessment of the attainment of education standards. Implementation involves changing the status quo by accepting and utilizing a new curriculum document and putting it into practice. Implementation is a phenomenon that attempts to integrate the new curriculum into existing practice (Print, 1993). Curriculum reform has to pay attention to preserving valuable features and practices of the education system, while adding and adapting valuable education experiences as they have occurred in progressive systems during the last few decades (UNMIK, 2001).

3.2.3 Curriculum Development and the Teacher

Continued professional growth of teachers is widely accepted as an essential ingredient to any educational reform (Fullan, 1991; Van den Akker, 1988). This professional development involves curriculum development and teacher professional development that are seen to strengthen one another (McKenney, 2001). Addressing these concerns, Clandinin and Connelly (1992) and Noddings (1986) made a plea for collaboration between researchers and practitioners in terms of studying the role of the teacher as a curriculum maker and understanding how the teacher shapes the curriculum. Indeed, the involvement of teachers in curriculum development is widely advocated as an effective form of inservice education (Ball & Cohen, 1996).

Gray (1998) indicated that time played a vital role in the professional development process as teachers need time to become immersed in activities and need time to think about how they will implement the curriculum. Teachers' learning also may be

meaningfully situated in their own classrooms where the participants' teaching is the focus of discussion and the settings emphasize teachers' learning of subject matter. Ben-Peretz (1990) advocated teacher participation in curriculum development because of the opportunities provided for experiencing decision-making with regard to content, scope, sequence and instructional strategies. Within this context, the creation of curriculum materials by the teachers can play an important role (Putman & Borko, 2000).

However, in most developing countries, there is no funding for the creation of curriculum materials; teachers lack not only textbooks but also supplementary materials and teaching guides (Baine & Mwamwenda, 1994). Even though teachers earn low salaries, almost all of the school budgets in developing countries are spent on personnel, which leave little funds in budgets for textbooks and other instructional materials (Van Blanken, 1995). When resources are available in developing countries, Lockheed and Lewin (1993) found that teacher guides that are well integrated with the textbook or other instructional materials do have a positive impact on student achievement.

Van den Akker (1998) identified four areas of implementation problems within the domain of science education - a lack of knowledge in subject content matter, lack of confidence in imparting subject matter, changing roles of the pupil and teacher, and assessment. There is no doubt that curriculum change is a difficult and complex process and studies of attempts at innovation have reported the lack of sustained impact on classroom practice (McKenney, 2001). On the other hand, De Feiter et al. (1998) reported that successful implementation could be accomplished through the provision of intensive support scenarios that include the use of well-tried, contextually relevant, preferably low-cost and locally available materials. Opportunities also are needed for the teachers to use the materials and practice innovations within a supportive school environment created by administrators.

In the case of Rwanda, the National Curriculum Development Centre made use of experienced teachers in the design of the new curriculum. Many of these teachers, who had taught in other countries such as Kenya, Uganda and South Africa and had returned

to Rwanda after the genocide, brought their own professional experiences into the curriculum development process. Although initially intended, the curriculum documents that were designed and distributed to schools in September 1998 did not have supporting textbooks or teacher guides. Thus under and unqualified teachers in Rwanda had to implement the new science curriculum without materials and textbooks making the whole process difficult and non-supportive (Ministry of Education, 1998b).

3.2.4 Using Multiple Perspectives to Study Curriculum Implementation

According to Rogan (2000), what happens in schools is dependent on the context and situation of the schools. Schubert (1986) sees issues related to curriculum implementation through perspectives, paradigms and possibilities. Perspectives form the context that nourishes the set of beliefs and assumptions, provide full and rich images of curriculum conditions and states of affairs. Anderson (1992) postulated six reasons why a multiplicity of perspectives approach should be used in education reform: the systemic nature of the curriculum reform process, the cross-disciplinary nature of new curriculum reform, the complexity of educational situations, researcher who fail to consider all the facets of research influence, the range of philosophical and psychological bases for educational change and the need to avoid mistakes in action

Only when teachers come to understand the reality of educational change in the context of their classroom will they implement changes (Sikes, 1992). Curriculum reformers, who mandate a curriculum change, fail to recognize that teachers are people that will choose a course of action, which will suit their purpose (Hargreaves, 1992). Allen and Glickman (1998) point out that in cases where the curriculum has been mandated, teachers are reluctant to implement curriculum reform because they lack an understanding of the process that was involved. However, where teachers perceive that there is a need for change and if they can contribute to the change, only then will they implement the change.

In this study I have used two perspectives: the socio-cultural and practical perspective to study curriculum reform through intention and implementation. The classroom is a

social setting involving teachers and students. The socio-cultural perspective is concerned with the relationships between the teacher and the students. From a socio-cultural perspective the teacher has to take into account the family background and the circumstances of the learners. According to Hargreaves, Earl and Schmidt (2002) the cultural perspective allows an investigation of how the teacher interprets the curriculum innovation and attempts to integrate it into the social and cultural contexts of schools. Change will affect teachers' beliefs as well as their practices, ideas, experiences and lives.

A socio-cultural perspective on the phenomena of student learning and engagement is dependent on the understanding that teachers have of the learners' background and home circumstances. Teachers will choose curriculum content with which the learners are familiar and which is contextually relevant and plan their lessons accordingly. The background of the learners determines the teaching and learning ethos of the classroom. The socio-economic status will determine and influence the teaching and learning of curriculum content. The practical perspective refers to the challenges that teachers face with changing their own knowledge and skills. Teachers need to develop and administer creative assessment instruments; to teach mixed-ability classes; to integrate ideas and material from different disciplines. Curriculum reform often requires teachers to adopt a multitude of complex new roles (Hargreaves et al., 2001). Teachers require opportunities to experience to experience observation, training, feedback and practice so that they can develop new skills and use these skills as an integral part of classroom routine (Hargreaves et al., 2001).

3.2.5 Dilemmas in Educational Reform

Educational reform is a complex process that affects the working lives of teachers and administrators. For teachers and administrators facing educational reform, whether it is school-based curriculum development or a systemic initiative with origins in the school and system restructuring, there are many uncertainties, tensions, constraints, paradoxes or dilemmas (Hargreaves, 1997). Dilemmas have been defined as situations that require a choice between two contrasting alternatives for a given situation or context, but

dilemmas are capable of resolution in an educational context. Within systems undergoing reform many administrators and principals face daily dilemmas as they balance the requirements of education departments with decisions made within schools (Wildy, 1998).

Woods et al. (1997) described four dilemma issues when implementing educational and curriculum change. The four dilemma issues are: teachers are aware of the dilemmas facing them, dilemmas involve choices that are difficult to make, dilemmas are situational and largely resolvable by professional action, and some sort of decision or action is necessary to resolve dilemmas. Woods et al. (1997) also described tensions and constraints as being special type of dilemmas. Tensions arise when trying to accommodate two or more opposing courses of action where choice is limited or circumscribed and when factors beyond the teacher's control impede decision-making. Tensions, constraints and dilemmas are an inherent part of educational change.

The reform process in education systems is full of conflict, uncertainty and ambiguity (Fullan, 1999). Lieberman (1995, p.12) argued that change results in "inevitable tensions" and that while time, persistence and new structures can help reduce tensions they cannot be completely eliminated. These tensions and dilemmas are features that must be addressed by those implementing reforms (Rizvi & Kemmis, 1987; Wildy, 1998).

According to Fullan (1990), one reason that reform creates tension is because change is difficult and combines steps that seemingly do not go together. Agents of change need to have a clear vision, to take initiative and empower others, to provide support and pressure, to start small and think big, to expect results and be patient, to have a plan and to be flexible. Educational change in a school system is above all a very personal experience in a social, but often, impersonal setting for the teachers. In the context of Rwanda, the civil war, subsequent genocide and post-genocide reconstruction has adversely affected the lives of teachers. The multiple dilemmas of effecting positive change in the schools and classrooms in which teachers work when they are poorly paid,

cannot meet the needs of their families, have no resources at their disposal and have no means of professional growth are examined in Chapter 6.

The success of a curriculum's implementation must reflect the willingness and ability of the developers to accommodate changes to the intent, content, learning activities and evaluation procedures to suit the new needs of the country. A new curriculum can be implemented more successfully if a strategy is developed to implement, present and support the process at a systemic level. In most cases, some modification is required to the implemented curriculum. These modifications take into account differing local contextual factors such as the nature of the students, differing school resources and teachers, community support and parental input (Print, 1993). The Minister of Education in Rwanda personally acknowledged that changes needed to be made to the content and evaluation procedures of the new curriculum so that the new curriculum was more suitable and relevant to the current Rwanda context.

People are wary of change not only because of the uncertainty associated with it, but also the underlying agenda of reform (Hargreaves, 1997). Furthermore the failure of educational reform is largely predictable as a consequence of not addressing the political or institutional aspects of change. Teachers and educators have trouble letting go of past customs or traditions and relinquishing strategies that had been previously supported by research that had been seen as right, natural and proper (Saranson, 1990).

A close look at change through tensions or dilemmas helps to disclose the politics of the rhetoric and reality in education and society (Fullan, 1993; Goodson & Hargreaves, 1996). Hargreaves (1994), pointing out the dialectics of structure and culture in change, suggested that more enduring changes occur not only as a result of the importation and implementation of external ideas, but mainly as a result of teachers' critical engagement with their historically formed practices, traditions, and structures. Current problems and successes cannot be separated from their historical roots, as is the case in Rwanda (Louden, 1991; Hargreaves, 1992, 1997; Tabulawa, 1997).

The need for redesigning school education and redefining its aims and objectives in Rwanda is linked to changes occurring in society, economy, politics, and education in the aftermath of the genocide. Consequences of this are the new needs of present day Rwandan society with changes in economic structure, the knowledge and skills that students need to be equipped with and the changes in the social context of education. The basic needs of present day Rwandan citizens and the masses of rural population are linked to the environment, food, shelter and health (International Monetary Fund, 2001).

3.3 A Socio-Political Framework for Science Education

3.3.1 Meeting Societal Demands on Schooling and Science Education

The curriculum movement of the 1960s has been criticized for often behaving as if schooling and science education take place in a social and political vacuum. Schools are established by society to fulfill a number of educational functions. The curriculum is the instrument to serve and fulfill the educational function. In many societies, especially developing societies, sciences and the physical sciences in particular, are subjects that filter the few students who are allowed to move into certain professions of high status, societal influence and economic security. This creation of an elitist educated minority in a country is the political demand of science education. Also a definite number of persons with scientific skills and expertise are needed in any society to maintain and expand a variety of aspects of its economy. This is the economic demand of science education (Fensham, 1988).

According to Fensham (1998), science education can assist people to have a sense of control rather than of subservience and help people take advantage of what science has to offer them. The role of human inventiveness in relation to man's fascination for science phenomena offer much potential for school science education to meet the demands of its learners for individual growth and satisfaction. There are clearly many ways in which cultures and social life can now be influenced by knowledge and applications from science (Fensham, 1988).

In the international literature, increasing attention is being given to the role of context in educational change (Hargreaves, 1998). Oginni (1996a) also has underlined the importance of context for science, technology and mathematics policy in Africa, stating that curriculum materials must be attuned to the socio-cultural setting of African children. Similarly, Rogan (2000, p 121) noted “curricula are embedded with cultural values”. A curriculum designed in a Western country may place value on individual development, which if adapted to the African context may be at odds with the African notion of ‘ubuntu’, which is the pillar of traditional African values and centres round love, gentleness, sharing and caring especially in times of difficulty (Mckenney, 2001). The dominance of Western curricula in African countries has stemmed from colonial legacies. Many curriculum innovations are frequently adopted from outside and have the potential of clashing values (Selvaratnam, 1988; Yolo, 1985).

Thijs (1999) distinguished five contextual factors that exert influence on curriculum development in Africa. These curriculum determinants can be summarised as: a) the historical context that includes traditional education, mission education and colonial education, b) the socio-political context that includes cultural factors, politics and societal factors, the years of civil war and the subsequent genocide, c) the economic context that includes budgets and expenditures, d) the administrative context that includes bureaucratic structure, centralized policy-making and school types, and e) the final context are the internal and external participants in the curriculum development process.

Similarly, Kyle (2001) emphasises that a transformed science education should be relevant to the people living in a particular environment, should acknowledge the political, social, and cultural forces at work in scientific labour, and should be linked to local contexts and issues of sustainability. Figure 4 (modified from Fensham, 1988) portrays a number of different societal demands on science education that schools in any society provide. This situation is also relevant to the Rwandan context where each of these demands has an effect on science education and the school system and continues to do so.

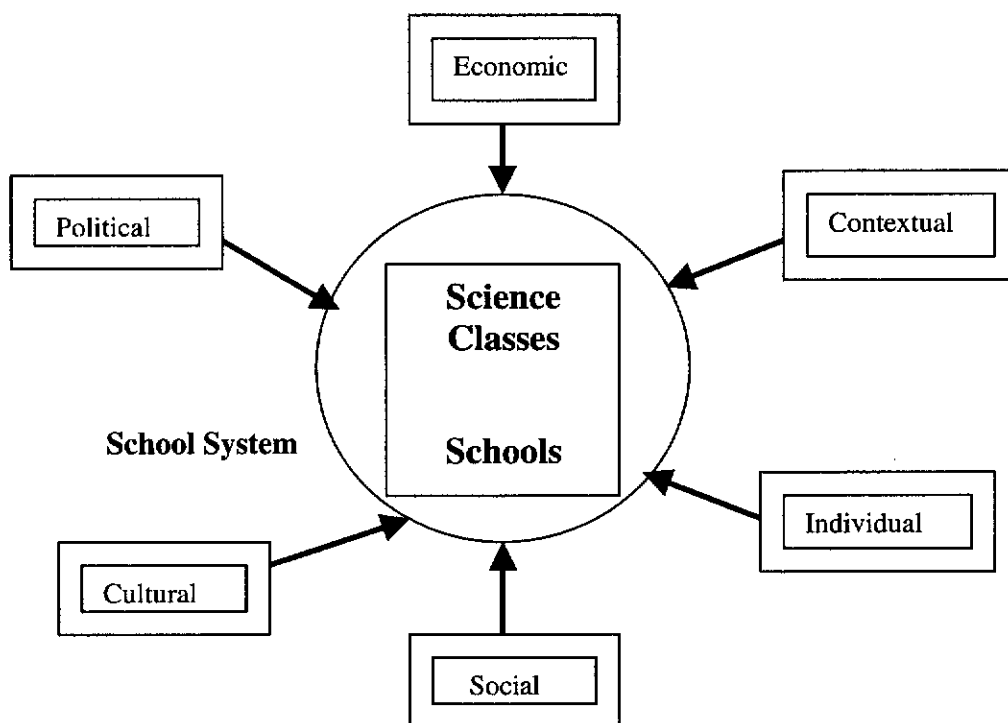


Figure 3: Competing societal demands on schooling and science education (adapted from Fensham, 1988)

3.3.2 Science Education for All

Science for all, the focus for science education since the mid-1980s, is that science education is the fundamental right to be accorded to every member of the population regardless of background, nationality, language, sex, and socio-economic circumstances. The stance is that scientific literacy is essential for the personal, social, economic and intellectual future of all students. Nevertheless, the rhetoric of science education for all is juxtaposed with the reality of science education for the privileged. In most developing countries, and especially transitional societies, science for all is not possible because only the minority of students attend secondary school.

Throughout the developed and developing world, there is agreement about the desirability of science education for all, but different researchers have different

orientations to the issues depending on whether the focus is on goals or the outcome of science education and processes or the means to achieve the goals (Wallace & Loudon, 2002). The goals orientation to science for all places emphasis on a broad set of aims and outcomes for school science and is usually organised around the acquisition and application of science knowledge and procedures. Lists of such goals can be found in many publications on scientific literacy (Bybee & Ben-Zvi, 1998; Fensham, 1985).

Three basic aspects of school science need to be changed if science education is to respond to society's demand for 'science for all'. These changes involve the science to be learned or the content of the science curriculum, the manner of teaching or the pedagogy and the assessment of students. Once these changes are determined two other aspects that become important for widely successful learning are the school and classroom climate in which teaching and learning occurs and the evaluation or assessment of the learning. The content to be learned is influenced by the pedagogy and by the assessment (Fensham, 2000). For the great majority of the learners, especially those in the developing world who will not go on to science-related careers or learn science beyond primary school, the case for the content of their science learning in school must be built on learning outcomes that will be sustained by their lives in society as citizens, and in their personal life.

Fensham, (2000) argues that the content of school science must change; its conceptual content must be more selective and taught in a manner that gives ideas coherence and linkage. The content to be learned has to have some future significance if the intentions of science for all are to be furthered. In most developing countries attempts to change the content of upper secondary classes have been short-lived and this has had a negative effect on the primary classes (Fensham, 2000). As reported by De Vos and Reiding (1999) and Fensham (2000), curriculum developers face difficulties in embodying alternative views of science content. In the case of Rwanda, including aspects of survival skills, the developmental aspects of science, and UNESCO's Science Technology and Society (STS) themes into a designated curriculum and in textbooks are issues to be considered to ensure a curriculum of school science for all.

3.3.3 Non-formal Education

The Education Forum 2000 in Dakar, Senegal, adopted the Dakar Framework for Action (UNESCO, 2000a). This framework reiterated that: all children, young people and adults have the human right to benefit from an education that will meet their basic learning needs in the best and fullest sense of the term, and an education that includes learning to know, to do, to live together and to be. Unfortunately in Rwanda there are thousands of children living on the streets and children and adults living in the rural areas who have no access to education nor find the need to educate themselves.

The needs of these disadvantaged groups can be addressed through non-formal education programmes that have been successfully implemented in Kenya and India (Aggrawal, 2002, Thompson, 2001). Fordham (1993) suggests that in the 1970s, four characteristics came to be associated with non-formal education: relevance to the needs of disadvantaged groups, concern with specific categories of person, a focus on clearly defined purposes, flexibility in organization and methods of teaching. The Commonwealth Secretariat (1972) defines non-formal education as:

Non-formal education is any organised learning activity outside the structure of the formal system that is consciously aimed at meeting specific learning needs of particular sub-groups in the community - be they children, youth or adults. (p.2)

The range of initiatives and programmes that have adopted the title 'non-formal' are many and various. They include literacy and basic education for adults and young people, political and civic education, 'catching-up' programmes for school drop-outs, pre-school education for young children, and various kinds of educational work linked with development initiatives including agricultural extension and training programmes and health education.

Non-formal education is an education geared to tapping each individual's talents and potential and developing learners' personalities, so that they can improve their lives and transform their societies. To this end, new methods, approaches and techniques in

facilitating learning are called for within the contexts of youth and adult education. The concept of Youth and Adult Education presents tremendous challenges to current practices and, undoubtedly, opportunities for linkages between formal and non-formal education on the one hand, and education of children and adults on the other. Adult education is part of the process of lifelong learning of which the education of children and youth is an integral part.

The Government of Rwanda should assume primary responsibility for the provision of basic education, including non-formal education to masses of rural illiterate and street children. The content of non-formal education will be dictated by the functional needs of the learners; the duration and timing needs to remain flexible and cost needs to be low.

3.4 Psychological Constructs and Related Instruments Used in the Study

The internationalisation of science education research inevitably involves the use of well-accepted instruments in many countries and translated into different languages so that the threads of research are not limited to countries that share the original language of each research instrument (Anderson et al., 2001). The final section of this chapter briefly describes the psychological constructs and the related instruments used in the study. The instruments used in this study have been extensively used in the developed and the developing world and have high reliability and validity. Within the context of this research the four modified instruments were translated into French and administered to Rwandan teachers and students.

3.4.1 The School Level Environment

School environment instruments have been developed since the late 1950s. Moos in the early 1970s worked in a variety of environments and found three diverse psychosocial dimensions in the environments investigated. The relationship dimension identifies the nature and intensity of personal relationships and the extent to which people support and help each other. The personal development dimension assesses the directions along which personal growth and self-enhancement tend to occur. The System Maintenance

and System Change dimension is the extent to which the system maintains control and is responsive to change. Rentoul and Fraser (1983) first developed the School Level Environment Questionnaire (SLEQ).

The new form of the School Level Environment Questionnaire was first tested in 1990 and is an eight-scale instrument that measures the three dimensions mentioned above. The student support and affiliation scales measure the relationship dimension, the professional interest scale measures the personal development dimension, the staff freedom, innovation, resource adequacy, work pressure and participatory decision-making scales all measure the system change and maintenance dimension. The SLEQ is consistent with the theory of environment improvement, makes good sense to practising teachers, is specifically relevant to schools and is also very economic (Fisher & Fraser, 1990). In Rwanda, a four scale modified version of the original School Level Environment Questionnaire was administered to French and English teachers. The modified questionnaire has been described in Chapter 4.

3.4.2 Teachers' Efficacy Beliefs

Teachers develop their beliefs about teaching over years of being students themselves and from their own experiences as teachers (Perry, 1990). Interpretation of their experiences and knowledge produces learning that influences classroom practices (Tobin, 1996). Teachers' beliefs are highly stable and resistant to change, older beliefs being the most resistant to change (Kagan, 1992; Pajares, 1992). Teacher beliefs about instruction may be incompatible with contemporary views of learning and good teaching practice.

Gallagher (1996) describes exemplary teachers who are far less focussed with the presentation of content, showing greater concern for facilitating students' understanding of subject matter, applying this to real problems outside the classroom and developing positive attitudes towards science. Within a broader context, Czerniak and Lumpe (1996) discuss the relationship between teacher beliefs and science education reform in the areas of curriculum, teaching and student assessment, which are aimed at producing

a literate workforce. Many of these reform initiatives ignore the beliefs of classroom teachers and the incompatibilities of reform agendas and teacher beliefs (Cuban, 1990; Tobin et al., 1994).

Teacher efficacy beliefs refer to the extent to which teachers believe they have the capability to positively affect student achievement. According to Bandura (1977), behaviour is based on the principle that people not only expect specific behaviours to produce desirable outcomes (outcome expectancy), but they also have a belief in their ability to perform these behaviours (self-efficacy). Therefore teachers with high outcome expectancy and self-efficacy could be expected to demonstrate behaviour and act in a confident and decided manner. Individuals with low outcome expectancy coupled with high self-efficacy may be observed in certain situations to intensify efforts for a short period but will eventually become frustrated. Individuals low on both scales would give up easily if desired outcomes were not readily forthcoming.

Within the context of teacher effectiveness, Gibson and Dembo (1984) predict that:

Teachers who believe student learning can be influenced by effective teaching (outcome expectancy beliefs) and who have confidence in their own teaching abilities (self-efficacy) should persist longer, provide a greater academic focus in the classroom, and exhibit different types of feedback than teachers who have lower expectations concerning their ability to influence student learning. (p. 570)

Enoch & Riggs (1990) developed the original Science Teachers' Efficacy Belief Instrument (STEBI). The STEBI instrument assesses elementary science teacher's estimates of personal effectiveness in teaching science by evaluating two constructs, self-efficacy and outcome expectancy. High reliability and validity have previously been established for the Science Teacher Efficacy Belief Instrument (STEBI) scales for elementary science teachers. Internationally, Rich et al. (1996) adapted the original Enoch and Riggs (1990) self-efficacy instrument for use in Israel. Anderson et al. (2001) and Thair (1999) adapted the instruments for use in Denmark and Indonesia

respectively. A modified 11-item instrument was administered to French and English teachers in Rwanda.

3.4.3 Science-Related Attitudes

The Test of Science-Related Attitudes (TOSRA) is designed to measure seven distinct science-related attitudes among secondary school students. The theoretical basis of this instrument comes from Klopfer's (1971) categories for the affective domain in science education, with five scales measuring attitudes of science and two scales measuring scientific attitudes. The theoretical base is represented in the seven science-related attitude scales: Social Implication of Science, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. The scales can be suitable for group administration and can also be administered within a normal class lesson. The scales can be used to monitor student progress towards achieving attitudinal aims and for assessing progress of individual aims.

This instrument has been extensively used since 1978 in a number of developing and developed countries (Fraser, 1981). Many studies have utilised selected items and scales in the TOSRA rather than using all the items and scales. Khine (2001) and Lee (2001) administered two scales of the TOSRA in Brunei and Korea, respectively. In the case of Rwanda, a 10 item modified instrument measuring the two mentioned scales were used so as to provide information about the two science-related attitudes at a particular time.

3.4.4 The Development-Related Functions of Science

A new science curriculum was implemented in Rwanda in September 1998. The new science curriculum in Rwanda has tried to include the potential development-related functions of science education. The development related functions include aspects of rural subsistence-based activities, equipping young people with skills to survive, issues relating to environmental preservation, and issues relating to HIV/AIDS, health, disease, water, sanitation and agriculture.

Items modified from a study carried out in Botswana by Vlaardingerbroek (1998) were used in a questionnaire on the developmental functions of science education. The modified instrument consisted of 17 statements about the development functions of science education in the new Rwandan science curriculum. The purpose of the instrument was to solicit views of teachers and students in Rwanda if the developmental functions of science have been included in the implemented science curriculum.

3.5 Summary of Chapter 3

The first section of this review of literature provided information on science education reform in Africa since the independence of most African states with an emphasis on the developmental aspects of science, the link between science education and economic development and the need for a contextually relevant science education. Reforms in Science Education have also taken place in the East African region especially Kenya and Uganda since the 1980s and 1990s and a brief mention of this has been made in the chapter. The new Rwandan Curriculum implemented in 1998 has incorporated the developmental aspects of science into the curriculum. This theoretical background to curriculum implementation provides the basis for examining the new science curriculum implemented in Rwandan schools in Chapter 5.

The second section of the review identified issues of curriculum intention and implementation and addressed issues related to aims, goals and objectives of science curriculum. The section also discussed the institutionalisation of curriculum development and science education in the developing world. Institutionalisation has meant that most countries have localised their science curricula and have also accumulated direct experience of the difficulties of implementing changes in teaching and learning practices.

Review of literature on 'Science Education for All' in the third section of the chapter laid the onus on science educators to review the science curricula of their country to make it more relevant to their context. A brief discussion on non-formal education has

been included in this section. In the final section the psychological constructs of the instruments used were briefly reviewed and a brief description of the instruments used for the study has been provided.

The literature review in Chapter 3 has provided a contextual background and the theoretical basis for carrying out this research study. Chapter 4 describes the theoretical framework for the study, the methods used in the study, the rationale employed in the selection of research instruments and the data collection procedures.

CHAPTER FOUR

RESEARCH DESIGN AND PROCEDURES

It will be seen that qualitative techniques are appropriate to support an ethnographic naturalistic paradigm. There are times however when the issues and concerns, require information that is best supported by more conventional quantitative methods.....In such cases the responsive evaluator will not shrink from the appropriate application. (Guba & Lincoln, 1989, p. 36)

4.0 Introduction

Quantitative and qualitative methods were used to study science education reform and identify constraints in the implementation of a relevant science education program in Rwanda. The approaches were combined within a case study methodology in order to provide an in-depth picture of the reform process in a transitional, complex society like Rwanda. The data collected using the different methodologies allowed triangulation of the methods and cross validation of the data to provide a coherent and complete picture of the reform process (Guba & Lincoln, 2000).

A number of advantages have been identified for merging qualitative and quantitative methods, including the added richness of data provided by combined inputs from different methods and the improved credibility of the research findings provided by the triangulation of data from different data collection approaches (Fraser & Tobin, 1991). The quantitative approach, which conceptualised reality in terms of selected variables and the relationship between them, rested on measurement of pre-structured data. The qualitative approach employed an interpretative framework, drawing on elements of the constructivist paradigm (Taylor, 1994). The selection of research methodologies was therefore guided by recent trends in the field of science education.

This study examined science education in Rwanda from a number of perspectives that included the historical aspect, the current political situation, socio-economic factors, and the implementation of the science curriculum. The first part of this chapter discusses the theoretical framework used for the study, describes the research questions and addresses the issue of rigour in the research process. The second part discusses the questionnaire used for quantitative data collection. The final part discusses qualitative data collection methods used in the study. The chapter concludes with a brief summary.

4.1 Theoretical Framework for the Study

When embarking upon educational research, several methodological orientations are possible. The challenge in my case was to select a methodology that would provide the best information and possible answers to the research questions. Reichardt and Cook (1979) suggest that researchers should use a blend of methods that suit the research problem at hand. Similarly, Miles and Huberman (1984) argue that more and more quantitative researchers operating from a logical positivistic stance are using naturalistic and phenomenological approaches to complement tests and surveys; also an increasing number of ethnographers and qualitative researchers are using pre-designed conceptual frameworks and pre-structured instrumentation.

An intermediary position, taken by Patton (1990), states that one can usefully mix methods without being limited by allegiance to a single paradigm. He calls such an approach the paradigm of choices and suggests that, even within a single study, researchers can usefully view the same data from different perspectives and can interpret data in more than one way (Patton, 1990). In other words, qualitative data can be collected and used in conjunction with quantitative data. The rigor in the study stems from matching research methods to the research questions within the contextual frame of reference. In this interpretive case study, quantitative data were collected through the survey questionnaire but the data relating to the historical aspects, curriculum implementation and study of socio-cultural factors were primarily qualitative.

4.1.1 Why use a Case Study Approach?

A case study, like research of all kinds, has a conceptual structure organised around a small number of research questions that seek information or revolve around themes. Nine research questions dealing with four specific issues guided this research. Case studies are concerned about process and meaning rather than outcomes and rely on fieldwork (Merriam, 1998). Merriam also argued that there are four essential properties that distinguish case studies. Case studies are particularistic, in other words concerned about how a particular group confronts a problem. They are descriptive, that is complete and literal descriptions are provided of the units being studied. They are heuristic in that they illuminate the readers' understanding of the case and are inductive where reasoning is relied on to interpret the data grounded in a context.

Each of these four characteristics satisfies the needs of the study. First the research aims to study the science education reform process in Rwanda. Second this thesis aims to provide a detailed description of the process of science education reform in Rwanda. Third, this study is heuristic because it aims to make the reader understand the complexity of education reform in Rwanda; and finally the study is inductive because the data are interpreted by taking into account the complex realities of Rwanda. In this case study, I sought what is common and particular about the case and portrayed something of the uncommon by drawing elements from the nature of the case, the historical background, the physical setting, curriculum development and implementation, and the socio-cultural factors.

This study also draws on a constructive perspective, which assumes that there are multiple realities in which the researchers and their subjects create their own understanding (von Glasersfeld, 1987; 1993). According to Gergen (1995, p. 25), meaning is achieved through dialogue and communication between two or more persons, and is concerned with "negotiation, co-operation, conflict, rhetoric, rituals, roles and social scenarios...." Indeed, as described in Chapter 2, the lives of the Rwandese are in a constant process of co-operation, negotiation, survival and reconciliation especially in the post-genocide period. This investigation of the process of science education reform in a transitional society has interpretations that

are focussed on the questions “what is happening here?” and “what do the teacher and student comments mean from a human perspective?”

Furthermore, Cronbach (1975, p. 123) calls a case study an “interpretation in context” in which the aims are to seek a holistic description and explanation including identifying the significant factors of the phenomenon. Through this case study I have tried to provide a holistic description of factors affecting and influencing the science education reform process. As Yin (1984) observes, in a case study, it is impossible to separate the phenomenon’s variables from their context. In order for practitioners to take what is suitable in this case to their own situation, the contextual factors in which the interactions occurred must be fully understood. Chapter 2 of this thesis described in detail the variables that have influenced the education reform process in Rwanda. According to Giroux (1988, 1991), researchers need to place themselves in their work in terms of sex, race and culture in order to determine and negotiate the stance taken with subjects. As a head teacher, I had worked in Rwanda for two years from 1997 to 1999, established a school, hired and worked with local teachers and implemented the new curriculum from the Ministry of Education in my school.

I used a case study approach because a case study is the most appropriate format for school-based research and is the most memorable and meaningful endeavour for teachers (Hitchcock & Hughes, 1995). This study focuses on the exploration of a phenomenon (the science education reform process, i.e., the case) without experimenting upon it (Stake, 1994) and retaining the meaningful, holistic characteristics of real-life events (Yin, 1994, p. 14) over a defined period of time, the post-genocide period (Hammersley & Atkinson 1995; Merriam, 1988).

Similar to the representations used by Niyozov (2001), my research was bounded in space (the tiny land-locked nation of Rwanda), time (the post-genocide period), population (teachers and students), focus (context, curriculum, school environment, beliefs and dilemmas), and scale (primary and lower secondary schools). It was also interpretive, based on my experiences living and working in Rwanda and I had retained links with students, parents, teachers and workers (Hammersley & Atkinson, 1995; Merriam, 1988, 1998). In addition, my research focuses on the socio-cultural

context of the post-genocide period, thus becoming "more than an intensive, holistic description and analysis of a social phenomenon. Concerns with the socio-political and cultural contexts are what set this study apart" (Merriam, 1988, p. 23). In chapter 10, this study has produced researcher, teacher and student stories focused on the complex social, political and cultural realities of life in Rwanda.

Thus this case study is concerned with developing a rich and vivid chronological description of events; the research has endeavoured to describe and analyse events and focus upon teachers, students, education personnel and their perceptions. Data collection methods were used that discerned richness and complexity. The results of this case study represent my interpretations, understandings and reflections of the science education process in the unique context of Rwanda. I have made use of different methods of data collection, which have been chosen to take into consideration the complexity of the situation, are culturally sensitive and can be communicated to the reader.

4.1.2 Research Rigour in this Study

Rigour is just as important in research conducted from a constructivist disposition as it is from a positivist one. Where positivism concerns itself with validity, reliability and objectivity, the constructivist paradigm replaces these issues with credibility, dependability and confirmability respectively (Guba & Lincoln, 1989, 1994, 2000). Conventionally, internal validity and external validity are the artifacts of positivism. The issues of validity and reliability of the questionnaires are discussed later in this chapter. In the following paragraphs, I explain the notions of triangulation and validity in connection with this particular study. The purpose of this discussion is to indicate to the reader that the issue of rigour has been kept in mind during the course of this study.

4.1.3 Triangulation

The use of multiple data collection methods also can be seen as triangulation. Triangulation is not a tool for validation, but as an alternative to validation, this strategy adds rigor, breadth complexity, richness and depth to any enquiry. Patton (1990) describes different forms of triangulation, three of which have been used for this case study. First, triangulation of methods involves different techniques for data

collection that can combine both quantitative and qualitative methods. Because, there is no single method that can grasp all of the subtle variations involved in this particular research study, the application of multi-methods to this study is appropriate (Denzin & Lincoln, 2000). Second, using the accounts of different participants in the interview and observation process refers to multiple perspectives triangulation, which is also an important feature of case studies. Interviews and observations were carried out with multiple participants; thus, a multidimensional picture of the science education reform process was created by an amalgam of perspectives rather than only a single view. Respondent reaction to interviews and observations arising from the researcher's presence were counterbalanced where possible by use of written and archival materials (Denzin & Lincoln, 2000). Third, theory triangulation examines the study's different foundation principles of action and interpretation. The use of a multi-dimensional framework comprising epistemological, ontological and developmental perspectives makes theory triangulation important in this study.

4.2 The Quality Criteria of the Study

Analysis that is meticulously done, based on clearly articulated theories and which is responsive to research questions, must also yield results that are meaningful to the people for whom they are intended and described in a language they understand. Validity implies whether the results of this research are meaningful to the people in Rwanda and if the results can be used to improve programs and practice or solve issues in the area of science education. Patton (1990) asserts that validity is replaced by authenticity and credibility and that the ultimate test of an evaluation report is the response of information users and readers to that report. This is the test of validity. Is the report believable? As a researcher, I continually asked the question: Did I really understand and describe what I am studying in the same way that the people who live it do (LeCompte, 2000)? Patton recommends both openness and integrity in the conduct of the fieldwork and in the reporting of the results.

The discipline and rigor of qualitative analysis depends upon presenting solid descriptive data, which is often called thick descriptions (Denzin, 1994), in such a way that others reading the results can understand and draw their own interpretations (Patton, 1990, p. 375).

4.2.1 Credibility as Validity

Guba and Lincoln (1989, p. 237) preferred to use the term ‘credibility’ to internal validity and described it as an attempt to establish the match between the constructed realities of respondents and those realities as represented by the researcher. Polkinghorne (1995, p. 20) also referred to the importance of the credibility of a story and argued that triangulation using several independent reports of an event increases the validity of the event having occurred. In order to check the credibility of the research, some techniques are recommended by Guba and Lincoln (1989) and Merriam (1998). These techniques were prolonged engagement at the site of the enquiry, persistent observation, peer debriefing, and finally member checks of emerging data. In this study, the credibility issues were addressed in a way consistent with Merriam’s (1998) and Guba and Lincoln (1989) constructivist strategies by using both qualitative and quantitative methods for data collection. Member checks were made regularly during the course of the study. Peer debriefing took place as I discussed emergent themes with head teachers and teachers in schools in Rwanda and my supervisor. I also visited schools a number of times during the data collection period and had also visited some of the schools during the two-year period that I had previously worked in Rwanda.

4.2.2 External Validity as Transferability

External validity is concerned with the extent to which the findings of the study can be applied to other situations (Merriam, 1998). According to Guba and Lincoln (1989, p. 241) establishing transferability requires providing as “thick a database as humanly possible in order to facilitate transferability judgments on the part of others who may wish to apply the study to their own situation”. I have endeavored to provide a detailed description of the teachers, the students, the classrooms of the education system in Rwanda, including extensive details of time, place and contexts of the investigation.

4.2.3 Reliability as Dependability

Reliability is concerned with the stability of data over time or the extent to which findings may be replicated (Guba & Lincoln, 1989, 2000; Merriam, 1998). To ensure dependable results, Merriam (1998) suggested, stating assumptions, using triangulation and providing an audit trail. I have explained the use of triangulation to

increase the reliability. An audit trail, according to Guba and Lincoln (1989), is a process that is established, trackable and documentable so that the analysis of the collected data can be confirmed. Merriam (1998) explained the detail that was required for dependability and cited Goetz and Le Compte's (1984, p.216) interpretation "that other researchers can use the original report as an operating manual by which to replicate the study."

4.2.4 Objectivity as Confirmability

Guba and Lincoln (1989) proposed the concept of confirmability as a parallel notion for objectivity. Confirmability is concerned with "assuring that the data, interpretations and outcomes of the enquiry are rooted in contexts and persons apart from the evaluator" (p. 243). To confirm that the data has an audit trail that traces the conversion of data into findings and demonstrates that the findings are not simply part of the researcher's imagination was necessary for the study. Chapter 4 on research design and procedures establishes the confirmability audit so the process of data collection is clear, explicit and provides a level of detail that would enable other researchers to carry out a similar study.

4.2.5 Validity as Authenticity

The authenticity criteria are the hallmark of a trustworthy and rigorous enquiry and include fairness, educative authenticity and catalytic authenticity (Guba & Lincoln, 1989, 1994, 200). Fairness is thought to be the quality of balance so that all stakeholders' views, perspectives and voices are apparent in the text. Fairness is an attempt to prevent the participants of the study from being marginalized and to ensure that all voices in the enquiry are represented in the text. This research study includes the perspectives and voices of many of the participants: teachers, students and education personnel. Educative authenticity is the criteria for determining a level of awareness by the researcher and participants for research and social purpose. In this study, I have tried to understand the complexity of change in Rwanda and have incorporated aspects of socio-cultural and political changes (Denzin & Lincoln, 2000).

4.3 Research Methodology Matrix

Using a case study methodology, and a multi-dimensional framework the research study involved qualitative and quantitative methods, to study the science education reform process in Rwanda. The relationship between the five research questions, the instruments and the data collection strategies are shown in Table 2.

Table 2: Summary of Research Questions and Data Collection and Analysis Strategies

Research Questions	Data Type	Instrument Developed	Data Collection Strategy	Data Analysis
1) What are the historical and political factors influencing change in education in Rwanda?	Qualitative	Interview protocol	Historical data, Curriculum documents, Ministry of Education Reports,	Descriptive and Anecdotal
2) What is the status of the intended primary and secondary science curriculum?				
3) What dilemmas do teachers face in the implementation of a relevant science education program?	Qualitative	Interview protocol classroom observations and anecdotal evidence	Administering questionnaire, interviews and personal observations	Statistical, Descriptive and Anecdotal
4) What are the constraints faced by teachers in the implementation of a relevant science education program?				
5) What is the status of teachers and students in the study sample?	Qualitative and Quantitative	Interview protocol classroom observations and reports	Administering questionnaire, mining data, interviews and observations	Descriptive and Narrative
6) What are teachers' perceptions of the school environment?				
7) What are teachers' beliefs about science teaching?				
8) What are students' attitudes towards learning science?				
9) What is the influence and effect of socio-cultural and political factors on the lives of teachers and students in a transitional society like Rwanda?	Qualitative	Interview protocol	Mining data from reports historical documents and interviews, personal reflections	Descriptive, Anecdotal and Narrative

4.4 Data Collection Procedures

Fieldwork took place over a period of three months in Rwanda in one main cycle of data collection, eliminating the practical and economical difficulty of traveling to Central Africa from Australia twice. When I began my fieldwork, I knew the country well and personally knew the Minister of Education, the Director of Primary Education and the Director of the national Examination Board. This personal knowledge allowed me access to schools in the form of a letter from the Education Minister who was extremely supportive of the research and was keen to know the outcomes of the study. (See Appendix K and L for letters of introduction.)

The fieldwork was planned in English-medium schools, but this decision changed after meeting the Minister of Education, as he recommended that I also administer the questionnaire and carry out observations in French-medium government schools. Subsequently, I hired and worked with a local bilingual (English and French) teacher, Celestin, who translated the student and teacher survey instrument into French. I also hired a cab driver, Anton, to take me on my journeys to the Rwandan schools. If not for these two young men, the collection of data for the study would have been very difficult, especially in the rural areas of Rwanda. Working with two local people who were educated and multi-lingual but who did not have steady or well-paid jobs also provided a very different dimension to the study, enabling me to gain insights into everyday hardships that people in Rwanda face. Discussions with Celestin and Anton opened new dimensions of reflection for me. The three of us formed an unusual partnership becoming a common sight as we visited libraries, schools, and photocopied material or shared a coke and samosas at a roadside café. This partnership reaffirmed my perceptions about the difficulties that even the educated in transitional societies face.

4.4.1 The Schools

This case study comprised 12 schools that were government (3), government catholic (3), private (4), private Christian (1) and a school administered by a women's Non Government Organisation (1). The urban (5), semi-urban (2) and rural (5) schools displayed a range of resource adequacy, infrastructure, teaching staff, student make-up

and administrative structures. There were three primary schools, five secondary schools, two primary and secondary schools and one pedagogical high school that trained students as primary teachers. In addition, data sources included the Kigali Institute of Education for student teachers training to be primary and secondary science teachers. Six schools were bilingual having both French and English streams, four were Anglophone and two Francophone.

Schools in Rwanda existed within a formal hierarchical structure (Ministry of Education, 1997a). I first had to visit the school and meet with the head teacher because most schools did not have a telephone and it was necessary to make that first visit to establish contact and explain my research. On several occasions, I had to repeat these visits, as the head teacher was not available. All schools were presented with a letter of introduction from the Minister of Education, explaining that the research was officially approved and was not an inspection. This official letter of approval, which carried with it the benefits of enhanced access (Lewin, 1993), was also shown to educators and senior education personnel prior to conducting interviews.

4.4.2 Design of the Questionnaire

The use of surveys is one of the most common methods used in research. According to Pareek and Rao (1980), one needs to consider the extent to which a survey is meaningful to the culture in which it is to be conducted, particularly if it is used in cultures different from the one in which it was developed. The use of multiple methods of data collection helped me to interpret the questionnaire data and provided a more meaningful account of science education in Rwanda this is further explained in Chapter 9 of the thesis. In this research study, I used modified instruments for the teacher and the student questionnaires that were modified to suit the needs of Rwanda.

Within the context of the present study involving Rwandan teachers and students, the design of the questionnaire was important in determining the quality of data and response rates. Separate questionnaires developed for students and teachers were based on instruments used in prior established studies in a developing country context. The

instruments had already been validated and reliable results had been obtained in Australia, Indonesia, South Korea and Brunei. Results have been discussed under the specific instruments mentioned later in this chapter. This approach was taken because of the difficulty of conducting a pilot study of the questionnaire due to the complex situation of the country and logistical constraints of a single visit to Rwanda. A number of studies examining questionnaire design indicated that critical elements include structure, length, appearance and cover page of the questionnaire (Boser & Clark, 1992) and those elements are described in Table 3.

Table 3: Summary of Questionnaire Design Elements Used

Design Element	Questionnaire
Questionnaire Items	The use of Likert scale Each item and response appear on the same page
Questionnaire length	Teacher Questionnaire: items on 6 pages Student Questionnaire: items on 6 pages
Questionnaire appearance	Professionally printed Curtin University logo Green coloured for student questionnaire Buff coloured for teacher questionnaire
Cover Page	Use of SMEC name Brief explanation about research and outline Statement of confidentiality Name and address of the researcher

The English version of the questionnaire was translated into French by a bilingual teacher, and then back translated by an independent third party. Two French teachers, who also were bilingual, then checked the back translations to ensure that the French version maintained the original meanings and concepts of the original English version (Brislin, 1970). Since the goal of this aspect of the research was to adapt the survey instrument for Francophone Rwandan teachers and students, the modified and translated instrument needed to be as similar as possible to the Anglophone version by identifying and minimizing cultural differences, finding equivalent words and phrases, ensuring that

the essential meaning of the text did not change, ensuring that the difficulty level of the items did not change (Martin & Gregory, 2000).

4.4.3 The Students

Four hundred and seventy four students from the 12 schools described in section 4.3.1 took part in the study; 332 were English-speaking students and 142 were French-speaking students and included students from Year 6 to Year 12.

4.4.4 The Teachers

The teacher questionnaire was administered to 125 teachers in the 12 Rwandan schools of whom 95 were English-speaking and 30 were French-speaking. In most schools, I was present when the questionnaire was administered but in three schools - two private primary schools and a government secondary school - I was asked to leave the questionnaire with the teachers and then come back at a later date to collect the questionnaire. The Director of Studies in each of the schools took up the responsibility of collecting the questionnaire from the teachers. At the Kigali Institute of Education, the teacher questionnaire also was administered to 30 student teachers, many of whom had already been teachers and had returned to upgrade their skills and work towards an undergraduate degree. However, because the physics student teachers were busy having lectures at a particular time and the biology and chemistry student teachers had lectures at different times, seeing the student teachers together was difficult and involved going to the Institute several times.

4.5 Quantitative Data Collection

4.5.1 The Teacher and Student Questionnaire

Part A and B of the student and teacher questionnaires were very similar, with minor differences in wording appropriate for students and teachers.

4.5.1.1 Part A: Teachers' and Students' Background Information

The first section of the questionnaire contained items designed to elicit background information from the study participants. (See Appendix M, N, O and P for French and

English teacher and student questionnaires.) Data sought from teachers included sex, age, years of teaching, educational qualifications, type of school, areas of teaching expertise and details of any professional development activity. Data sought from students included sex, age, type of school and year level. Analyses of these descriptive data are presented in Chapter 9.

4.5.1.2 Part B: The Development-Related Functions of Science

The purpose of this section of the questionnaire was to solicit views from teachers and students on the potential development-related functions of the new science curriculum and to obtain opinions regarding the importance of the development-related functions in the context of the new curriculum implemented in 1998. This section used items modified from a study carried out in Botswana by Vlaardingerbroek (1998). Examples of stated development-related functions of science were “the science curriculum promotes active interest in preserving the natural environment”, “the science curriculum equips young people with skills to be self-employed” and “the science curriculum promotes a healthy diet and an avoidance of drugs.” The response categories for each item were arranged on a 5-point Likert scale from strongly disagree (1) to strongly agree (5).

4.5.1.3 Part C of the Teacher Questionnaire: The School Level Environment Questionnaire

The school environment makes a major contribution to the effectiveness of a school (Fisher & Fraser, 1990). A modified version of the School Level Environment Questionnaire (SLEQ) was administered to Francophone and Anglophone Rwandan teachers. For Rwanda, a modified version of the SLEQ was used with four scales: Affiliation, Staff Freedom, Resource Adequacy and Work Pressure were used in the final modified instrument containing 19 items. These four scales seemed most appropriate to the Rwandan context. Affiliation measures the relationship dimension; Staff Freedom is measured by the system change dimension, Resource Adequacy and Work Pressure by the system maintenance dimension. All items were arranged in a cyclic order. Each scale had positively and negatively marked items. Positive items are

scored 5 for strongly agree to 1 for strongly disagree. Negative items are scored in the reverse manner. The analysis of the items for reliability included information about each scale’s internal consistency and discriminant validity. This has been included in Chapter 9. Examples of positive items and negative items for each scale along with the scale description are listed in Table 4.

Table 4: Description of Scales, Examples of Sample Items and Scoring in the Modified SLEQ Instrument

Scale name	Scale Description	Sample item	Scoring
Affiliation	Teachers can obtain assistance, advice and encouragement and are made to feel accepted by colleagues.	I feel accepted by other teachers.	(+)
		I seldom receive encouragement from colleagues.	(-)
Staff Freedom	Teachers are free of set rules, guidelines and supervision to ensure rule compliance.	I am not expected to conform to a particular teaching style.	(+)
		I am supervised to ensure that I follow directions.	(-)
Resource Adequacy	Support personnel, facilities, finances and resources are adequate and suitable.	The library includes an adequate selection of periodicals and books.	(+)
		The supply of equipment and resources is inadequate.	(-)
Work pressure	The extent to which work pressure dominates the school environment.	There is constant pressure to keep working.	(+)
		Teachers do not have to work very hard in this school.	(-)

4.5.1.4 Part D of the Teacher Questionnaire: Teachers’ Beliefs about Science Teaching and Learning

Part D of the questionnaire comprised a modified version of the original Science Teachers’ Efficacy Belief Instrument (STEBI) (Enoch & Riggs, 1990). Within the

context of the current study, 11 items of the original instrument were administered to Anglophone and Francophone teachers in Rwanda. The instrument consisted of two scales, Self-Efficacy and Outcome Expectancy. The two scales evaluated by the modified instrument assess elementary science teacher's estimates of personal effectiveness in teaching science. The items used Likert scales and positively and negatively worded items to assess science teachers' beliefs about their teaching. English and French versions of the instrument were administered to science teachers in Rwanda. Examples of scale descriptions and sample items are in Table 5.

Table 5: Description and Examples of Science Teachers' Efficacy Beliefs Instrument Scales

Scale name	Scale Description	Sample item	Scoring
Science Teaching Outcome Expectancy	Student learning is influenced by effective teaching	When a student does better in science it is often because the teacher exerted a little extra effort	(+)
Personal Science Teaching Efficacy	Teachers are free of set rules, guidelines and supervision to ensure rule compliance.	I continually find better ways to teach science	(+)

4.5.1.5 Part C of the Student Questionnaire: The Measure of Student Related Attitudes

The Test of Science-Related Attitudes (TOSRA) is designed to measure seven distinct science-related attitudes among secondary school students. For this study, two scales, Attitude to Scientific Enquiry and Enjoyment of Science Lessons of five items each were administered to students in Rwanda. It was the aim of the researcher to use TOSRA to obtain information about the science-related attitudes of Rwandan students. A major advantage of TOSRA is that it yields a separate score for a number of distinct attitudinal aims and this makes it possible to obtain a profile of attitude scores for groups of students (Fraser, 1982). The scale description and examples of sample items are

shown in Table 6. The response categories for each item were arranged on a 5-point Likert scale of strongly disagree (1) to strongly agree allocated a score of (5).

Table 6: Scale Description and Examples of Sample Items of two Scales of Student Related Attitude.

Name of Science-Related Attitude	Scale Description	Sample item	Scoring
Attitude to Scientific Enquiry	This scale measures attitude to scientific enquiry and experimentation as ways of obtaining information about the natural world.	Science lessons are fun.	(+)
		The material covered in science lessons is not interesting.	(-)
Enjoyment of Science Lessons	This scale measures the enjoyment of science learning experiences.	I prefer to do experiments than to read about them.	(+)
		It is better to ask a teacher the answer than to find out by doing experiments.	(-)

4.5.2 Analysis of Quantitative Data

The quantitative component of the study with validity, reliability and objectivity is explained in this section. Frequency distributions were carried out for Part A of the questionnaire and the results are presented in Chapter 6 in the form of pie charts and graphs in response to specific research questions. A bar graph presents results of Part B of the questionnaire related to the development-related functions of science education showing the relationship between the developmental aspects of the new curriculum and the percentage of teachers' and students' perceptions of their incorporation into the new curriculum. For sections C and D of the teacher questionnaire and section C of the student questionnaire, analysis included factor analysis, internal consistency reliability (the extent to which items in a given scale measure the same aspect), discriminant validity (the extent to which a given scale measures a unique aspect not measured by

other scales) and calculation of means. Factor analysis was used to examine the fit of the conceptually derived instrument scales with statistically derived factors. Details of these analyses are provided in Chapters 6 and 7.

4.5.2.1 Reliability Coefficients

In interpreting reliability coefficients, McMillan and Schumacher (1993) indicate that an acceptable range for most instruments is .70 to .90. However, these authors suggest that as reliability is essentially a function of the nature of the trait being examined, measures of achievement should generally have high reliabilities. On the other hand, measures such as personality may have lower reliabilities. Further, high reliabilities are required if results are used to make decisions about individuals whereas studies of groups can tolerate lower reliability. The same authors suggest that a reliability of .50 is acceptable in exploratory research (McMillan & Schumacher, 1993).

4.5.2.2 Internal Consistency Reliability

In the development of a questionnaire, it is necessary to establish that each item in a scale assesses a common construct. If this is the case, then the scale is referred to as being homogenous or having internal consistency. The internal consistency of each scale in the three instruments used in the questionnaire, i.e. the SLEQ, the TOSRA, the Teacher Belief instrument, was established using Cronbach's (1970) alpha coefficient. The results for the internal consistency of the scales of the questionnaire are described in Chapters 6 and 7 as responses to research questions.

4.5.2.3 Factor Structure

Establishing meaning for grouping of items identified by factor loadings is important in establishing validity with factor analysis and these groupings should make sense (Tabachnick & Fidell, 1996); 0.30 is generally considered to be the least item correlation for useful items (Coakes & Steed, 2000). Factor analysis is typically undertaken to validate the scale structure of an instrument using the data obtained from a sample of respondents completing the total instrument and is a way of determining the nature of underlying patterns among a large number of variables. The factor analysis for the

modified School Level Environment Questionnaire, the modified Teacher Beliefs instrument and The Science Attitude Scale are presented in Chapter 9.

4.5.2.4 Discriminant Validity

Discriminant validity assesses the extent to which a scale is unique in the dimension that it covers (i.e., the concept is not included in another scale of the instrument). As a convenient index of the discriminant validity of raw scale scores, the mean magnitude of the correlation of one scale with other scales in the modified SLEQ, the modified Teacher Beliefs instrument and two scales of the TOSRA was calculated.

4.5.2.5 Means and Standard Deviation

The mean and standard deviation of each scale from the SLEQ and Teacher Beliefs instrument of the teacher questionnaire and TOSRA of the student questionnaire were computed to provided a measure of the extent to which the scores deviated from their mean for each scale. The means obtained were used as a primary source of comparison between scales.

4.6 Qualitative Data Collection Methods

Socio-historical qualitative research stresses that any phenomenon, including teaching, has meaning only within a context, which illuminates its history, development, underlying assumptions, current location and future trends (Hathaway, 1995; Merriam, 1998). Data collection methods involving classroom observations, interviews, historical and documentary data, curriculum analysis and researcher's interpretation about social and cultural issues in Rwanda were designed to capture a richer interpretation of the various influences in the education reform process. Classroom observations were carried out in science classrooms to provide insights into the teaching practices, which occur in this transitional society. Interviews were used since they can provide a rich source of insights into cultural aspects (Fontana & Frey, 2000). Mining data from historical and policy documents was an integral and important part of the qualitative data collection process and this has been further explained in the Section 4.6.1 on mining data in this chapter. An overview and analysis of the science curriculum documents provided

insights into the implementation of the science curriculum and has been detailed in Chapter 5.

4.6.1 Classroom Observations

Classroom observations have been widely used in educational research and can be used to validate other sources of data. When using this methodology in a cultural setting other than my own, as a researcher I had to consider subject reactivity (the possibility of subjects changing their behaviour because they are aware of being observed), cultural relativism (the cultural aspects such as social background that can affect the way in which a researcher interprets observations) and observer bias (the chances of observers using their own values to interpret observations) (Longabaugh, 1980).

Non-participant observation of five theoretical lessons in the classroom and four practical science lessons in the laboratory in four different schools provided the opportunity to gain deeper insights into teaching practices in Rwanda. The selection of classes for classroom observation was based on the enthusiasm and willingness of the teachers to open their classrooms to outside scrutiny and their willingness to be open and candid with the researcher.

For classroom observations, I employed a semi-structured observation schedule (See Appendix Q for the observation schedule used in the study.), modified from the one used by Thair (1999) in Indonesia and Australia that focused on aspects of the science curriculum in action. The schedule was used to capture interactions of the whole class or group of individuals and to differentiate different types of teacher and student activities. The schedule is based on guidelines provided by McKernan (1991) and the overall classroom ethos, lesson activities, approaches used to facilitate student learning, general classroom climate and participation by students were areas examined. During observations, I took on the role of a non-participant observer, by attempting to gain an insider's perspective without being involved in activities (Adler & Adler, 1994). As recommended by Denzin (1989), the observations were recorded in the form of notes and included references to participants, interactions and interpretations in the classroom.

The classroom observations often were followed by an interview or discussion, which helped me interpret and understand what had occurred during the lesson and also served to cross check findings, lending greater credibility to the findings.

I observed one theoretical lesson on the periodic table in a classroom in a well-resourced private school and a practical lesson on floating and sinking in a Year 6 classroom in an extremely poorly resourced rural school. I also observed a practical biology lesson on food and nutritional value in the laboratory in a Year 9 class in a well-known rural government high school, and a practical and theoretical chemistry lesson on the mole and molar values in a government secondary school that trains primary teachers. Finally, I observed a theoretical lesson on the human body in a private school.

4.6.2 Note Taking in School

I also took advantage of situations as they presented themselves. As travel to rural schools meant that I spent the entire day at the school, I could learn a lot during breaks and lunchtime listening to staff conversations. When walking around schools, I was able to acquire a sense of common patterns of work. I also observed the infrastructure, resources and always asked to see the school laboratory. Noting the thickness of dust on the apparatus gave me an indication of the frequency of its use. I asked about the availability of textbooks, as these were not published in Rwanda and extremely scarce. I made notes of my observations during my visits to each school and the data collected in this way gave considerable insight into the learning milieu of the schools (Lewin, 1990b).

4.6.3 Interviews

The interview is a conversation, the art of asking questions and listening and is not a neutral tool, for at least two people create the reality of the interview situation. The method is influenced by the personal characteristics of the interviewer and interviewee including class, gender and ethnicity (Denzin & Lincoln, 2000). According to Fontana and Frey (1994), interviews provide insights gained by talking to the participants and provide a flexible method of data collection. Interviews can be both structured and

unstructured, providing information that is considered authentic and reliable depending largely on the situation (Lewin, 1990b). The type of questions framed and the way in which the questions are posed should take into consideration the background of the interviewer and the interviewee. In addition, the interviewer's sex, race, culture and attitude can have a distinct effect on the responses (Fontana & Frey, 1994).

I used semi-structured interviews in this study to accommodate a flexible approach and provide scope to probe responses. I was guided by an interview schedule for the interviews (See Appendix R for the interview schedule used in the study). I used the schedule to ensure that key topics were discussed with all interviewees, though not in the same order and in the same depth. My translator and interpreter accompanied me to those interviews in Rwanda where the interviewees were French speaking. Interviews with teachers, students at secondary level, senior education personnel and head teachers were designed to provide a better understanding of the system in existence.

Twenty educators, including teachers, heads of department, personnel from the Ministry of Education, the Institute of Science and Technology and the Institute of Education, were interviewed. The interviews covered a number of areas including science teaching, the new curriculum, examinations, professional development activities and the future of the education system in Rwanda. In addition, group interviews were arranged informally as the opportunities arose, as they were not planned as a central feature of the data collection process. Data from the student interviews were designed to enrich the study and help with the interpretation of questionnaire responses. Whenever possible, I also interviewed teachers after I had observed their science lessons. The difficulty of traveling within Rwanda did not allow me to visit schools as many times as I would have liked.

For some interviews I used a range of questions that were appropriate for different informants. For example, the Director of the National Examination Board was asked questions on the examination process and the Director for Secondary Education was asked questions specific to secondary science education. I tried to let interviewees

recount stories of events in their schools that would give insight into sources of agreement or disagreement with aspects of science teaching or the new science curriculum. I allowed the interviewees to do most of the talking. The data from interviews were used to support the results of the quantitative data and were also organized in the form of vignettes to enrich accounts of different aspects of the implementation of the new science curriculum (Lewin, 1990b). (See Appendix S and T for a transcribed English and French interview.)

4.6.4 The Key Informants

Although 20 education personnel were interviewed, four teachers whom I had worked with during my two years in Rwanda formed my key informants. I had interacted with them over a period of two years and interviewed them formally and informally on several occasions during the course of data collection. Chapter 5 of the thesis focuses to a major part on my interactions with these four teachers: Bathilde, Jean-Bosco, Didier and Socrates. Bathilde and Jean-Bosco were survivors of the genocide, had experienced and lost family to the genocide. Didier and Socrates were refugee teachers in neighbouring countries of Uganda and Burundi, respectively, and had returned to Rwanda after the genocide.

Bathilde was a teacher in my school when I taught in Rwanda. During the genocide she hid in the forest for three months and lost most of her family except her oldest child. Bathilde has seen pain, loss, war and bloodshed. The three months when she was in hiding in the bush gave her a new perspective on life. She has married again and built a new home. Bathilde is excellent at training young children to perform in oral poetry and song. Bathilde does not talk about leaving Rwanda but about rebuilding and about hope for the future. Although not very highly qualified, having only a Diploma in Education, she is a very talented and well-respected teacher. The concepts of planning, class displays and assessment were new to her but she was very vocal and passionate about education for the children of Rwanda.

Jean Bosco was one of the youngest staff members in the school. The war broke out whilst Jean Bosco was a student of languages at the University. His mother, father and sister hid in a church for shelter during the genocide. His father disappeared during this period and even after five years his mother grieves for her husband, as she does not know what has happened to him. Jean Bosco and his brother escaped from the '*interahamwe*' and his brother joined the rebel army only to be killed. Jean Bosco carries tremendous burdens for a young person and has the keen desire to study further. However, he cannot do so at this stage as his mother needs him, nor does he have the means. Jean Bosco was fluent in English, French and Kinyarwanda and taught at all primary levels. An extremely popular teacher, he was very approachable and a happy person in spite of the trauma that he had experienced.

Didier was a refugee in Uganda for the last three decades before the genocide. He is among the Rwandese who were born and raised as refugees after his parents fled the country during the 1962 rebellion. Of his life in exile, Didier says: "It was an experience that taught me how to relate with people from diverse cultures". Having trained and obtained a Diploma in Education, he was a young, enthusiastic teacher who came back to Rwanda to help rebuild the country after the genocide. Gentle and dedicated, he was fortunate to be part of a professional development program in Uganda that trained teachers in the child-to-child program where a child in school becomes the link between school, home and the community. Didier taught at my school for two years during my time in Rwanda and still teaches there. He was an exemplary teacher teaching the Year 6 class and training students to appear for the national examinations at the end of Year 6. He would like to educate himself further and upgrade his qualifications, but he does not have the resources or the facilities to do so.

Socrates was one of the few Rwandan University graduate teachers and had returned to Rwanda from Burundi after living there for three decades. Socrates had a deep commitment to rebuilding Rwanda and was especially interested in justice and reconciliation. He talked about studying for a law degree so as to help the justice system in the country. Socrates was appointed a coordinator of science at the school where I

worked at and had a natural ability and skill of working with people. He was always looking for ways in which small communities could be established in the school or in the neighbourhood.

These four teachers were my main informants for data that comprised Chapter 6 on dilemmas encountered by Rwandan teachers. I had talked to them extensively when I worked as a head teacher in Rwanda and during the data collection phase. Chapter 6 also contains interview quotes from our discourse and interactions.

4.6.5 Coding of Interviews

According to Cohen, Manion, and Morrison, (2000) coding is a process that helps in defining categories and organizing them into some form of order and structure, that is, establishing “units of analysis of the data indicating how these units are similar to and different from each other” (p. 148). This process may be conducted by using different forms of coding. Open coding is the process where the researcher forms the initial categories, axial coding is a process where the researcher assembles the data in a different way after open coding. In selective coding, the researcher identifies an excerpt from the data and writes a story that will result in the integration of categories in axial coding.

Ryan and Bernard (2000) also regard coding as an important aspect of whole text analysis, and have a view that it is through coding that the researcher is able “to make judgments about the meanings of contiguous blocks of text” (p. 780). One of the major tasks related to coding is being able to define and locate items within the data records (LeCompte & Preissle, 1993). Coding is regarded as an important aspect of interview analysis, especially in case study research, as it is an approach to analysis of social episodes in terms of the actors themselves (Cohen et al., 2000, p. 21).

Within the context of this study, coding helped in defining categories or themes of the interview data. The themes were categorized into specific areas of constraints faced by teachers and students and have been explained in Chapter 7. Coding in this thesis has

been presented in a manner so as to be able to locate items within interview data. The format is a simple one and I have used an eight-character code (for example E.A.T3.05.00 or F.H.EP4.06.00) to cross reference data to the interview transcripts. The first letter identifies if the interview is in English (E) or French (F), the second character identifies if the interview was audio-taped (A) or hand written (H), the third and fourth character represents if the interviewee was a teacher (T), senior teacher (ST) or education personnel (EP), each interviewee was assigned a number which represents the next character, the last four characters represent the month and the year of the interview. In the similar manner, field notes were coded as (FN.S1.05.00); which read as notes made during a visit to School 1 in May 2000. Classroom observations were coded as (CO.P/T.S3.06.00) which cross-referenced as a classroom observation of a practical or a theory lesson in school 3 during June 2000.

4.6.6 Analysis of Qualitative Data

Qualitative data for this study comprised interviews, classroom observations, curriculum documents, data from historical documents and reports from the Ministry of Education. To turn data into results involved as a first step putting all field notes and interviews into a file in order of their date of creation and categorising files on the basis of the participants and type of data (e.g., interviews, field notes, classroom observations). The next step involved finding similar items or units of analysis. Once these items were identified, they were then organised into groups and items that were similar. By looking at each set of interview and classroom observation data, step three involved creating patterns so that the data now began to resemble a coherent explanation or description of aspects that might be contributing to the science education reform process (Merriam, 1998).

The final step involved linking each group of related patterns to build an overall description as answers to the research questions. Using the steps detailed above, data collected from the interviews with teachers, students and education personnel brought out emerging themes or categories that highlighted the dilemmas and constraints that are being faced by practitioners in the implementation of a relevant science education

program. The themes were related to the changes that had taken place and were taking place in Rwanda in the years before and after the war. The complexities of the change process and the interrelated changes taking place at a structural, pedagogical and curriculum level have been highlighted by the emerging themes that are discussed in Chapter 7.

4.7 Documentary Data

4.7.1 Mining Data from Historical Documents and Reports

Historical and cross-cultural studies are areas where documents are crucial to an investigation (McMillan, 1992). The documents sought existed independent of a research agenda and were therefore non-reactive and did not affect the research process. They were a product of the context in which they were produced and therefore grounded in the real world.

Historical data were generated based on a study of documents from the Ministry of Education and World Bank covering a period of 23 years from 1977 to 2000 in Rwanda. The policy documents and reports helped look for facts and specific events related to education policy and reform of the past two decades (McMillan, 1992). Interpretation of historical documents took on special importance because events had occurred and it was important to describe, analyse and interpret them (Wiersma, 1991). I used library searches extensively and identified past and present research. The World Bank documentation centre in Kigali, Rwanda had an extension collection of reports since the first 4-year plan was implemented in Rwanda in the early 1970's. Senior Ministry of Education staff helped me obtain the most recent policy documents available in the education sector after the genocide. The policy documents and reports helped look for facts and specific events related to education policy and reform of the past two decades (McMillan, 1992).

Historical data brought to light that the education reform process in Rwanda had been ongoing and had always been funded by the World Bank and the UNDP, but this process has often been marred by the political, ethnic and socio-cultural agenda of the leaders in

power. Determining the authenticity and accuracy of documents was part of the research process and my responsibility as researcher to determine as much as possible about the historical documents and ministerial reports, their origins, the author and context. Analysis of historical data gave contextual richness to the analysis of data collected from questionnaires, interviews, observations and curriculum documents. Documents helped uncover meaning, develop understanding and discover insights (Merriam, 1988).

4.7.2 Science Curriculum Documents

The Primary Years 1 to 3 science curriculum program is written in Kinyarwanda, the local language of Rwanda, while the Years 4 to 6 had a curriculum document in French and English in the same booklet. My interpreter, Celestin, translated the Year 1 to Year 3 curriculum into English. From the Years 7 to 9, physics, chemistry, biology, agriculture and technology are compulsory for all students. After Year 9, students chose the subject stream that they want to pursue and specialize in. In the sciences they choose the biology-chemistry option, the mathematics-physics option or the teacher training option.

For analysing the curriculum, I undertook an intrinsic and performance analysis of the curriculum similar to that conducted by Lewin (1990b) in Malaysia and Sri Lanka. The intrinsic analysis used criteria embedded in the curriculum materials to reach judgments about their presentation, purpose, consistency, and quality of design with respect to content, pedagogy and evaluation procedures. An overall summary outline of the curriculum documents has been included in tabular form for lower primary, upper primary, lower secondary (Ordinary-level) and upper secondary (Advanced-level) science in Chapter 5. The performance analysis of the curriculum was based on the classroom observation data that examined the programme in action through the observation of both theoretical and practical science lessons.

4.7.3 Narrative and Narrative Analysis

As this study progressed, I became aware of the importance of examining social and cultural factors that might influence the learning environments in each country. Through

personal reflections, the present study involved interaction with respondents, which enabled the researcher to embark on a transformative process and understand the complexity of the education reform process in Rwanda (Giroux, 1988). The researchers' critique and reflexivity, as advocated by Fonow and Cook (1991), is concerned with the researcher's critical awareness of his or her assumptions, beliefs and actions (or the researcher's voice in the enquiry). Critical reflexivity acknowledges that the researcher is an integral part of the setting, and context that I, as the researcher, was trying to understand and represent. Most importantly, reflexivity in research allows more space for the voice of the people who are being studied. I wrote vignettes that took into account social action that is "locally distinct and situationally contingent" (Erickson, 1998, p. 1155) and was designed to develop a clearer picture of the interplay of factors.

Narrative Analysis is the first of Polkinghorne's (1995) narrative categories and involves the construction of narratives or vignettes from raw data. Data elements can be configured into a vignette in the process of narrative analysis where the vignette often begins with the events and actions that are reconstructed to show how and why an outcome has occurred. This process of developing storied accounts from personal histories has been described as narrative unity as it gives meaning to the personal and professional experiences of teachers and students. I have presented the vignettes as described by Guba and Lincoln (1989) who suggest that the analysis is "characterised by a thick description that not only clarifies context but also makes it possible for the reader to experience it" (p. 181).

Vignettes were used to represent a way of knowing and thinking (Casey, 1995), making use of the researcher's images, understanding and interpretations. After many of my observations, I wrote stories of real life situations during the data collection phase that affected me personally both as a researcher and a human being. These stories are designed to portray the complicated interplay of settings of science classroom in various parts of Rwanda.

In this study, the focus is on vignettes that preserve the complexity of human action with its changing interpersonal and environmental contexts. All vignettes have been created and constructed from non-fictional and real, remembered accounts of events that have occurred. One vignette is represented as a biography. The vignettes have a very specific syntactic shape (beginning-middle-end) and with a subject matter, which allows for or encourages the projection of human values upon this material (Scholes, 1981, p. 205). The constructed representations of my experience, in the form of vignettes, are presented in Chapters 6, 7 and 8.

I have used Polkinghorne's (1995) analysis of narrative to interpret and analyse the vignettes. The vignettes have been interpreted using two perspectives: the socio-cultural and practical perspectives. The vignettes were subjected to a process of constant comparative analysis whereby the vignettes were read and reread and an interpretive commentary was provided at the end of each vignette in terms of the socio-cultural and practical perspectives. The use of multiple perspectives has been explained in Chapter 3.

4.7.4 Photographs

The use of photography as a tool for enquiry is not widely used by science educators. Recognizing the complexity of the relationships in Rwanda, I believed that photographs would assist me in understanding and making meaning of the difficulties of life in Rwanda. As a holistic way of representing knowledge, Schratz and Steiner-Loffer suggest "breaking down reality into photographic image is an act of constructing new realities in our conceptual world" (1998, p. 246). I have avoided placing participants in any position of vulnerability that might accompany the identification and critique of situation. I have used eight pages of photographs and brief accompanying photographic essays in the Appendix U1 to Appendix U7 to give the reader an idea of the complexity of life, schools, laboratory work and culture in Rwanda. The photographs are an attempt to take the reader on a visual journey through schools and classes in Rwanda.

4.8 Summary of the Chapter

Cross-cultural studies are able to draw their methodology from a range of disciplines, including psychology, sociology, philosophy and anthropology. There is no single scientific method that applies to studies across cultures and the choice often depends upon the research questions posed. This interpretative case study combined quantitative and qualitative research methods to examine the science education reform process in the transitional society of Rwanda. The research used a case study methodology within a multi-dimensional framework. The present case study used multiple methods enhancing the credibility of the findings through triangulation and providing richness to the data. It has been widely accepted that multiple methods in any study are useful in achieving greater understanding (Keeves & Adams, 1994; Tobin & Fraser, 1998).

Questionnaires were administered to students and teachers and provided an overview of development-related functions incorporated in the new curriculum, the school environment, the science efficacy beliefs and attitudes to science lessons. The data collected after administering the instrument to teachers and students in Rwanda were analysed for frequency distribution and to check reliability and validity of the questionnaires. Descriptive analyses described the age, gender, qualification and issues related to the professional development of teachers. Descriptive data also looked at the age and gender issues pertaining to students in Rwanda.

Observations were carried out in the classes of six teachers in Rwanda and recorded in the form of field notes. Teachers were then interviewed after the classroom observations. Notes and recordings of classroom observations gave rise to emerging themes that highlighted dilemmas and constraints in the implementation of the science curriculum. Interviews were held with teachers, student teachers, students, educators and officials from the Ministry of Education. Some of the interviews were tape-recorded. Interviews provided a rich source of insights into cultural aspects and also gave rise to emerging themes and dilemmas. Semi-structured interviews provided the opportunity to determine the limits of the respondent's knowledge and understanding and allowing probing in order to clarify misunderstandings.

Historical documents over a period of 23 years drew light on the past volatile history of Rwanda but also provided dramatic insights into the life, environment and traditions of the Rwandans. Science Curriculum Documents from Year 1 to Year 9 were analysed for scope, content and pedagogy.

The data from the interviews, classroom observations and my personal notes, were used to construct vignettes, to illustrate the complexity of the change process. The vignettes helped understand political, social, economic, ethnic and cultural factors that influence the education reform process. The richness and nuance of incidents in the Rwandan context are demonstrated and evoked in Chapter 8. Chapter 5 provides an analysis of primary and secondary science curriculum documents and a brief description and analysis of classroom observations of two science lessons.

CHAPTER FIVE

CURRICULUM INTENT AND IMPLEMENTATION: AN ANALYSIS OF THE SCIENCE CURRICULUM DOCUMENTS

The process of curriculum development appears much neater and much more predictable in textbook versions of curriculum development than it is in practice. (Eisner, 1994, p. 371)

5.0 Introduction

Between April and May 1996, a Commission was appointed by the Ministry of Education in Rwanda, led by a curriculum design specialist from Canada, to harmonise the primary and secondary curriculum in all subjects and to produce a new curriculum document. Each subject had a group of seven members, also known as the Commission of Teachers, which consisted of four members who were teachers from government schools or from the University of Rwanda, two secretaries to record the discussions in French and in English and a subject chairman (Ministry of Education, 1996). The commission developed a draft curriculum and the final published documents were published and presented to schools in September 1998 (Ministry of Education, 1998b).

When the new curriculum was implemented in Rwanda at the beginning of the academic year in September 1998, I was the head teacher of a school in Rwanda. Every school in Rwanda was provided with several sets of curriculum documents by the commune inspectorate. The primary Years 1 to 3 curriculum documents were printed in the local language, Kinyarwanda. Every subject had a curriculum document book and from Year 3 to Year 12 each document was printed in French and English. The inspectorate conducted a two-day orientation of the new curriculum in Kinyarwanda that was attended by Socrates and me. However, the documents provided to each school did not come with supporting teacher resource material; there were no textbooks and no teacher guides given to the schools to help implement the intended curriculum.

This chapter is in response to Research Question 2: What is the status of the intended primary and secondary science curriculum? The chapter has been divided into seven parts. The first part discusses the developmental aspects of science education included in the new science curriculum. The second part discusses inclusion of agriculture in lower secondary curriculum. The third part is an overview and summary of science and elementary technology curriculum for primary school. The fourth is an overview of chemistry, physics and biology curriculum documents for primary and secondary schools, and the fifth part discusses the technology programme in the teacher-training stream of the upper secondary school. The sixth part addresses the issue of resources, methodology, evaluation and the student profile described in the intended science curriculum. The seventh part describes curriculum implementation through classroom observations of two science lessons. The chapter concludes with a summary of curriculum overview.

5.1 Developmental Aspects of the Science Curriculum

The Ministry of Education acknowledged the need to include developmental aspects of science in the curriculum to make it more suited to the needs of a rural population. Subsequently, the developmental aspects of science education were intended to help Rwandan teachers, students and the community gain awareness of their environment and acquire the knowledge, values, skills and experiences which would enable them to act collectively to solve their environmental, health and sanitation problems.

Apart from these subjects included in the new science curriculum, landmine awareness and teaching about peace and reconciliation were also components that have been separately incorporated through assistance from UNICEF and local NGOs. Learning material for these subjects was designed and developed by the UNICEF and NGOs in conjunction with the Ministry of Education (1996). A review of primary and secondary curriculum documents established six major areas covered by the development aspects of science in the new science curriculum documents. These are indicated in Table 7.

Table 7: The Topics and Subject Areas of the Developmental Aspects of Science Included in the New Curriculum Documents.

Development-Related Topic	Subject Areas	Year Included in
Health	Human body, hygiene, first aid, AIDS, STDs and drug abuse	Upper primary, lower and upper secondary
Water	Water pollution, conservation and purification, water borne diseases	Upper primary and lower secondary
Sanitation	Building a pit latrine, disease, prevent mosquito infestation, cleanliness and sewage disposal	Upper primary and secondary
Environment	Fuels, deforestation, conservation, soil and soil erosion, trees, plants, agriculture	Upper primary, Secondary
Nutrition	Food and the food groups, balanced meals and malnourishment	Upper primary Secondary
Family and Population Studies	Reproduction and contraception	Taught briefly in Year 6 and in secondary school

In 1998, a questionnaire was administered to teachers and students in Botswana to measure the extent that developmental functions of science education had been incorporated into the newly reformed curriculum (Vlaardingerbroek, 1998). As part of the present study, a revised version of the questionnaire was administered to a sample of teachers and students in Rwanda.

Cronbach's alpha co-efficient was calculated at 0.82 for the teachers' instrument and 0.67 for the students' questionnaire indicating that all items measured the same construct

and acceptance of the modified version of the instrument used in Rwanda. Analysis of the data established the extent to which science teachers and students perceived that the development-related functions of science education had been incorporated into the new curriculum. The teachers perceived that the new curriculum prepared students for further study in the areas identified in Table 7 and students similarly perceived that they were taught the development related topics as indicated in Figure 4. For example, 87% of teachers and 94% of students perceived environmental awareness had been included in the new science curriculum. The next section discusses agriculture as a subject in the lower secondary science curriculum.

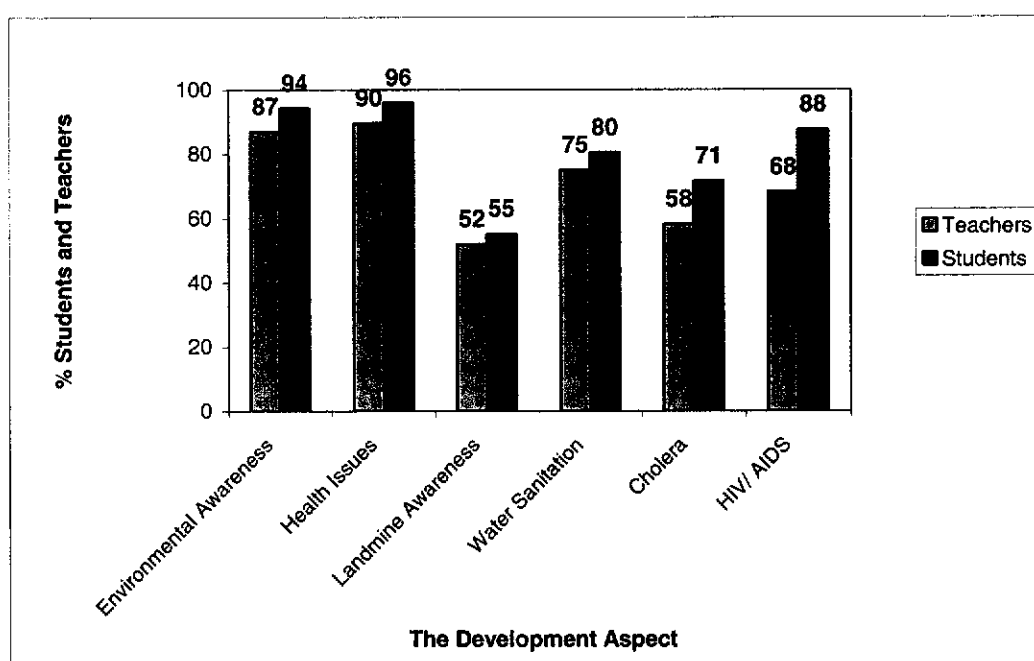


Figure 4: The Developmental Aspects of Science included in the New Curriculum as perceived by Students and Teachers in the study sample.

5.2 Inclusion of Agriculture in Lower Secondary School

The Ministry of Education recognised that over 90% of the population in Rwanda is rural, depends on agriculture and is essentially involved in subsistence farming for the people's livelihood and survival. Through the inclusion of agriculture in the new subject Introduction to Economics, the Ministry of Education hoped to create an awareness and interest among the students on rural development.

Introduction to Economics is a new subject that has been included as a compulsory subject for Years 7, 8, and 9 since 1998. The Introduction to Economics has three components—agriculture, economics and commerce. The agricultural component was intended to introduce and teach the basic principles and skills in agriculture and the Ministry hoped that schools would take an active role in community development (Ministry of Education, 1997e). The topics included in the agricultural component have been shown in Table 8.

Table 8: The Topics Included in the Agricultural Component of the New Curriculum Documents in Lower Secondary School

Topic	Subject Areas
Farming	Mixed farming, growing mono crops, subsistence farming, plantation crops
Farm Tools	A complete list of farm tools and their maintenance
Nursery Management	Plants, seeds and flower and vegetable beds
Animal Husbandry	Farm animals, animal disease, animal parasites, cattle rearing, pig farming and poultry farming.
Soil	Soil erosion, improving soil quality and water conservation

The time allocated for the agricultural component was two periods every three weeks and the subject was to be taught as a double lesson. The recommended teaching approach was to involve students in various practical activities and teachers in schools were supposed to give group projects to students. However, from personal experience during the period that I taught in Rwanda and from interview quotes, the allocated time for the subject was insufficient to effectively teach the subject or implement a student

project. Jean Bosco used to teach agriculture and made this comment about the agricultural component in the Introduction to Economics subject:

With only two periods every three weeks it is very difficult for me to initiate an agricultural project, as it means that students will have to make the time during the recess to oversee the project and this is very impractical. I would like to have a vegetable bed and grow some maize and beans but am not sure if the students will be consistent and have the time to take care of the plant beds. (E.HW.01.05)

The Commission of Teachers that designed the agriculture component in the subject Introduction to Economics recommended that the Ministry of Education provide every secondary school in Rwanda with farm equipment or be given a budget to buy the equipment (Ministry of Education, Initiation to Economy Curriculum Documents, 1997e). Teachers also were asked to progressively and continuously assess the students but were not given adequate training in the method of continuous assessment. As might be imagined in a poor nation like Rwanda, the Ministry of Education has not been able to provide schools with basic farm equipment or the necessary budget to buy the equipment. Nevertheless, although the provision of facilities for teaching and learning within this subject was not effective, some schools, especially the schools that had a boarding house section, managed to have small agricultural plots and farms that were developed and cared for by the students (FN.SV2.SV3.05.00).

5.3 Science and Elementary Technology in the Primary Curriculum

In primary schools, the science was reintroduced as Science and Elementary Technology. The subject consisted of knowledge, skills and attitudes so that students could advance from theoretical to practical knowledge. The programme was intended to help students joining secondary schools to follow science and elementary technology subjects easily.

In Rwanda, each of the three academic terms is made up of eleven weeks and the sub-topics listed in Table 9 had to be covered over one or several weeks of the academic

term. Teachers were advised that students in the examination class of Year 6 would have only two learning terms and general revision would be tackled in the third term. Thus the topics included for Year 6 had to be covered in two academic terms. In the curriculum documents it was stated that teachers must respect the everyday life experiences of students and make provision for these experiences within the environment of the classroom and the learning experiences of the students. Table 9 lists the topics in the upper primary science documents and the sub-topics to be covered under the respective topics in Years 4, 5 and 6. (MOE, 1997b)

Table 9: Topics and Sub-Topics in the Upper Primary Science and Elementary Technology Documents for Years 4, 5 and 6.

Topics	Primary 4	Primary 5	Primary 6
Tools and simple machines	Hand tools	Tools used by the mechanic and blacksmith	Simple machines and their maintenance
Water	Water cycle, sources, dangers of stagnant water	Water supply and pollution	Purification of water and effects of water pollution
Human body, hygiene and first aid	Nutrition, different parts of the body	Sensory organs, muscle and skeleton, internal organs.	Eye, skeleton and muscle, reproduction, digestion, different methods of cooking
Air and wind	Air, wind and dangers of wind	Air and sound	Composition of air
Light and heat	Source of light and heat	Propagation, reflection and refraction of light	

Table 9: Topics and Sub-Topics in the Upper Primary Science and Elementary Technology Documents for Years 4, 5 and 6. (continued).

Topics	Primary 4	Primary 5	Primary 6
Trees and the environment	Uses of trees, deforestation, conservation		
Electricity		Simple electric circuit, distribution of electricity, uses and dangers	
Heat			Definition and forms of energy
Magnetism			Types of magnets, magnetic field and compass
Metals	Properties and their uses	Classification of matter	Changes of states of matter
Animals	Animals and animal management	Modes of animal life	Reproduction and locomotion
Soil	Composition and characteristics	Ways and stages of soil preparation and utility	Use of artificial and natural fertilizers
Plants	Different types of plants, conditions and stages of germination	Types of crops and reproduction of plants	Functions of the parts of a plant and reproduction
Consumer education	Relationship between buyer and seller	Simple budgeting of personal family income	Managing co-operatives, book keeping and savings
Material making	Making of play and utility objects	Making of teaching aids and materials	Basic stitching

Student activities listed in Table 10 are suggested ways in which teachers can develop and provide the opportunities for their students to experience learning that involves discovery, manipulation, comprehension, synthesis and generalisation (Upper Primary Level Science and Elementary Technology Curriculum Documents, 1997).

Table 10: Methods and Corresponding Student Activities listed in the Upper Primary Science Documents

Methods	Student Activities
Discovery	Play, observe, class-tour, assemble, carry out experiments
Manipulation	Handicrafts, construct, diagram, modelling, cooking, sewing
Comprehension	Explain, distinguish, compare
Synthesis	Taking notes, making summary
Generalisation	Apply useful rules, formulas, following logical steps

Under the methodological notes in the science and elementary technology curriculum documents, the designated teaching approaches were discussion, guided observations, experiments, diagrams and illustrations, demonstrations, observations, comparisons, investigations and field visits. The curriculum documents informed teachers that the science and elementary technology subject was conceived from an integrative teaching orientation and was interdisciplinary as subjects from natural sciences, physics, environmental education and home economics were included. From my personal experience and observation in Rwanda, I observed that many teachers were not aware what manipulation, synthesis and generalisation meant. (See vignette on science lesson observation in chapter 7.) For unqualified and underqualified teachers, the task of teaching interdisciplinary science and elementary technology subjects in an interactive manner was very difficult.

5.4 Summary and Overview of Science Curriculum Documents for Lower and Upper Secondary School Students

A separate Commission of Teachers designed the curriculum for each science subject (physics, chemistry and biology) in the new secondary science curriculum. The Physics Commission recommended that all secondary schools be furnished with a laboratory and equipment. The curriculum documents for each of the science subjects also specified a list of equipment and laboratory material that must be provided to secondary schools by the Ministry of Education.

After completion of the National Examinations at the end of Year 6, some students move on to secondary school. Secondary education in Rwanda is made up of lower secondary (Years 7, 8, and 9), also known as Senior 1, 2 and 3 and upper secondary (Years 10, 11 and 12), also known as Senior 4, 5 and 6. Students are taught 12 subjects in lower secondary but as most of the subjects require specialist teachers this is a very difficult task to arrange in a country that already has insufficient teachers. (See Appendix V for the 12 subjects taught at lower secondary and appendix V for subject time allocation of subjects at lower secondary.) At the end of Year 9 students have a National Examination and a very small minority move to Year 10 or upper secondary in Rwanda.

Upper secondary is also called the advanced level and students are streamed into the mathematics and physics stream, the biology and chemistry stream, the vocational education stream or the teacher-training stream. (See Appendix W for options in the higher secondary curriculum.) The streaming is often dependent on the scores obtained by the student at the National Examination at the end of lower secondary or Year 9. In the teacher-training stream, the students are expected to study sciences because they are being trained to teach in primary school. Secondary students also have the advanced level or upper secondary national examination at the end of Year 12 or Senior 6. A summary and comparison of curriculum documents for chemistry, physics and biology are presented in Tables 11, 12 and 13, respectively. (Ministry of Education, Ordinary level science curriculum documents, 1997b to 1997f).

Table 11: Summary and Comparison of Curriculum Documents for Chemistry at Lower Secondary and Senior Secondary Levels in Rwanda

Area/Topic	Level/Program			
	O-Level Lower Secondary (Years 1-3)	Teacher-Training Senior Secondary (Years 4-6)	Biology Chemistry Senior Secondary (Years 4-6)	Mathematics Physics Senior Secondary (Years 4-6)
General Objectives	Provide students with basic science process skills	Apply scientific teaching methods; master the necessary scientific concepts	Apply science process skills in new situations by conducting scientific research	Acquire progressive scientific knowledge and skills
Contents	Basic chemistry	Same as Math-Physics Program, except on Energetics Thermodynamics.	Cover Teacher Training programs similar to Thermodynamics and aromatics compounds, ionic equilibrium, chemical kinetics, mole concepts, chemical equilibrium, electrochemistry, applied Chemistry	Cover Teacher Training Program contents, plus Thermodynamics Organic chemistry: aliphatic compounds
Practicals		Practical once in three weeks at least	Practical activities are highly recommended	2 periods of practical in at least 2 weeks.
Time Allocation	2 lessons per week	2 lessons per week (4 th & 5 th Year)	3 lessons per week	3 lessons per week
Teaching Methodology	Doing experiments, finding out problems, teacher-student discussions	Students expected to have a good knowledge of theoretical and practical chemistry, Experience with handling laboratory equipment, Group work, Year 12 students to be able to make observations, inferences and a report.		
Evaluation	Oral questions and Tests. 20 marks for practicals	Students' ability in handling laboratory material and making accurate observations and inferences. Daily assessment. Oral tests and examinations. Schools offering the biology chemistry combination must have laboratories, sufficient materials and chemicals.		

Table 12: Summary and Comparison of Curriculum Documents for Biology at Lower Secondary and Senior Secondary Levels in Rwanda.

Area/Topic	Level/Program			
	O Level Lower Secondary (Years 1-3)	Teacher-Training Senior Secondary (Years 4-6)	Biology Chemistry Senior Secondary (Years 4-6)	Mathematics Physics Senior Secondary (Years 4-6)
General Objectives	Develop a scientific approach Capacity to think, observe and carry out experiments. Respect for human beings and nature	Same objectives as in the lower secondary Student develops capacity to seek information for himself. Transfer and apply biological knowledge to different socio-professional activities. To explore, analyse, state hypothesis and express in good and clear language.		
Contents	Plants, animals, micro-organisms, vertebrates and invertebrates Nutrition, life processes, respiration, non-flowering plants, organisms and the environment, nervous system and sensory organs, reproduction and genetics	Same content as the biology chemistry stream	Same content with the addition of alcoholism, drugs, microbial infections and evolution	Botany, Zoology, Microbiology, Hygiene, disease endocrinology, the human internal environment and its regulation, genetics, ecology and ecosystems
Practicals	Practical work to be done in groups	At least 2 hours of practical work to be set aside by the teacher.		
Time Allocation	2 lessons per week	2 hours per week	2 hours per week	2 hours per week
Teaching Methodology	Interactive learner-centred activities	Observations, description, carrying out and interpretation of experiments. Students to be taken on excursions. Oral and written expression during experiments. Accuracy in manipulation and diagrams.		
Evaluation		Students evaluated on practical records and investigations, oral tests, individual and group evaluations, short written tests and long essays		

Table 13: Summary and Comparison of Curriculum Documents for Physics at Lower Secondary and Senior Secondary Levels in Rwanda.

Area/Topic	Level/Program			
	O Level Lower Secondary (Years 1-3)	Teacher-Training Senior Secondary (Years 4-6)	Biology Chemistry Senior Secondary (Years 4-6)	Mathematics Physics Senior Secondary (Years 4-6)
General Objectives	Discover the order of the physical environment and understand natural phenomena in the physical environment	Knowledge for understanding the physical environment, contribute to the whole formation of students.		Deepen knowledge and concepts of Physics, develop an initiative for inventiveness, translate knowledge into technological skills
Contents	Physical measurement, matter and properties, mechanics, heat, calorimetry, electro statistics, generators and receptors electricity	Optics, electrostatics, direct current electricity, kinematics, dynamics, thermodynamics, heat, kinetic theory, gas laws, waves, electromagnetic induction, modern physics, electronics		Same content as teacher-training and biology chemistry stream with the addition of electro statistics, energy problems in the world, mechanics, laser and electronic problems in the world.
Practicals and Teaching Methodology	Physics was to be taught experimentally, mathematically and diagrammatically			
Time Allocation	2 lessons per week	2 hours per week and must include simultaneous practical component		
Evaluation	Students to have a theory paper covering 80% and practical paper covering 20%	At the end of Year 10 and Year 11 students should be examined and there must be a test after every chapter. At the end of Year 12 there must be two theory papers and one practical examination on all topics from Year 10, 11 and 12.		

5.5 Technology Programme at the Advanced Level for the Teacher-Training Stream

The technology programme was introduced at the advanced or senior secondary level of the teacher-training stream in Years 10, 11 and 12 or (Senior 4, 5, and 6). The basic aim of the subject was to enable student teachers to teach science and elementary technology to students in primary schools. The topics and the subtopics for the technology programme includes health sciences, home sciences, physics, chemistry, agriculture and livestock management as shown in Table 14.

Table 14: List of Topics and Sub-Topics for the Technology Programme (Ministry of Education, Advanced level technology programme for the teacher training stream, 1997f).

Topic	Sub-Topic
Water	Sources, purification, conservation, making a traditional water filter
Domestic Tools	Traditional brooms, sisal dusters, making clay pots and calabashes, energy saving and environmental friendly stove, traditional refrigerator, soap making.
Weaving	Using sisal, papyrus, banana fibre and palm leaves to make mats, bags and baskets. Use of bark cloth, traditional dyes.
Small Machines	Sewing machine, mincer, maintenance and repair
Honey harvesting	Bee-hive construction, collect and filter honey, make candles
Milk Technology	Milking animals, filtration, milk products
Hides and Skins	Sources, quality, flaying, skin treatment, tanning
Simple House Construction	Simple house plan, site of construction and construction material, building material, types of roofs
Means of Communication	Verbal, written, gestures, signs, symbols, maps, photographs, telephone, radio, television, internet

The general objective of the technology programme for the teacher-training stream at upper secondary was based on three main principles: the appreciation of their own and other peoples' artistic and cultural heritage; understanding traditional technology and

adoption of modern technology; and encouraging research and innovation using locally available materials.

According to the technology curriculum documents, teachers were expected to organise activities and encourage observation, experimentation, understanding, discovery, and imagination. Teachers needed to be sensitive to the students' emotional attitudes and personal initiatives. Recommendations in the documents suggested that students work on projects individually or in-group situations and personal initiatives were to be encouraged. The teacher was required to consistently provide opportunity for students to be 'scientifically oriented' and to 'exercise precision in all practical work'. The students were to be 'continuously monitored', 'assessed and [their] marks recorded on a progressive form for final evaluation' (Technology Curriculum documents data, 1997, p 24).

5.6 Restrictions to Implementing the Intended Curriculum

The Ministry of Education in Rwanda commenced implementation of the new curriculum for the primary and secondary schools at the beginning of the academic year in September 1998. The Inspectorate provided the new curriculum documents designed and developed by the National Curriculum Centre to each school. This part of the chapter discusses issues related to textbooks, resources, teaching methodology, assessment and evaluation and the expected student profile at the end of Year 9.

5.6.1 Textbooks and Resources

During my time in Rwanda, from September 1997 to August 1999, there were no textbooks published by the Ministry and textbooks that were available were obtained from the neighbouring countries of Kenya and Uganda but these were not adapted to the Rwandan context. Private schools that could afford to buy textbooks did so, but many government and some private schools went without textbooks and teaching the new content was extremely difficult for the already poorly qualified teachers. In a recent personal communication with my interpreter Celestin, he has written:

I have visited five schools in Kigali to check on the school curricula [i.e. to look at the science curriculum documents]. I also discussed with teachers of sciences (Mathematics, Physics, Biology, Chemistry and Geography). I found that in general, there has not been any change regarding the curriculum contents since 1998. The teachers are using the curriculum documents from 1998.

Another point is that teachers have difficulty in completing the programmes especially if the same material has to be taught in two different sections having different numbers of hours: this is the case of some classes like Senior 5 biology, Senior 5 mathematics-physics. So, in one of the streams of senior secondary, the programme is always unfinished. [As shown in tables 11, 12, and 13, students in the upper secondary are streamed according to the subjects they select and although there is some overlap in content of the subjects, some of the biology, physics and chemistry content is only included for a particular stream].

Teachers also say that there is still a terrible lack of documentation (books). The Ministry of Education has still not published textbooks. So courses cannot be well prepared. In addition, there has been no improvement in school laboratories except where they receive gifts from international organisations and non-governmental organisations. (PC.E.I.10.02)

Thus eight years after the genocide and four years after the new curriculum documents were developed, distributed and implemented in schools, textbooks and teacher guides are still not published in Rwanda nor has the Ministry of Education supplied laboratory equipment to schools.

5.6.2 Teaching Methodology

According to the analysis of the curriculum documents, my observations of a sample of lessons and from my own experience when working in Rwanda, the teaching methodology described in the new curriculum documents was idealistic and was not able to meet the reality of schools and the classroom environments in Rwanda. This was especially the case because teachers had no professional development in the new

interactive methodologies specified in the new curriculum documents. Most of the teachers in Rwanda were unable to use the interactive strategies, as the number of students in classes in most schools was large, with children seated in rows, and where learning was didactic and teacher-directed (Ministry of Education, 2000).

5.6.3 Assessment and Evaluation

The evaluation and assessment sections of the curriculum documents specified that teachers had to progressively and continuously assess the students. However, continuous assessment was not the norm in Rwanda. In the primary years, evaluation had to be based on diagnostic, summative and formative evaluation but teachers in Rwanda were not sure what these words meant because they were used to regular testing and an examination at the end of the year with students ranked from top to bottom in achievement (FN.SV3.SV4.). Consequently, despite the intent of the curriculum documents, using tests and examinations as a form of assessment has not changed since the implementation of the new curriculum. Furthermore, four years after the implementation of the new curriculum, sciences are not examined for the National Examinations at the end of Year 6, as was planned in the curriculum reform process. Instead students are examined for mathematics and languages (i.e. Kinyarwanda, French, or English) and based on the assessment of only two subjects are admitted into secondary schools.

Assessment practices have a big influence on the type of learning that takes place and also on the perceptions and attitudes held by teachers, students, and parents towards education and its meaning. The director of science of a well-known government secondary school in rural Rwanda made this comment about assessment practices at his school:

Assessment practices in Rwanda are inclined more to serving administrative requirements than the learning needs of the learner. I believe that, just like instructional approaches, assessment approaches should aim to engage the learner in a discovery journey. As much as it is necessary to fulfil administrative requirements (records of test scores), it is also important to view and use assessment

as a learning tool and not just as a way of gathering a set of test marks to feed into the report books. (E.A.ST3.05.00)

According to the new secondary science curriculum documents, teachers had to continuously assess students and were encouraged to have a test after every chapter. However as already stated, most schools did not have textbooks. Students had to be evaluated on practical records and investigations, oral tests, individual and group evaluations, short written tests and long essays. In reality, students were rarely evaluated on practical investigations, as these were not held in most schools in Rwanda.

The curriculum documents recommended that there must be two theory papers for the National Examinations amounting to 80% of the marks and one practical examination amounting to 20%. The National Examinations at the end of Year 9 covered content from Year 7, 8 and 9 and at the end of Year 12 covered content from Year 10, 11 and 12. The new curriculum, despite its emphasis on interactive teaching strategies, was geared towards examinations, which were conducted at the end of each year and National Examinations that were held at the end of Years 6, 9 and 12.

5.6.4 Student Profile at the end of Year 9

At the end of Year 9, the Ministry of Education, Curriculum documents, of 1997, specified that upon completion of the O-level, the student should have acquired the knowledge, attitudes and skills to

- Enable him to think scientifically and logically
- Use three languages fluently,
- Possess the basic knowledge of mathematics, science and technology.
- Acquire civic, religious and moral values,
- Develop a sense of curiosity and creativity
- Fit into the international community
- Acquire artistic skills and aesthetic values
- Understand the risk of unsafe sex and basic knowledge of hygiene, HIV/AIDS

- Acquire basic knowledge of elementary accounts, commerce and agriculture

A complete and detailed profile has been included in Appendix X. It is admirable that the Ministry of Education has such high expectations of the secondary students completing Year 9, but this profile outline is unrealistic and does not fit the reality of schools and classrooms in Rwanda, where over 90% of the population is rural, and where only 20% of primary school leavers attend secondary school. Most schools in Rwanda are extremely poorly resourced and science teaching is theoretical, so most students do not develop the opportunity to think scientifically or logically. Most students in Rwanda already speak two languages but the current government wants Rwanda to be a tri-lingual society, despite the lack of language teachers and language learning resources.

The goal of building religious, civic and moral values among students in a society that is trying to rebuild after the genocide and essentially has a military regime is difficult. Many of the students have seen pain and trauma and are aware of the thousands of genocide perpetrators languishing in Rwandan jails. Reconciliation, conflict resolution and peace education are subjects that need to be included in the curriculum in order to foster strong civic and moral values (AEGIS, 2000).

Can teachers develop curiosity, artistic skills and creativity when poverty, hunger, disease and malnourishment are rampant and endemic through out the country? Over 68% of the primary level students will not attend secondary schools and many students, especially in the rural areas, are so poor that they have not traveled further than their village market. Will these students fit into the international community and why is there a need for them to fit into the international community? HIV/AIDS is a pandemic in Rwanda and students need to understand the importance of safe sex. The last point in the student profile is oriented towards helping students understand the concept of running a small business or rural subsistence based activity. However, there are no teachers and no material to teach accounts and commerce (Ministry of Education, 2000). With endemic poverty and a lack of resources it is not feasible for students to start businesses (IMF, 2001). Thus the

student profile specified in the curriculum documents is not realistic and contextually appropriate to the current situation in Rwanda.

5.7 Observation of Two Science Lessons

From the overview of the content, objectives and methodology of the intended curriculum documents, the next part of this chapter addresses the implementation of the intended programme. According to Sikes (1992), only when teachers come to understand the reality of educational change in the context of their classroom will they implement changes. In the form of vignettes, I have described a practical science lesson in a Primary Year 5 class, in a rural primary Christian school and a practical biology lesson in a Year 9 class in a rural secondary government school.

5.7.1 A Science Lesson in a Year 5 Class in a Rural Primary School

It is 9.30 a.m. on a beautiful day in Rwanda and I am at a rural school, an hour and half away from Kigali. I have travelled with Celestin, my interpreter and Anton my driver along a bitumen road with forests on both sides. The drive to the school is beautiful and we pass villages, resettlement schemes and health centres. The school has only two blocks of classes with no sport-field. The school is very poorly constructed and some classes do not have doors or windowpanes.

I am aware that protocol in Rwanda dictated that I meet the principal before meeting any of the teachers or going into any class. I talk to the principal about my research and he was happy for me to visit the classrooms. He informed me that being a small school they had one teacher teach science for most of the classes, as this was her subject specialisation. I am introduced to the teacher, Hope, and she welcomes me and says that she is indeed happy not only to have me visit her class but also to be interviewed.

The class did not have any classroom displays and any other resources. There were about 25 students in this Year 5 class, both were boys and girls, some of whom wore a uniform and others did not. When the teacher and I entered the class, all students stood and

greeted us. There were no desks in the class only benches and I observed the difficulty students had when writing with a book on their laps.

Hope started the lesson by informing her learners that she was going to be teaching them about *floating* and *sinking*. She asked the students to come closer to the desk and they seated themselves around the teacher's desk. The teacher had a prepared lesson plan; she introduced the lesson and led the discussion.

She wrote down the words *floating* and *sinking* on the board and asked if any students knew what the words meant. Some of the students raised their hands.

A student answered, "*Floating means when something stays on top of water and sinking means when something goes under water.*"

Hope then proceeded to show the objects she had got for the lesson. She informed the class that all the objects were from the school compound except for the plastic container and the water that Hope had got from her house. All the students were watching the demonstration intently and were curious about the objects.

Hope asked the class, "*Would anyone like to name these objects for me?*" and there was a spontaneous chorus of answers, together they answered, "*Stone, a piece of sponge, stick, nail, plastic spoon, metal spoon, clay.*"

Hope then said that she would call a student to come up to the table and put an object in the container and observe what happens. Several students were called to the desk and they were quite pleased to be selected. At first some of them were shy to do as asked and hesitated but as they saw their classmates perform the experiment they were happy to do the same.

Hope then asked the students what would happen if she put the clay into the container and formed the clay into the shape of a boat. I could see from the faces of the students that although some may have known the answer they were hesitant to respond.

Hope continued with the demonstration. When she first put the ball of clay into the container it sank, but when she reshaped it to form a boat it floated. She then called a student and asked the student to use the sponge for the demonstration. At first the sponge floated, but soon it sank to the bottom when the air pockets were filled with water. At this stage, Hope reinforced the definitions of floating, sinking and density and wrote out definitions on the chalkboard.

The teacher had a tattered teacher's book with her but there were no textbooks for the students and no material for them to carry out the experiment in groups. Students had their own notebooks and at the end of the demonstration they went back to their places and made notes on the lessons as directed by the teacher. Hope was very gentle with the students and her students appeared to enjoy the lesson. At the end of the lesson she gave them a few questions on the board and also asked them to draw the experiment in their class books.

5.7.2 Interpretive Commentary

Hope was an experienced teacher who believed that it was important for students to know scientific concepts. She integrated processes of observation, inference and experimentation with the concepts of floating and sinking. The lesson was a demonstration with limited student participation. However, she tried to involve most of the students in the demonstration and although she initiated all activities, there was teacher-student interaction and students were not passive learners. Hope asked appropriate enquiry-based questions like, what do you think is happening? what causes this to happen? what do you think will float or sink? The enquiry-based questions checked for students' attainment of lesson objectives. The students responded to teacher questions spontaneously and accepted roles and procedures. The hands-on activities were conceptually focussed and generally the teacher knew the answers to the questions she asked. The students enjoyed this lesson on floating and sinking, the teacher achieved the objectives of the lesson, with the students appeared to develop an understanding the concepts of floating, sinking and density. A Photograph of this lesson has been included in Appendix U2.

5.7.4 A Practical Biology Lesson in a Year 9 Class in a Rural Government Secondary School.

It is just before lunchtime at a rural secondary school. I have been informed at the Ministry of Education that I am visiting a well-known rural government secondary school that has over a thousand students. There are several single storey buildings spread around a fenced area and indeed structurally the school appears very good. I met and introduced myself to the Deputy Headmaster and the Director of Science.

The school has well equipped laboratories that have been donated and rehabilitated by an international organisation and after lunch I am to observe a practical biology lesson. I am introduced to the teacher, a young man in his late twenties. Ephrem is happy that I am visiting his class. He told me that the bunch of nearly 40 students is very enthusiastic and enjoys practical lessons. As he has no laboratory assistants, he had to prepare the reagents himself and is sometimes handicapped by lack of water, electricity, gas and reagents.

Ephrem has used his lunch break to get the food samples and reagents ready. There is no water electricity or gas; so Didier has got some jerry cans of water ready, and he has a paraffin stove set up in the front on a stool near the teacher's desk. A bell rings to mark the end of the lunch break. Students start strolling into the laboratory. All of them are smartly dressed in their uniforms. The laboratory is well-equipped and has charts displayed on the walls.

Ephrem began by informing the class that during this practical lesson the students will be *Testing some food samples for nutrients identification*. Different equipment has already been laid out for the students to use. I am impressed that students have safety goggles for use. Although there isn't one for each student, I find that the students are using the safety goggles and laboratory coats.

Ephrem is ready to begin the lesson. The students are seated on stools around the laboratory benches. He tells the class: "*Nutrients such as carbohydrates especially*

sugar and starch and proteins can be detected using an indicator. The indicators produce a distinct characteristic colour when a substance is present. Lipids can be detected by their ability to make paper translucent.”

“For this lab, I have provided various food samples, you will test for various nutrients and then compare your results to the standards.” A student asks what a standard is and Ephrem answers, *“ This is the result of the tests that show a positive response for a known substance.”*

Ephrem has prepared a 15% glucose solution, a 1% starch solution, and a gelatine solution. For the indicators, he has Benedict’s solution, Lugol’s solution, Biuret solution ready and some ordinary brown paper. The class has been provided with some food samples from their afternoon meal—rice, potatoes, beans, meat, and the margarine. He also has a small tub of the local brand of margarine called Blue Band.

He explained to the students how he would like them to do the tests. It appears as though the students are familiar with laboratory routine. He asked the students to form groups in which they will work and I observed that he actually allowed the students to pick their own group. Once the students have divided themselves into groups of four or five, there are about 9 groups. He asks each group to take 9 test tubes and a test tube rack and informs the students that:

3 test tubes will test for sugar, 3 for starch and 3 for protein.

Out of the 3 test tubes, one will test the positive or standard sample, one test tube will test the negative sample and one will test the food sample.

In the case of the standard solutions, the sugar sample is glucose solution, the starch sample is starch solution, and the protein sample is the gelatine solution. The negative samples all contain distilled water only.

Ephrem drew a table on the blackboard that he would like the students to draw in their practical class workbooks and use for the experiment. The table had a standard format of

aim, procedure, observations and results. The students did not have any textbooks or notes to follow the instructions, but they write down and followed the instructions given on the blackboard.

During the experiment, the test tubes have to be heated in a hot water bath for 5 minutes. This seems to be the most difficult task as there is only one paraffin stove to be shared by the whole class. The water once heated cannot be kept at a constant temperature and on several occasions I fear that there might be an accident because of too many students around the stove.

The students carry out the experiment according to the instructions given by Ephrem. The food samples and the indicator bottles are on the teacher's desk so when the students have finished copying the procedure and start the experiment many of them converge and crowd around the teacher's desk. All the groups are able to perform the experiment, Ephrem responded and answered student queries. He moved around the class but has to pay attention to his desk as the food samples, indicator bottles are on his desk and the stove is on a stool near his desk. Towards the end of the 45 minutes lesson, Ephrem asks the students to reassemble in their groups and asks some of the groups to provide the results of their experiments to the class.

5.7.3 Interpretive Commentary

The biology practical was a hands-on activity that was directed by the teacher. The laboratory was well equipped and had resources like chemical reagents but no water, electricity or gas. The teacher-student interaction in the class was about student understanding of the procedures and the content. There was occasional checking of attainment of the lesson's objectives by the teacher. Most of the student questions were about clarifying procedures or repeating information. The teacher controlled the resources in the laboratory. The students did not appear to be confused about procedures in the laboratory during the practical. The biology practical lesson was thus a didactic teacher-directed lesson that was well organised and that the students were able to

understand and carry out. Photographs of the lesson have been included in Appendix U3 and U4.

5.8 Comments about the New Curriculum

When the new curriculum documents were distributed to schools the Inspectorate conducted a workshop for all head teachers and heads of department. At the time of implementation of the new curriculum, I was working in Rwanda as a head teacher and attended the workshop. The entire workshop was conducted in Kinyarwanda although most of the teachers taught in only English and French schools. Socrates came along with me to the meeting and acted as my interpreter. His comment about this curriculum orientation session was as follows:

Commune inspectors were expected to train head teachers and teachers. They tried to do so but were themselves limited in skills and qualifications. We are expected to change teaching methods but this is impossible with large classes, the pressure of examinations, lack of textbooks and resources. The inspectors themselves are not sure of the interactive strategies and learner-centred teaching methods. They do not know about diagnostic, summative and formative evaluation.
(E.A.T2.05.00)

In spite of the immense difficulties and constraints in curriculum implementation, the new curriculum documents that were presented in French and English gave tremendous hope for the future of education in Rwanda. This hope is endorsed by the program director of an international volunteer organisation that provided volunteer science teachers to Rwanda:

The new curriculum documents have given hope to the teachers and students in Rwanda. But it is important that young Rwandans display a shared sense of the need for change. Change has to be brought about in the education system of Rwanda but this change has to fit reality. There is a need for huge manpower resources and skills in the education sector. Today young Rwandans take to

teaching as a last resort. It is important to put education into context, think about the out of school youth and the rural poor. The new curriculum should put education into context and must be progressive. (E.H.EP1.04.00)

The new science curriculum documents have been a start, a way forward and signify tremendous hope for the Ministry of Education in Rwanda, but it must meet the highly varied needs of Rwandan students. The curriculum can mean nothing in practice if it is not examined for its appropriateness of the existing situation in Rwanda (McKenney, 2001). The attempts to improve science curriculum quality in Rwanda will depend on the realistic initial appraisals of the goals and objectives of the new curriculum and the Ministry's understanding of the reality of classroom practice in Rwanda (Lewin, 1985). Currently, the new science curriculum has introduced subject innovations and approaches but further research will be required to identify if existing curricular intentions are implemented in an impoverished system with under and unqualified teachers.

5.9 Summary of the Chapter

My understanding of the intention and implementation of the science curriculum documents has been presented in Chapter 5. The overview of the science curriculum documents reinforced the emphasis on content and examination and brings out crucial issues of relevance. Whilst it was not within the scope of the present study to look at cultural aspects of the curriculum, it would be of interest for further research to look at the notion of the silent curriculum and cultural and gender elements of teacher-learner and learner-learner interactions. Based on my experience as principal for two years in Rwanda, I had observed innumerable science lessons but only unique features portrayed in two science lessons have been included in this chapter.

Through Chapter 5, I have responded to Research Question 2 and provided an overview and analysis of the intended primary and secondary science curriculum documents. Chapter 6 discusses seven emergent dilemmas faced by teachers in Rwanda from observations, interviews and interactions with the key informants.

CHAPTER SIX

DILEMMAS FACED BY TEACHERS IN THE IMPLEMENTATION OF A RELEVANT SCIENCE EDUCATION

By systematically failing to record the voices of ordinary teachers, the literature on educators' careers actually silences them. Methodologically, this means that even while investigating an issue where decision making is paramount, researchers speculate on teachers' motivations, or at best, survey them with a set of forced-choice options. Theoretically, what emerges is an instrumental view of teachers, one in which they are reduced to objects, which can be manipulated for particular ends. Politically, the results are educational policies constructed around institutionally convenient systems of rewards and punishment, rather than in congruence with teachers' desires to create significance in their lives. (Casey, 1993, p. 88)

6.0 Introduction

This chapter focuses on seven dilemmas that I identified through analysing interview transcripts, teachers' classroom practices and talking to education personnel from the National Examination Board, the Ministry of Education and the Institute of Education. An analysis of these dilemmas in turn sheds light on the tensions faced by teachers in implementing a relevant science curriculum in Rwanda. Regardless of the changed times and conditions, the teachers continue to see teaching as their responsibility, as shown by teachers' care for their students, the school and the community of which they are a part. Goodson and Cole (1994) noted that the whole idea of looking at teachers as change agents, and transformative intellectuals, would not yield results if we ignored the micro-political and contextual realities of school life. In this chapter, seven dilemmas faced by

the teachers were identified and these dilemmas take into account the personal and professional realities that teachers face in implementing their duties.

Educational reformers have agreed that for change (internally or externally initiated) to succeed, the reform process will have to deal with changing pre-established practices, values, attitudes, norms and structures within an educational structure (Cuban, 1988; Hargreaves, 1994). The tensions and dilemmas identified in this study, as Fullan has suggested, can be viewed as opportunities from which teachers involved in the education reform process in Rwanda can learn. Knowledge of the dilemmas provides important evidence of what teachers enduringly value and what concerns they might have about their own practices (Anderson, 1997, Wallace & Loudon, 2000, 2002). Thus, the dilemmas may provide insight into why, despite so many changes, pre-established practices inside classrooms have almost remained the same in Rwanda (Cuban, 1988; Sarason, 1982; Tabulawa, 1997).

This study also suggests that without professional, material, and emotional support, teachers cannot handle all challenges on their own, especially under the extreme difficulties that they face in their everyday and professional lives in Rwanda. Left to handle so many increasingly complex challenges on their own, teachers often have no option but to lower their expectations, contend with failure in their objectives, compromise their values, wonder whether they should stay in teaching or look for alternative jobs (Liston & Zeichner, 1991).

I have tried to develop insights to understand teachers' knowledge and practices so that this understanding can be made available to others. This chapter includes those issues about which the teachers were most vocal—justice, gender, ethnic tensions, language and poverty—and is written in a way to make these teachers' voices and visions clearly heard (Goodson, 1992; 1997). As will be evident, the teachers involved in this study would certainly agree with Fullan (1993) that tensions and dilemmas are inherent to teaching because many of these tensions cannot be avoided.

The chapter includes quotes from interviews with teachers, head teachers and education personnel but focuses specifically on my interactions with the key informants: Bathilde, Jean Bosco, Didier and Socrates, whom I have introduced in chapter 4. This chapter responds to Research Question 3: What dilemmas do teachers face in the implementation of a relevant science education program?

In the aftermath of the horrific genocide in 1994, teachers in Rwanda continued to be accountable in a time of difficulty, pain, grieving and trauma. Jean Bosco had lost his father and brother during the genocide. He and his mother, both teachers, continued teaching, often with little appreciation and acknowledgement from the Ministry of Education and continue to serve the community in a time when many people focused on their own personal interests. His mother, who is a government teacher, is often not paid on time and sometimes six months can elapse before she will be paid. The genocide did not make him bitter or angry and he continues teaching and hopes that the future will be better for the children of Rwanda:

I hope that there will be more schools and tertiary institutions in Rwanda so that the children of Rwanda can benefit and continue their studies. It is important that children study. If they have qualifications then they are able to get a job, to look after themselves and their family. (E.H.T6.06.00)

Jean Bosco dreams of and works for a stable and peaceful Rwanda in a time when he sees poverty on the rise in the country and its people facing extreme hardship. He endorses justice and hard work in a time when corruption is taking over Rwandan society. Further he experiences tensions and feels guilty for failures that stem more from the educational and societal systems rather than from the teachers' own mistakes.

I would like to continue my studies and go back to university to become a lawyer. I feel I will then be able to help people who are innocent victims and also help the justice system so that we can always have peace. (E.H.T6.06.00)

Many teachers in Rwanda live at the lowest imaginable socio-economic level and do not have access to running water and electricity at home. The wage they earn is barely sufficient to meet the daily household needs of immediate and extended family. The sanitation facilities in most homes in Rwanda also are the most basic. The teachers are forced to endure extreme hardship and most have them have faced grief, pain and trauma yet they are resilient and show a tenacity to survive against great odds and rebuild the education system.

I am invited to the home of my interpreter Celestin, to have supper with his family. Celestin has been my constant companion these last few months. He translated documents from French to English for me, carries out the French interviews and administers the French questionnaires. I arrive at his home and meet his wife and five children. The family lives in a very simple basic mud home and I realise that Celestin has no access to water, electricity or sanitation. His wife has prepared a delicious meal of fish, potatoes, rice and meat that I share with his family. Celestin has been translating documents for me by candlelight and lamplight. I am humbled by this incident and realise that Celestin who has lived through the genocide can survive inspite of his difficulties.

6.1 Dilemma 1: How to teach and carry out laboratory work without resources and training?

Most teachers in schools in Rwanda have never performed any laboratory work and have done few demonstration experiments. Many teachers have never been given any training in practical activities and from interviews with teachers, it became clear that they were unaware of the didactic and organisational problems related to the use of laboratory equipment. After some discussion they recognised that they were not clear how laboratory work could be done under existing school conditions. In some instances, schools had laboratory equipment donated by aid organisations that teachers did not use. A young British volunteer chemistry teacher, teaching chemistry to high school pedagogy students made this comment about the laboratory in her school as I observed a practical lesson on the mole and the mole concept in her class.

This school has an excellent laboratory but many teachers do not know how to use the equipment and do not know names and use of reagents. After I arrived at the school I tried to create a system of labelling and storage. (E.H.T4.05.00)

Teachers asked for support materials for teaching science. In my interview with Didier, he said that teachers in most primary schools felt an acute need for all kinds of demonstration equipment: from simple locally available equipment like bark cloth, banana fibre, and seeds to slide-projectors, overhead projectors, maps, test tubes, magnets. However, he expressed concern that the provision of laboratory equipment may not change their style of teaching much because of existing factors such as overloaded classes, lesson times, lack of physical space in schools and a lack of in-service training. Didier made this comment about primary science:

Science is a practical subject but many primary schools are not interested in teaching science. The schools do not have the simple equipment or the means to buy the equipment. I feel the Ministry of Education must stress the importance of learning science in primary school. (E.A.T2.05.00)

Through years of working with students and colleagues, and as active members of the community, these teachers have formed ideas about how the current troubled, weakened and underdeveloped Rwandan society could be made a better place for its citizens. They have exhibited a broader understanding of teaching. Socrates is an example of a teacher who is an active member of the community. In an interview, he stated:

It is important to create a feeling of community among the teachers. We must be able to support and help each other. If each of us contributes a small amount of our salary to helping one teacher each month, then we can help the teacher buy a cow, or grains to plant in his fields. I also want to develop a project to build better homes for the teachers. (F.H.T5.06.00)

Jean-Bosco and Didier, apart from being teachers, also had small farms and cattle that gave them a unique knowledge of agriculture, farming and cattle-rearing. They were always eager to share this knowledge with the students and fellow teachers. Although they used a relatively limited number of methods in their teaching during the study, their voices reveal that through their years of teaching, they have developed a richer methodological repertoire than the one they exposed. They often suggested that a method, as a technique, essentially depends on context and situation (Niyozov, 2001). The teachers believe they can produce methodologies if they are given the resources and freedom to experiment (Farrell, 1994). In my interview with Didier, he spoke of a unique approach to teaching science that incorporated agricultural and basic science with population and family studies that was successfully started in Uganda in the late 1980s:

The approach included concepts of the child-to-child program and compound approach where the students in class formed the link between the class, school compound, their home and the village community.

Each student in primary school was assigned a project. They were taught how to make a nursery bed and grow maize and beans, they were taught poultry farming and animal husbandry where maybe a cow or pigs were bought by the school. Students recorded growth charts and parents came to have a look at the projects.

Through these projects students learned to care for their environment, they learned about soil quality, soil erosion and how to improve soil condition. This unique project was very successful and maybe we can try the approach here in Rwanda.
(E.A.T2.05.00)

During my interview with the Director of the National Examination Board, he expressed his thoughts on practical science, especially in primary and lower secondary schools:

The Ministry of Education with the help of UNICEF and UNESCO is trying to obtain micro-science kits from South Africa for primary schools in Rwanda. I also

feel concerned that even if UNICEF provided equipment to schools most of it would never be used because of teachers' lack of training in practical/laboratory work and the teachers' fear of reappraisals if the equipment was broken or damaged. (E.A.EP1.05.00)

According to the Director of the National Examination Board, the Ministry of Education was trying to accelerate progress in science by establishing 12 government schools as centres of excellence. Some of the secondary government schools were known as the '*Groupe Scolaire*' schools and I had the opportunity to visit four of these during my data collection phase in Rwanda. Most of these schools were very good schools and had good infrastructure. All four schools had excellent buildings and laboratories although I observed that the maintenance of existing laboratory materials was not always satisfactory. In one school, I found that plastic models of human body were stored in a cabinet. In another school, expired chemicals and broken equipment were placed among still functioning and useful materials. Many did not have chemicals and reagents that were labelled or properly stored. It was obvious that development of habits for using and maintaining science equipment would have to be inculcated. (FN.SV7.SV8.SV9.05.06.00)

One of the main premises of teaching science in primary schools is to connect it as closely as possible with the everyday life of students. This approach teaches students a way of learning, acting and thinking about science that is valid outside of the school buildings. I encountered two cases concerning teachers' attitudes towards using locally available materials in teaching science in primary school and lower secondary. In one school, a female teacher very proudly showed me her creative solution to setting up an experiment without equipment. She taught children how to make a simple electroscope with a piece of wire by hanging a small ball of silvered paper on a string. In another case, a male teacher was very disappointed at being forced by the poor school conditions to use his pen and a sweatshirt to demonstrate static electricity instead of using a proper ebonite rod and wool rubber. (FN.SV4.05.00)

A secondary science teacher in a private school used the concept of a science fair to involve students in her school in practical science projects. This private high school science teacher in the school in which I had previously taught shared her thoughts on the science fair that she had initiated and successfully conducted in early 2000.

When I saw that practical science could not be carried out at the school, I decided to have a science fair so that students could perform experiments and demonstrate these to the parents. The whole school was involved in the process. Forty different projects were assigned to students at all class levels. The Year 1s did a project on domestic and wild animals. The Year 2s had a project on plant growth. There were projects on the weather, a fishing game to separate metals, salt and pepper separation, producing energy from potatoes and respiration. The science fair was really successful and the students, teachers and students were all pleased.

(E.A.T1.05.00)

A set of tools (screwdrivers, tongs, knives) is required for performing science experiments, and different types of materials (paper, isolating tape, balloons, plastic bags, straws, polyethylene buckets with handles, sponges, jars, candles, nails, nuts and bolts) are also used in practical science (Popov, 2000). The new curriculum documents list the basic equipment needed to teach science at the primary and secondary level. Some of these materials are locally available. Science laboratory suppliers used to offer such materials as citric acid, aluminium foil, iron nails, sand, soap solution, household starch, sodium chloride, and many other chemicals and reagents for three to four times higher prices than in ordinary shops.

While organising the science fair the science teacher had to obtain many of the materials from neighbouring Uganda. Two teachers from the private school had to travel to Kampala, Uganda and buy the material (FN.SV1.05.00). During the interviews, teachers and school directors persistently asked for concrete materials for use in practical science.

They complained that schools do not have, for example, microscopes, magnifying glasses, barometers, models of the solar system or human body, and maps.

According to Didier, provision of such materials would make, on the one hand, his lessons much more effective and, on the other hand, he could gain more respect in school for his scientific way of work. As an optimal condition for carrying out practical science, teachers and school principals would like to have a laboratory and a set of equipment for each science subject: chemistry, physics, biology, and agriculture. All schools wanted to modernise their schools and appealed for the construction of a science laboratory at the Kigali Institute of Education so that student teachers studying to be science teachers could have training and practice in conducting practicals.

There was always the possibility of finding different materials for practical work in science that was locally produced or easily accessible in the local market. Therefore, it was important for all schools to have some amount of money for the purchase of consumables and tools for science experiments. Who will provide such money on a sustainable basis? Will it be the Ministry of Education, the Municipality, the local community or the parents is an issue that needs to be discussed and addressed?

Schools in Rwanda do not have the budget for the purchase of any equipment. As has been illustrated from interviews with teachers and personnel from the Ministry of Education the teaching of practical science is a dilemma that has been acknowledged by the Ministry of Education. However, to date, four years after the implementation of the new curriculum, schools have not been provided with basic laboratory equipment and resources.

6.2 Dilemma 2: How to meet Ministry goals in implementing a new science curriculum for all the school aged population when the emphasis is only on set examinations?

The competitive nature of the examination-driven curriculum places enormous pressure on both the teachers and the students and fosters a teacher-centred classroom. There is constant pressure to maintain high achievement scores, improve the position of schools in national examination rankings and a constant need to improve student test results. Teachers who teach the examination classes especially feel this pressure, which encourages teachers to concentrate on improving test scores, and allowed limited opportunities for discussions or questions. Memorisation was considered an effective method of preparing students for examination. Didier who teaches sciences for the national examination class claimed that the entire focus of his teaching was the national examinations and student performances at the examinations:

I teach so that my students do well in the exams and it is important that students and teachers look at questions that are repeated in past papers so that students do well and, in turn, the school gets a higher standing. Internal assessment is not part of the criteria at all. (E.A.T2.05.00)

Schools that perform well in national examinations are announced on the radio and mentioned in the newspapers, so it also becomes the duty of the head teachers to ensure that the students realise the importance of national examinations and that the students' focus in Years 6, 9 and 12 is on the national examinations. A science teacher in a private urban school commented on the difficulty of making sense of the detail in the curriculum content and the amount of content to be taught in physics, chemistry and biology, especially at the lower secondary level. She also commented on the constant pressure of both school examinations and the national examinations.

The course content of the science subjects is too detailed and there are too many topics to be covered and time is usually not on our side; there is too much to cover within a short period of time. I cannot understand why it is necessary to include so many subjects and have so much content. Although most of the developmental aspects of the new curriculum are included in the curriculum, they cannot be effectively taught because of the pressure of teaching without textbooks and what is relevant to the exams. (E.A.T1.05.00)

School examinations are organised at commune level in Rwanda and are mainly controlled by the National Examination Board that makes the whole process highly centralised. Internal assessment is not part of the grading process. All my observations of lessons and interviews with teachers indicated that school examinations stimulate the development of students' memorisation and regurgitation skills and that examinations took precedence over other school activities. Success was identified with goal achievement and performance in school. Students' examination results were most important so that students could pursue secondary and tertiary education. Consequently, teachers concentrated on completing content and teaching for the examinations that allowed limited opportunities for discussions or questions. Once again Didier made a comment about the intense preparation needed by students:

As the exams draw nearer, the teachers teaching the exam classes are expected to come on Saturdays and Sundays and even during the holidays and this puts a lot of pressure on the students and teachers as we do not have a break at all. (E.A.T2.05.00)

Whilst I was a head teacher in Rwanda, four teachers from my school were invited to grade the national examinations. Didier was one of the teachers who were part of the examination marking process and he talked of the confusion:

It was rather chaotic during the marking process. The National Exam Board was not organised and the marking guides were not delivered on time. There was confusion

with regards to the grading system and there seemed to be no mark for the process [of working out an answer to a problem], but only for the end result. (E.A.T2.05.00)

Thus it is extremely difficult for under-qualified teachers with poor content knowledge to implement and effectively teach the science curriculum when the whole emphasis is only on students' achieving and performing well in examinations. Currently, student success in Rwanda involves succeeding in examinations. Success does not include student learning experiences, but completing the curriculum content and teaching for the examinations. Teachers in Rwanda face the dilemma of meeting Ministry goals in implementing a new science education for all the school aged population when the emphasis is only on set examinations.

6.3 Dilemma 3: How to effectively teach the developmental aspect of science incorporated into the new curriculum without textbooks and resources?

The development aspects of science education are designed to help teachers, students and the community in developing countries like Rwanda gain awareness of their environment through their health, their communities and the inter-relationship between these factors. The development aspects of science education can enable teachers and students to acquire the knowledge, values, skills and experiences that will enable them to act collectively to solve their environmental, health and sanitation problems (Vlaardingerbroek, 1998).

Since the genocide in 1994, there has been a need to convey information on health issues such as awareness of cholera and polio, sexually transmitted diseases, HIV/AIDS, acute respiratory infections and sanitation issues. Cholera and water-borne diseases are the main killers in crisis situations of refugees and displaced people. The legacy of landmines remains long after the war has ended and landmines do not discriminate between soldier, farmer, women and child.

A possible outcome of teaching the development-related aspects of science education for teachers and students at both primary and secondary levels in Rwanda is that issues affecting Rwandan society can be discussed. For example, in talking about the AIDS pandemic affecting Rwandan society, Socrates explained that learning and discussing about AIDS/HIV had to go beyond the classroom:

Teaching about HIV/AIDS, sexually transmitted diseases, poverty and health should move beyond the classroom. It has to be carried out at the community level so that we get students from different schools intermingling with each other but we also get parents, social workers and local community leaders involved. (F.H.T5.06.00)

For teachers like Jean-Bosco and Didier, the notion of education went beyond the classroom doors and school and beyond working only with the children. Teaching, for these two teachers in a relatively homogeneous community, included the whole community of school students, young people and adults. Didier would spend many hours talking with fellow teachers or other staff at the school trying to just listen to them and be supportive. This kindness and compassion for his colleagues gave him respect and made him popular among fellow teachers (FN. SV1.05.00).

As mentioned in discussing the first dilemma, Didier was an advocate of the child-to-child program where the children at school form a link between the school, home and the wider community. He felt that the development aspects of the science curriculum could be taught in this manner:

If I teach my students how to build a pit latrine and they practically build one at the school, then I am sure they will teach their parents how to do so at home and the community. Similarly, if I taught the students how to collect rainwater they would be able to do so, as water provided by the Ministry is so scarce. If I teach them simple methods of water purification, it will help them in the control of water-borne diseases. There is so much we can teach and learn in this manner. (E.A.T2.05.00)

While Giroux (1988, 1991) calls for regarding teachers as intellectuals, and Cochran-Smith (1998) suggests that teachers should be teachers for social change, the teachers in this study and the key informants are naturally situated within both these positions. Although Bathilde, Jean Bosco, Didier and Socrates were not highly qualified in science, they displayed a wisdom that was a result of their experience, an understanding of their context that was result of their struggles, and they displayed a passion and thirst for upgrading their skills. Their role in the wider community made them teachers for social change.

At the same time, the lack of basic needs at home meant that their domestic life was often difficult. I had personally visited a number of teachers' homes including those of the four key informants for this study. Many teachers did not have access to water and sanitation, most teachers still cooked using charcoal stoves, and did not own a vehicle. They had to walk long distances to reach their place of work. These four teachers have developed views and ideas that extend beyond classroom doors and school walls. Through keeping the past, present and future of all Rwandans as their focus, they also consider the socio-political realities of their life and speak about the kind of society that teachers in post-genocide Rwanda desire.

Rwandan teachers have never had teacher manuals, student textbooks or any other didactic support materials for science teaching. Most of them have never been given any in-service training either. Rwandan teachers have never been exposed to alternative work-styles (Ministry of Education, 1996). Teaching is totally based on teacher content knowledge that is limited. Consequently, teachers are impeded in carrying out their daily classroom duties by lack of basic resources, they have no pedagogical support, textbooks, other curricular materials and most schools have poor infrastructure. Teaching takes place in an environment where learning takes place with insufficient desks, chalk, chalkboards, no water or electricity, and poor financial conditions that include low, unreliable salaries that often are not paid on time (World Bank, 2000).

A science teacher from a private school shared her thoughts on the difficulty of teaching the development aspects of the new curriculum without resources:

The developmental aspects of science that include issues about health, sanitation, population studies, and HIV/AIDS have been included in the new curriculum but I do not have any supporting material to teach these aspects. There are no textbooks for each year level, no supplies for practical work and I have to often search around Kigali for materials. There are no teacher's guides and no examples of past examination papers too. How am I to teach and talk about population and population control if I do not have an idea about the Rwandan situation?
(E.A.T1.05.00)

Thus, effectively teaching the developmental aspects of science incorporated into the new science curriculum poses a dilemma for science teachers in Rwanda.

6.4 Dilemma 4: How to progress professionally without opportunity for further studies?

Goodson and Cole (1994) noted that the whole idea of looking at teachers as change agents, transformative intellectuals and empowerers of themselves and others will not yield results if we ignore the micro-political and contextual realities of school life. "In other words, teacher development in its broadest sense depends on teachers having access to professional knowledge beyond just the personal, practical and pedagogical" (Goodson & Cole, 1994, p. 103). Although professional development courses continue to exist in Rwanda, the courses do not take into account the personal realities of teachers, the practical realities of lack of resources and pedagogical realities of poor methodological practices. In-service usually consists of one-shot retraining courses, arranged in centres, and run by educators who often have little understanding of the context, history and complexity of teaching and learning in difficult situations. Very few schools in Rwanda had their own professional development plan. A deputy head teacher from a well known rural government school stated:

There are no facilities for professional development at our school. Most teachers work individually. Many are not motivated and feel demoralised. We have not been paid by the government for 6 months and only survive on contributions from the parent teacher association (PTA). In this situation, can you expect us to upgrade our qualifications or improve our classroom teaching practices? (E.A.ST3.05.00)

A head teacher in a Rwandan school is more an administrator than a mentor or initiator of professional development activities in the school. The head teacher's responsibility is more concerned with obtaining funds for running the school or buying food and grains if the school has a boarding section (FN.SV4.05.00). My interpreter, Celestin, who has worked in Rwanda since 1988 commented:

When I was appointed and obtained a job in a rural school, I had no formal interview. The need for teachers was really great. The headmaster just gave me a timetable and I had to teach. I had no orientation or initiation process. The school had the mathematics/physics stream and a pedagogy stream, which meant it trained teachers to be primary teachers. (TR.05.00)

Rwandan teachers' status and remuneration have always been low, but in the Rwandan context, where there were never many white-collar and industrial workers, teacher salaries appeared relatively high in comparison to the rural poor. Thus, despite their generally low wages, the teachers could manage to provide for their basic needs. My interpreter, Celestin, commented about teacher wages before the civil war:

In the 1980s, the monthly salary for a teacher was about Rwandan Francs 20,000. This was equivalent to US\$105 in government schools. The private school teachers were paid slightly higher about US\$130. With this salary, a teacher regardless of his qualification and experience was able to pay rent and provide food and clothing for his/her family. The Rwandan currency had a value before the civil war and teachers did not have to work in other schools to survive. (FN.I.06.00)

However, since the genocide teachers have become impoverished, along with most Rwandans, and find themselves professionally unequipped to face the new realities of teaching new content and using new methods specified in the new science curriculum documents. Bathilde, Jean Bosco, Didier and Socrates stated that their greatest challenges are systemic: they lack support and appreciation for any initiatives they may want to carry out in the school, their wages continue to be low although they work in a private school and they constantly face a lack of resources. To them teaching is more than subject matter and methodology, teachers' practices include their vision, commitment, and relationships. A science teacher at a well-known rural government school commented when asked about professional development.

Teacher professional development does not exist in the school. Teachers do not meet to exchange views. There is little initiative because of the poverty of their situation. There is no time to enhance a teacher's skill and improve their pedagogic practice. (F.H.ST2.05.00)

In an attempt to increase manpower resources, the government has introduced scholarships and there are a number of young students studying at the Kigali Institute of Science and Technology, Kigali Institute of Education and Kigali Health Institute. More than 400 students have been sent to India for undergraduate and graduate studies. The Kigali Institute of Education has a total student population of 1000 who are pursuing studies that will lead to Bachelor of Arts and Bachelor of Science degrees in Education. Over 60% of the students are training to become science teachers (Ministry of Education, 2000). However, a deputy headmaster of a well-known rural government high school did not understand the criteria for selection of students and obtaining a scholarship:

There are no opportunities for professional development since getting a scholarship is somehow a mystery. It does not depend on the choice, the knowledge or the capacity of the candidate. So the scholarship is organised in secret ways. Before the genocide nobody got scholarship and I feel after the war it is still the same. I know

that the government has sent many young students to India and America but I am not sure how they are selected. (F.H.ST2.05.00)

During my meeting with a senior official from the Kigali Institute of Education (KIE), he stated:

Teachers' education is an important part of improving the education sector in Rwanda. The Institute of Education plans to conduct training programmes for secondary school teachers at the prefecture level.

The in-service training programmes for teachers and school administrators will reduce the number of unqualified teachers in schools, thereby improving the overall quality of education. Presently over 50% of secondary school teachers and administrators are unqualified, and this must be rectified soon. (E.A.EP5.05.00)

In March 2001, the Rwanda Science Education Project was initiated at the National University of Rwanda. Through this project, science students and faculty at the university were exposed to interactive learning methods, case-based science instruction, multi-media and internet based exercises, and demonstrations of problem-based laboratories in biology and chemistry (Billeter et al. 2002).

A module on Teaching Biology in Secondary Schools in Rwanda and on activities in physics was taught to science student teachers in early 2002 (Billeter & Mills, 2001, 2002). The Ministry of Education has the immense task of upgrading the skills and qualifications of more than 50% of Rwandan teachers. Even though the Ministry of Education, has initiated training programmes and projects, the dilemma faced by teachers, head teachers and education personnel is how to progress professionally and upgrade their skills without monetary assistance and support?

6.5 Dilemma 5: How to produce a contextually relevant new Rwandan Science Curriculum?

Teachers in Rwanda were aware of the new science curriculum implemented in September 1998, but they had very scarce information about the process of curriculum design and development. There was no open discussion forum about curriculum reform in Rwanda and so the majority of teachers did not feel that they were in any way involved in the process of curriculum design. One of the plans of action of the Ministry of Education in 1997 was to strengthen the CNDP (National Centre for Curriculum Development) and the plan of action stated:

The Rwandan Education System will introduce far-reaching reforms in terms of subject matter taught. The reforms will provide a synthesis of English-speaking and French-speaking systems. New student profiles have been defined for pupils completing primary school, lower secondary education and for those completing A-levels, and technical and vocational training. The expected outcome was to be the development of a new curriculum for primary, secondary and vocational streams. (Ministry of Education, Plan of Action 1997)

In January 1995, 866 primary teachers participated in a mine awareness education campaign. With the help of British soldiers from United Nations Mission In Rwanda (UNAMIR), different kinds of mines used in Rwanda were identified (UNAMIR, UNESCO-PEER, UNICEF, 1995). Subsequently, the UNICEF in conjunction with UNESCO and the Ministry of Education developed and distributed teaching kits and posters of land mine information. In their report the authors of the kits state:

Posters were produced representing the shape, height of the landmines and form when they were laid. 886 trainers were trained using the cascade model. A six member-UNESCO-PEER educator's team carried out the training, each prefecture in Rwanda was divided into zones, and each zone represented two communes. At the commune level the training was for inspectors and directors of education. After they were trained they provided training to the teachers of their

province. Lesson plans were developed and were written in a manner that the subject could be taught in an inter-disciplinary manner in language, social sciences or health lessons. (UNESCO-PEER, 1998)

It was during this period that the idea of interdisciplinary and interactive teaching was introduced in Rwanda and the new curriculum documents were implemented in schools in Rwanda in September 1998. However, both Bathilde and Jean Bosco considered the curriculum content to be of little relevance to the realities of land-locked Rwanda. Physics, Chemistry and Biology at the secondary level continued to be content laden. As a survivor of the genocide, a mother and a teacher, Bathilde spoke as follows:

I would like to discuss how the genocide affected and shattered people's lives and how the people of Rwanda have come to survive and heal. I would like to explore and discuss local and national ethnic diversity. I would like to discuss what is wrong with Rwanda, and conflicts in other African states and why poor countries continue being at the mercy of external aid. I would like to discuss how peace, reconciliation and consensus could be achieved. I would like to let the students speak when necessary so that there is student dialogue and students are able to speak more in her class. (F.H.T7.06.00)

Jean Bosco talked passionately about the history of Rwanda, and felt that its culture, language, mountains and people continue largely to be left out of the picture. He commented:

History continues to concentrate on the past and excludes the current problems of Rwanda--such as poverty, justice, and reconciliation. History has continued to be about learning names, facts and events, rather than about discussing life issues. In addition, there is also little evidence that History has moved from indoctrination to an unconfined inquiry. (E.H.T6.06.00)

There is some evidence that these teachers' concerns were being addressed. For example, in October 1996, two years after the genocide, the Ministry of Education

added a subject called 'civisme' to the standard primary curriculum. The subject includes Education for Peace, Human Rights and Life Skills. It involved the development of a teacher's guide for education for peace and reconciliation and a children's book. A project developed in one region of rural Kigali aimed to recount and construct a memory of the genocide through reconciliation and democracy. Working with the Ministry of Education and the National Commission for Unity and Reconciliation, the project aimed to examine how the genocide can be used in teaching and how survivors can meet with schoolchildren and relate their experiences (AEGIS, 2000).

Didier, Bathilde, Jean Bosco, and Socrates would make the curriculum relevant, if they were allocated time to do it, provided with conditions to learn and create, and given support from their head teachers. However, their job is still about completing the syllabus material and teaching for the tests and national examinations. They would make the curriculum relevant if they knew that letting the students talk about their homes and communities would not cause students to fail during the examinations. The four teachers illustrated many ways by which they have tried to make curriculum relevant and brought into the classrooms their students' experiences. According to Socrates, in many rural schools agriculture was part of the curriculum and was designed to meet the needs of curriculum relevancy.

Agriculture was scheduled in all classes. All teachers were given a few hours of agriculture and this was included in their timetable. Students used to grow a variety of crops and contribute to the food stock in boarding schools. The course was practical and the students loved being outdoors. In addition to this, students also had a certain time allocated each week to improve sanitation facilities and clean up the school and the compound. Teachers and students freely participated in this collective activity. (E.A.T1.05.00)

The four teachers also suggested that connecting the classroom to the community is a powerful concept that can work so naturally for the villages in Rwanda. Didier is passionate about the child-to-child concept in teaching science to the students and wider

community. This study suggests that connecting the classroom and community plays a fundamental role in understanding one's self and one's community and can contribute to the appreciation and development of the local culture, including the resolution of social issues and problems which continue being excluded from the curriculum. Furthermore, the teachers invite us to honestly acknowledge that developing policies and creating structures will not mean that there will be improvement. The overview of the science curriculum documents presented in Chapter 5 indicates that the new curriculum does not include the vast and rich natural beauty of Rwanda, no content has been included about the mountains, the volcanoes, the forests, the national parks, the flora and fauna. Endangered species like the mountain gorilla, other primates and a variety of tropical birds are not discussed.

Interviews with science teachers, analysis of science curriculum documents and science lesson observations indicated the need to develop a science curriculum that is contextually relevant to the Rwandan context. The high school science teacher who had conducted the science fair expressed her thoughts on the current science curriculum:

The curriculum is haphazard and not very clear. It would be better if the Ministry of Education considers integrating science up to Year 9. Then science could be made easy to understand for the Rwandan students. Currently students are forced to cope even though there is no link in subject content from Year 6, the last year of primary school and Year 7, the first year of secondary school. The subject content is too high for students in lower secondary. (E.A.T1.05.00)

The Ministry of Education (1998) has stated that the historical development of post-genocide Rwanda requires a multilingual education system in which Kinyarwanda, French and English are used. However, imparting multilingual education can only be possible if there are teachers qualified to teach in French and English and teaching materials are available in both the languages. In the two years that I was teaching in Rwanda, schools and teachers were waiting for new textbooks to be printed and

distributed but these did not arrive. To address this issue, the 1997 plan aimed at formulating and implementing a policy on school textbooks and teaching material:

The lack of teaching materials, school textbooks and teaching guides places constraints on the education system that considerably affects the quality of teaching. It is important that the country develops and print textbooks so that the subject matter of the books reflects the new education objectives, the new profiles and the new curricula. (Ministry of Education, Plan of Action, 1997)

In informal talks with the Minister of Education, he expressed his views on the curriculum implementation phase (FN.EP.04.00). His intention was to revise and reform the science curriculum for students so that it would be easier for teachers and students and be more relevant to the Rwandan context. The current curriculum allows very little opportunity for teachers to use different pedagogical approaches and practices. The dilemma that the Curriculum Development Centre faces is how to make the curriculum contextually relevant for the students of Rwanda.

6.6 Dilemma 6: How to introduce interactive learning methods within a dominant teacher-centred pedagogy?

Since the re-establishment of the new Ministry of Education after the genocide in 1995, the main emphasis in Rwanda has been on teacher training and upgrading the skills of the existing teaching force. Among those upgraded skills are action plans on education policy in Rwanda have stressed the supposed move to interactive learning methods (Ministry of Education, 2000a;Curriculum documents, 1997). In reality, however, teacher-centred instruction has continued to dominate teachers' pedagogy.

Through an inquiry into the educational and societal structures of Botswana, Tabulawa (1997) found that classroom practices had deeper social, cultural, institutional, and historical roots and despite so much investment and innovation efforts in Botswana transmission methods of instruction have persisted. True knowledge is with the teacher.

In every school and class that I visited in Rwanda, students were expected to stand and greet me as a visitor to their class and to sit quietly until I had left. I observed that students in the secondary schools were curious about me, they wanted to know where I came from, and what I did and if they could write to me in Australia. However, the students were not allowed to talk and ask spontaneous questions. Rather, the teacher was in control of the class and the students were expected to follow her instructions (FN.SV.05.06.00).

The four teachers who were key informants in this study tried to use interactive teaching strategies within their classrooms. They had knowledge of the physical and social environment of Rwanda; knowledge of educational and socio-political changes that had taken place in Rwanda and about emotions and affects of these changes. All of these teachers made use of these forms of knowledge for the broader conceptualisation of their classrooms and profession. I have provided an account of my observation of a science lesson in Didier's Year 6 class.

I am observing a science lesson in a Year 6. This is Didier's class and he also has to prepare the students for the national exams to be held in June. I observe that the classroom is big enough to comfortably accommodate all the learners. This is a high cost private school, so the infrastructure in the school is good. There were about 20 students in the class and each student has his or her own desk and chair. There is evidence of students work on the display boards. The school had obtained banana fibreboards and used these to display student's work and posters and charts. The idea of using banana fibre was indeed a unique and attractive one.

Didier is going to teach the class about the human eye. He displayed a mixture of both traditional and learner-centred approaches. He had drawn a picture of the eye on a chart. I was aware that he had asked for permission and had spent the morning obtaining a goat and cow's eye to show the class. Didier introduced the lesson and discussed the various parts of the eye and the connection between the eye and the brain. His concrete resource of the eye helped stimulate student discussion. He made extensive use of question and answering as a teaching

approach. The students were all attentive during the lesson. At the end of the lesson, he assigned the students the task of drawing and writing about the eye in their class workbooks. The students quietly and diligently began working on this task. (CO.S1.05.00)

The science classroom observations revealed pedagogical, cultural, environmental and systemic factors that had contributed to the persistence of teacher-centred pedagogy. Though transmission had been the dominant mode of teaching methodology in Didier's class, interaction often took place inside his teacher-directed approaches. He was trying to do his best under the existing conditions. Jean-Bosco and Bathilde's occasional deviance from teacher-dominated approaches arose partly from their own belief in the necessity of variety for improving the teaching and learning process. My field notes emphasised this:

I had often noticed Bathilde take her class out into the school grounds to teach a lesson on the environment. She also brought a number of locally available materials into her class for use by the students. Jean Bosco often used story and drama in his lessons and the students enjoyed these activities. (CO.S1.05.00)

In most classrooms in Rwanda, teachers continue to write definitions of concepts and draw illustrations from the textbooks on the blackboard. Students replicate these diagrams and formulas in their notebooks. This mode of copying from the blackboard is supposed to assist the students' memorisation skills through repetition and reproduction.

In Rwanda, as in many countries of sub-Saharan Africa, the centralised and bureaucratic system of administration has remained intact. Teachers still fear inspectors and other official visitors, whom they think judge them according to their lesson plans and how well they follow a prescribed scheme of work. Hierarchy persists in Rwanda; schools have annual inspections and records and statistics have to be made available to the inspectors at the commune level. So far, the reform initiatives in Rwanda have not taken into account the local contextual realities and the local people's voices and visions about how to live and teach in their area. Schooling remained more about getting a certificate

and trying to move out of the rural areas into urban areas or even outside Rwanda. Teachers continued to view themselves as receivers and transmitters of knowledge and their students as receivers of that knowledge.

To Didier and Socrates it is important to be considered part of the reform process. They would like to share their ideas on pedagogy, examinations and student discipline. Current problems and successes cannot be separated from their historical roots (Goodson, 1997; Hargreaves, 1997; Louden, 1991, Tabulawa, 1997). Many of the teachers and students in Rwanda have seen trauma and experienced grief. Their past experiences can play an important part in the teaching and learning process. Unless the political, socio-cultural and practical questions of norms, habits and interests are not critically dealt with, talk about the shift to child-centred interactive learning pedagogy will always remain rhetorical, and will continue to support practices that promote obedience, and submission (Niyozov, 2001).

Although many of the goals and procedures of Rwanda's education system have been revised to include student-centred learning and a new science curriculum has been implemented that deals with the developmental aspects of science education, it is often difficult for teachers to adapt fully to the new conditions. As a result, many former practices, values and systems remain, making the implementation of reforms and the curriculum difficult. For teachers, however, to adopt or adapt new ideas will come mainly by sorting out the practicalities, the advantages and disadvantages between what they have and what they are offered. It is important to unleash teachers' creative and critical capacities, to transfer every encounter into teachable moments that could be used in the classroom, home and community particularly in developing countries (Niyozov, 1996). The dilemma in this case is how to adopt interactive learning strategies when the emphasis is on completing the curriculum content, and on set national and school examinations.

6.7 Dilemma 7: How to Implement Science Education for All?

According to Stinner and Williams (1998, p. 1028), science for everyone is “science that is comprehensible to all students, that students find meaningful and interesting, and that relates to their everyday lives and experiences”. Science for all takes the position that science education is the fundamental right to be accorded to every member of the population regardless of background, nationality, language, sex, and socio-economic circumstances. The stance is that scientific literacy is essential for the personal, social, economic and intellectual future of all students in our global community (Fensham, 1988). According to Socrates,

The great majority of students, especially in Rwanda, will not go on to science-related careers or even learn science beyond primary school, many will not go to secondary school. It is important that the content of their science learning in school be built on learning outcomes that can be sustained when they leave school and begin lives as citizens in Rwanda. (E.A.T1.05.00)

The linking of science education with work experience, the inter-locking of content knowledge and practical application and the use of environmental and community resources are important elements in the consideration of an approach to science education for students who will not study beyond primary school. These goals are similar to the goals of the Indian National Policy on Education (1986). The Indian National Policy on Education (1986) stressed the importance of science education for all and endeavoured to meet the challenge of the high drop out rate at each stage of schooling, as well as catered to the needs of the immense rural community. With a similar scenario in Rwanda, science education must have a strong component of non-formal education.

In a developing, primarily agricultural country, it is possible and indeed necessary to teach science with an emphasis on rural applications. In an interview with a lecturer at the Kigali Institute of Science and Technology, he talked about non-conventional

science courses that had been effectively and successfully adapted in Indian villages that could be adapted to the Rwandan context

While teaching at a village institution in Southern India we linked basic science with aspects of sustainable development. There were regular rural and village camps. We talked about rural technology and its link to science education. We discussed renewable energy from the sun and wind. We also introduced information technology to village students.

This model made use of imparting scientific knowledge for the purpose of social and community development. The project has been so successful that 200 villages in Southern India adopted the model. Rwanda, which is primarily a rural country and has a huge number of rural poor, can look at and implement this model of teaching in villages. (E.H.EP7.06.00).

Hegarty-Hazel (1995) suggests that science education needs to remain closely aligned to the world of the learner so that it does not become alienating and unsuccessful in its goals. Science for all can only be achieved through recognition, particularly on the part of the teachers; of the cultural experiences brought to the learning of science by all students especially those from marginalized communities (Tobin, 1998).

It is not possible to teach science without some content, skills and application goals, but the Ministry of Education in Rwanda could also consider the experiences of different groups of students because the present curriculum has goals that may not be appropriate for others (Wallace & Loudon, 2002). The dilemma in the case of Rwanda is how to make school science practical, relevant, available and appropriate.

5.8 Summary

Like the teachers of Niyozov's 2001 study, given the conditions in Rwanda and the complex dilemmas that teachers face, the puzzle is not why teachers leave teaching; rather the real puzzle is why good and creative teachers like Bathilde, Jean Bosco, Didier and Socrates continue teaching and trying to excel.

The teachers' voices and classroom practices linked us both to the fundamental qualities of human experience and to the crucial questions of the communities of Rwandan society. Changing teachers' practices, while ignoring the realities of their life makes the teachers vulnerable and exploits their motivation, and commitment.

The dilemmas identified have implications for educational change and teacher development. For a change to occur, the teachers and their students require opportunities for learning and teaching. Although the dilemma and tensions identified in this chapter are similar to those in other transitional societies, I have tried to address the dilemma using the voices of the four key informants. In Chapter 11, some recommendations have been made to address the dilemmas identified in this chapter. Chapter 7 details the constraints faced by teachers in the implementation of science education in Rwanda.

CHAPTER SEVEN

CONSTRAINTS FACED BY TEACHERS IN THE IMPLEMENTATION OF A RELEVANT SCIENCE EDUCATION

Educational reformers must not confuse a change in policy with a change in practice. Reformers must understand that in order to accept changes in practices a process of unlearning what custom, tradition, and even research have told education personnel is right, natural and proper has to take place. (Saranson, 1990, p. 101)

7.0 Introduction

This chapter deals with the constraints faced by teachers and educational practitioners in Rwanda in the implementation of the new science curriculum. Qualitative data for this chapter comprised interviews, classroom observations, curriculum documents, and documentary data from historical documents and reports from the Ministry of Education. My interpretations of the themes that have emerged from the data are presented in the form of constraints experienced by teachers in the implementation of a relevant science education. Short vignettes and quotes from the analysis of interview data and examples of classroom lessons support the constraints.

The vignettes are accounts of actual school visits, classroom observations and my personal encounters with teachers and students; these events occurred during the data collection phase and conclude with a short interpretive commentary. All quotes are from field notes generated from the interview transcripts, classroom observations and additional comments. The results have been summarised as responses to Research Question 4: What are the constraints faced by practitioners in the implementation of a relevant science education?

The emerging themes from classroom observations and interviews highlight the constraints faced by teachers, students and Ministry of Education personnel in providing a relevant science education. Each emerging theme has been identified and described as a constraint.

7.1 Infrastructure

A widespread outcome of the war and genocide in Rwanda was the destruction of all government buildings such as schools, hospitals, and health centres. Many schools were destroyed, severely damaged and reduce to rubble (UNESCO, 1998). In 1994, when the new Minister of Education took office, reminders of the war were everywhere; there were grenade holes in the walls, no windowpanes and the garden of the Ministry of Education building was strewn with documents from the Ministry. Furthermore the Ministry of Education was faced with severe shortages; there was no paper and stationery, records and documents were missing or destroyed, the educational personnel had no transport to visit schools in rural areas and most of all the Ministry did not have money and finances to carry out the task of rehabilitation. Rehabilitation began with aid from international organisations (Ministry of Education, 1998b).

During the crucial period of post-genocide reconstruction, the emphasis was on physical reconstruction and rebuilding of damaged schools; 3000 classrooms were rehabilitated during the emergency phase and 1560 new classrooms were constructed. Furniture was provided for 4,455 classrooms. In addition, seven government secondary schools, the Ministry of Education and a Centre for Pedagogical Training were rehabilitated and re-equipped under the emergency programme (Ministry of Education, 1996). Nearly all secondary schools experienced a shortage of laboratories and teaching equipment. Despite these developments, this study highlighted the acute need for a significant improvement in structural facilities, including the availability of water and sanitation in nearly every school in Rwanda. Many schools had no toilets or latrines within the school and had pit latrines outdoors.

The structural damage created circumstances that made the teaching and learning process difficult, especially in rural schools. A principal in a small, rural Christian boarding primary school who was struggling to improve the infrastructure in his school, hoped for the best in the near future, and stated:

I just have the minimal basics in terms of structure. I need more latrines for the school; we don't have access to water or electricity. There are no desks in the school. We desperately need help and funds. Funds and material resources are slow in coming and this can be extremely frustrating at times. (E.H.ST2.05.00)

Similarly, the deputy-headmaster of a well-known rural government high school had this to say about science laboratories:

Most schools have no laboratories; many laboratories were destroyed during the genocide and are being rehabilitated. The new private schools have no provision for laboratories and wait for sponsors to build labs. Many teachers are not well qualified in sciences to perform practicals in laboratories. (F.H.ST4.05.00)

A story told to me by Mutesi, a dedicated teacher in rural Rwanda, who is a survivor of the genocide, illustrates how she believes that education is the foundation of every occupation.

7.1.1 Vignette 1 The Legacy of War

The civil war and the culminating genocide have left a mark on the country. The legacy of destroyed structures is apparent throughout and the struggle to rebuild is evident. Many buildings, including schools and hospitals, had been needlessly destroyed. Roads have been wrecked and there still are no roads in most places. Water wells have been filled in. The country was also land-mined and on some days one hears the detonating of unexploded land mines, which can be unnerving.

Mutesi says that the war did not just destroy human lives it also wrecked our schools, our hospitals and health centres in the villages. Of the twelve women teachers in the school, seven are widows and have lost their husbands and children to the genocide. Some 80% of the students in the school are orphans. Everyone here has experienced loss and trauma. During the wet season, the number of students coming to the school reduces because it is difficult to walk long distances in rain and fog especially if the children have no shoes and umbrellas. Many of the children are malnourished because of acute poverty. Many are affected by malaria several times a year and some die of malnourishment or cerebral malaria.

Many school buildings are in a deplorable state. The students just sit on benches and in some rural areas wooden planks. They have walked miles to reach school and have no tables to write on or books and pencils to write with. There are no school canteens and the children do not bring any food, so most teachers and students go without lunch. This means that the afternoon lessons are difficult and cannot be properly taught or learned. I hope that our school will be rehabilitated and get resources. I firmly believe that the government should invest in education and increase funding for repair of schools, for resources and for teacher salaries.

7.1.2 Interpretive Commentary

In writing this story I have tried to portray the precarious condition of most schools in rural Rwanda. This shows the difficulty, pain and ugly effects of war and destruction. In its plan of action for the education sector in Rwanda, the Ministry of Education in 1998 proposed that instead of depending on imported and costly material and plans and techniques, which are often poorly adapted to the conditions of the country, it was possible to construct schools at a moderate price and for which only minimum maintenance is required. The emphasis was on the use of local materials and calling on the skills of the large labour-force in the communes. Regular maintenance of infrastructures and equipment would also contribute to reducing expenses by extending the period before repairs or renovation were required. Maintenance should be effectively monitored by the Ministry of Education and minor repair and maintenance must be

carried out with parents in the school and the community. By the end of 1999, more than 4560 classrooms had been rehabilitated, but the quality of construction in many cases was poor due to lack of contractor performance, changing security conditions and poor supervision. In most schools, there has been no allocation and provision for maintenance and repair.

7.2 Human Resources

In 1994 the new Rwandan Government experienced a critical shortage of skilled teachers as highlighted in Figure 9. Young teachers in Rwanda were often not provided with ongoing pedagogical training and practical internship. Teachers have often been teaching out of areas for which they were qualified and there was a specific lack of teachers for mathematics, sciences and languages. In Rwanda after the genocide, the proportion of qualified teachers fell from 60% before the genocide to 33% after the genocide (Ministry of Education, 1998).

With regards to higher and secondary education there were very few qualified graduate teaching staff. The majority of the teachers for pre-school education had no specific training for the task. In Rwanda, teachers have often to teach between 60 to 80 students in one class and most of the teachers have only completed secondary education. From 1999, the Kigali Institute of Education in Rwanda is training about 120 young student science teachers who will graduate with an undergraduate degree and in 2002 they are being allocated to teach secondary schools in the country. It remains to be seen how many of these young graduates will be motivated enough to stay in the teaching profession, and/or teach in the rural areas. A smiling female high school principal of a rural catholic, girls' school expressed her feelings:

I am usually an optimistic person and have been in the education system before and after the genocide. There is acute poverty and I see that people are desperate and have lost meaning for life. The teacher salaries are low and often not delivered by

the Ministry of Education on time. We need teachers to teach and books to implement the program. (F.H.ST4.06.00)

One of the foremost objectives of the Government of National Unity sworn in July 1994 was to open all primary and secondary schools by January 1995 as a means of healing and reconciliation. The main objective of the post-conflict education sector project was the training of 6000 teachers. During the emergency period, 5600 new primary teachers were recruited and trained in a five-day training program that was not adequate. Organizing this training was difficult as there were very few qualified teacher trainers and teacher-training material had been destroyed during the war. Sixty percent of primary teachers still remain unqualified.

One of my biggest dilemmas as a head teacher in Rwanda was to have my teachers teach practical science and show them that simple experiments could be carried out with locally available material. I decided to hold a one-day professional development session whilst working in Rwanda, where I would invite teachers from schools in Kigali and involve and empower the teachers in my school to conduct the session. Vignette 2 is an indication of my efforts to upgrade the skills of other teachers. The vignette is a retrospective reflection of a professional development exercise carried out by me in 1999 when I worked as a head teacher in Rwanda.

7.2.1 Vignette 2 A Professional Development Exercise

I planned this science professional development program with three co-ordinators from my school. I wanted the exercise to serve multiple purposes. I wanted my teachers to be empowered, to reach out to other schools in the community, to demonstrate how easy it is to conduct practical science in primary school and to impart some interactive learning strategies.

The response to the session was tremendous. All the invited schools decided to send a team of five teachers. I had a planning session with my teachers. We decided on the experiments we could perform. I allowed my teachers to decided

and asked them to select experiments that could be done with locally available material. I threw in a challenge, could we also show integration with interaction. My teachers responded to the challenge.

On the day of the professional development session my teachers had laid out four stations where hands-on activities would be carried out in small groups. The total number of teachers attending the session was about 50. One of the stations was germination and beans. I was amazed at the different variety of beans that are available and eaten in Rwanda. Teachers compared size, shape and colour, this in turn generated discussion on monocotyledons and dicotyledons. Making musical instruments from beans was also discussed.

Another station was the health station; five health issues that affect the lives of Rwandans were the focus of interest; cholera, HIV/AIDS, malaria, diarrhoea and malnourishment. The teachers displayed a combination of traditional and scientific knowledge when they talked about oral rehydration that can be simply made with water, salt and sugar, the simple meals that can be made from locally available millet and milk to counteract malnourishment, the need to talk about protected sex and care for AIDS patients.

The next station focussed on water: ways of water storage and purification, using sand, alum and clean river pebbles my teachers' demonstrated purification of water. They discussed in a group how rainwater could be stored so that it does not run down the hillsides and is wasted. Water is such a precious commodity in Rwanda that this station generated a lot of discussion.

The final station was called from waste to wealth and here all local material was put to use. From banana fibre teachers made balls, boards and cards, from wood they made statues and whistles, from hide they made drums, from metal strip they made cars, planes and bicycles, from gourds they made calabashes. The teachers realised that the knowledge they had was used to recycle. At the end of the day 50 tired but happy teachers received certificates and a handout containing notes of the days activities. They had used interactive strategies, integrated other

subjects into science teaching and worked in groups. This was a one-off only professional development experience for the teachers from the other schools.

7.2.2 Interpretive Commentary

This retrospective scenario highlights the need of teachers to upgrade and improve their qualifications and skills. During the course of two years in Rwanda, I had several professional development sessions with the teachers from my school. After each professional development session I would feel the teachers needed more than one-day sessions. They needed to upgrade from being diploma holders to degree holders and ought to have the means and facility for distance education or to study part time or in the evenings. In March 1998, a new-integrated teacher development program to upgrade 3500 unqualified teachers and 3000 under-qualified teachers commenced.

I had met the Director of pre-school, primary and special education in the Ministry of Education several times whilst I was a head teacher in Rwanda and during the data collection phase. He made a comment about the education reform process in informal talks with me:

At the beginning of 1995, the Ministry of Education and all its implementing partners put education on the agenda during a special conference on education policy and planning in order to establish the "what", "when", and "how" for the reconstruction of education. Priority was given to the creation of infrastructure, acquiring material resources and equipment and implementing emergency plans for teacher training at all levels. A special fund was created for children who were orphans of the genocide so that they would not be excluded from the school system.
(FN.EP5.06.00)

The Ministry of Education (1998b) in its report, while listing the problems and challenges faced by Rwanda acknowledged that teachers who did not have sufficient level of general, vocational or pedagogical training caused a drop in the quality of the education system.

7.3 Material Resources

Most schools lack basic equipment and books and this lack of equipment, including technical and laboratory equipment, continues to frustrate teachers and head teachers. School facilities are inadequate with missing equipment that often is unevenly distributed throughout the country. There are severe regional disparities in terms of access and distribution of educational resources, although this has improved in the period 1998-2000 (Ministry of Education, 2000).

An experienced school headmaster from a well-known rural government secondary boarding school who could only spend a short time with me had this to say about the lack of resources:

A lot of my time is spent on administrative matters such as where can I find the money to repair the school, improve resources or find maize and beans required for the students most of whom board in the school. I need the material resources and thus have to compromise on professional development.(F.H.ST3.05.00)

Schools and classrooms operate in extremely precarious material and physical condition: teaching materials are often reduced to a blackboard and chalk, school equipment often does not work and when it does it may either not be operational or teachers may not be trained to use the equipment. In many cases, due to the lack of a maintenance budget, teachers are hesitant to use laboratory equipment for fear of damaging equipment (Ministry of Education, 1997).

Most schools also do not have access to water and electricity and so do not have the means to conserve perishable goods like food samples, fruits, vegetables, germinated seeds or insects or animals to be used for dissection. Classes thus remain theoretical and practical work is limited to several demonstration exercises that the students watch. (FN.SV4.05.00)

7.3.1 Vignette 3 **The Need for Resources**

I am visiting a secondary school in semi-urban Rwanda, just 12 kilometres out of the capital Kigali. Celestin my interpreter is unable to accompany me but I am not worried because the school director and principal know me. The school director used to be my deputy at the school I was working and the headmaster of the school was a young, dynamic, extremely well spoken and well-read University graduate. However as we drive towards the school, I start getting worried, there is no road and we are lost. Anton my driver stops to ask for directions but is misled. I am not sure what to do and suddenly we see a by-road, a tiny mud lane that allows access to only one car at a time. We follow this route and reach the school.

The school is still in a state of disrepair. Classrooms have bare walls and have desks and tables and a blackboard. Most have an open space for windows and doors. I am once again told that the majority of the students in the school are orphans and the government pays for their fees. These fees are always delayed and this affects the school, as the school relies on fees for supplies and to pay its staff. The school gets some help with the payment of teacher salaries from the government but often the government salaries are not paid on time and sometimes delayed for six months.

The school has no laboratory or library. It is a secondary school and some of the students appear to be more than twenty years of age. I am aware and am told that the students have had interrupted education due to war and displacement. There are no proper toilets or bathrooms and no access to water or electricity.

I talk to the headmaster and he is a returnee refugee. He is a university graduate. He talks about a whole range of issues: the learning and teaching of science, the lack of material and financial resources, the motivation of teachers and the need to keep them in the profession. I do a lot of listening as I sense his frustration and helplessness. He talks of his unsuccessful efforts in obtaining a better job, lack of help to further his own professional development. He talks about how he functions amidst these difficulties. The British High Commission has helped the school in small ways and although a tiny drop as compared to the needs, it still helps.

I have administered French and English teacher and student questionnaires at the school. I have had the opportunity to talk to some of the teachers. I am beginning to understand the multiple problems and constraints the head teacher, the teacher and the students face.

7.3.2 Interpretive Commentary

This school is characteristic of the many in Rwanda. As an educator I feel that education is the right of every child in the world and teachers need basic resources to teach. As a teacher from the developing world, I understand that resources are always inadequate in schools in the developing world and teachers learn to improvise. The head teachers and teachers in Rwanda do not ask for much: they can make do with the minimum resources but in most cases even these basics of chalk, paper, pens, pencils, teacher guides and textbooks are not available. I often wonder when the country will reach the stage of having at least adequate basic resources for its schools. I have no answers and struggle to understand the complexity of implementing a relevant and effective education and delivery in the complex transitional society of Rwanda.

7.4 Finances

There is a general shortage of funds in Rwanda and this affects the implementation of all educational projects. In Rwanda, the UN agencies, government, bilateral and non-governmental agencies are funding economic, health and educational projects. In the context of transitional societies it is important that these agencies view long-term sustainable goals in education as a determinant for funding. Twelve percent of the government's ordinary budget was allocated for education in Rwanda in 1998. Ninety three percent of the Ministry of Education budget was spent on salaries, whilst only five percent was spent on teaching materials and there was no budget allocation for training. Food, transport and maintenance took up the rest of the budget (Ministry of Education). The average salaries of teachers in Rwanda are between US \$85 to US \$100 in

government schools per month and in some private schools this may go up to US \$300-400, which is still a very low wage.

Apart from the external sources, the Ministry of Education has looked at internal sources of funds like parental contributions, community fund raising efforts, and assistance from religious institutions. Local communities have tried to provide resources needed to operate or repair schools but in view of pervasive poverty in the rural areas, most parents do not have the means to support schools. In urban areas parental contributions do not contribute to operating costs but sometimes do support minor repairs. Sometimes parents pay a contribution every four months, which increases the monthly salary of a teacher by about 25%. The lack of funds for non-salary items like teaching materials, books and equipment is particularly serious. Many poor parents in both the urban and rural areas are unable to provide uniform and shoes for their children (Ministry of Education, 1997).

Each and every one of the teachers and head teachers, whether in private or government schools with whom I spoke discussed the need for funds. All felt that without adequate budget allocations to cover the cost of school operations, maintenance, repairs, and the provision for teaching materials, there was a serious constraint of sustainability. I have provided a vignette to demonstrate this acute need for finances.

7.4.1 Vignette 4 A Visit to a Rural Christian Boarding School

I travelled with Celestin and Anton to a Christian primary school in rural Rwanda, an hour and a half drive away from the capital Kigali. We climbed a hill along a mud road to reach the school; at the bottom of the hill rested a lake. The entire scene was picturesque.

I knew the principal of the school. I had met him and spoken to him during my earlier time in Rwanda in 1999 and knew him to be an English-speaking teacher from Uganda. He was a refugee returnee. I knew he was struggling against great odds to run his school, but I always found in him a quiet optimism. The buildings were just a simple structure with no doors and windows. The school was a

Christian charity school and had a boarding section with 85 girls and boys who lived in the boarding house. The school walls were bare and students had no desks, only benches on which to sit. Some of the senior Year 5 and Year 6 classes had desks.

The children in the school were poor and this was apparent in their dress, their manner and communication. I was informed that many of the students were orphans. I was to spend half a day at the school. Everyone welcomed me and I administered the questionnaire to students and teachers. I observed a science lesson in a year 5 class. The teacher was a volunteer missionary teacher who was at the school for a period of one year. She brought in everything for the lesson from home, as the school has no resources and carried out an interesting lesson on floating and sinking with students being involved and participating. The lesson is described in the Chapter 5.

In my interview with the head teacher, I realise that he has to depend on funds from the church that supports the school and from parents. The Ministry of Education only pays the salaries for some of the teachers. The parents of the students are the rural poor and cannot help the school. The school is in desperate need of funds, to complete the infrastructure, to construct pit latrines and bathrooms in the boarding section, to obtain desks and chairs for the lower primary section, and to provide some resources for the teachers.

The head teacher is not sure when the funds will ever be enough for the school or even if he will get funds. In spite of his financial difficulties he is running the school and remains positive. He does not want to look for a better job although he would like to upgrade his skills. He wants to stay on at the school and develop and improve it further.

7.4.2 Interpretive Commentary

During my entire day at the school I had not eaten anything. I am not brave enough to drink the water or use the pit latrines. I realise that henceforth I must carry my own water and some bread and bananas not only for myself but also for my interpreter and

driver. I am humbled by this experience that even today human beings in transitional societies like Rwanda survive against great odds and learn resilience from a very young age. In a chronically poor country, with poverty having increased since the genocide, I am at a loss to understand how finances can be made available to the schools of Rwanda. What will happen if bilateral and international donors reduce the amount of aid for Rwanda? Can budget allocations for defence and security be reduced so that finances for health and education increase?

7.5 Governance

The Ministry of Education in Rwanda is responsible for the management of all levels of education, pre-school, primary, secondary and higher secondary and is divided into two administrative authorities—central and local. As the central administration, the Ministry of Education is responsible for organizing, monitoring and evaluating all educational and extracurricular activities in the country. The local administration is characterized by a double system of inspection at the district and commune levels. The head teachers are also an important factor in the local administration of education. Many developing countries like India and Uganda have managed to effectively decentralise governance and decisions and actions are often taken at the municipal level (UNESCO, 1999). However, in spite of the existence of district inspectorates, nearly all decisions are taken by the central administration thereby creating a bottleneck for regional and local services.

The Director of Secondary Education in the Ministry of Education is a young woman who is a university graduate and a returnee refugee; she shared her vision for increasing the number of secondary schools throughout the country:

The Ministry of Education is trying to sensitise parents to build communal schools in all villages and communes and the Ministry will then try to support these schools by providing desks, chairs and teachers' salaries but the governance of the schools will have to be through the Parents' Associations or Committees. (E.H.EP8.06.00)

Though the intention of the Ministry of Education is to decentralize the administrative management of the education system, a large part of the management tasks and responsibilities are still executed by a sole central administration and in many cases by the Minister himself. Indeed, local administrators and inspectors currently do not have the skills, qualifications or experience to shoulder responsibility. At present the state of the inspectorates is such that they cannot deal with the multiple responsibilities of pedagogical activities, administration of schools, management of teachers and maintaining the financial records of the personnel under their jurisdiction (FN.EP.05.00).

This centralized administrative feature creates difficulties for head teachers as problems cannot usually be resolved at the commune level and have to be taken up at the Ministry level. Unfortunately, due to the lack of qualified and experienced human resources the Ministry is not able to place enough suitable people to cater to the decentralized management of the system. The current inspectorates do not have the necessary human, material, logistical and financial resources needed to effectively improve the system. The Director of Pre-school, Primary and Special Education in the Ministry of Education talked about decentralisation and mentioned that the Minister of Education is keen to have decentralisation structures in place:

The Ministry of Education has used an innovative approach in the decentralisation process of reconstruction of schools and school administration especially at the village level. On one hand, each village was to elect a management committee with one person designated responsible for education in that village. On the other hand, parents were mobilised and asked to participate in the construction of the schools - not with financial contributions but more with their labour. (UNESCO, 2000; FN.EP.05.00)

Parents' Associations have been revived and have taken charge of several school activities, such as renovation, budgeting, and attendance. Fee-paying classes are being opened in each school. In addition, schools and parent associations have initiated

complementary fundraising activities, such as selling the school gardens' agricultural products, opening of school revolving funds, seeking sponsors, and selling teaching materials.

7.6 Pressures Experienced by Teachers and Students

The nature of the examination-driven curriculum places pressure on both the teacher and the student to maintain high achievement scores, to improve the position of schools in national examinations and to improve student test results. As mentioned in the previous chapter, schools that do well in the national examinations were announced on the radio and mentioned in the newspapers, thus head teachers did their best to ensure that the students' focus in Years 6, 9 and 12 was on the national examinations.

As a result of this school culture, examinations took precedence over other activities. The self-discipline, teaching and homework patterns required for success were inculcated in the students. Examination results were most important, so that students could go for higher education. The teachers were encouraged to complete curriculum content, train students in solving examination papers, concentrate on developing the academic ability. This style of teaching allowed limited opportunities for group discussions, small group activity or questions. Memorisation was considered an effective method of preparing students for examination. In all schools, students were ranked in order of merit and performance and students were known by their performance and academic ability.

During my experience as a head teacher in Rwanda, I often had discussions with my teachers at the school on the issues of student ranking, the constant testing and the pressures experienced by students and teachers because of the examinations. Most teachers felt that it was important to do well in the examinations as the results reflected their good teaching methods and student effort as is typified by this comment:

The education system that we went through as students and as teachers was one in which the emphasis was on passing the Year 6, Year 10 and Year 12 exams. Undoubtedly, this led to an examination-led education system that measures achievement of learners by how much content they can remember. Hence we are bound to develop a learning culture that is centred on passing the national examinations, which does not necessarily guarantee that meaningful learning has taken place. All we recall of those days was the intense preparation and reading. (FN.T3.T4.05.00)

The final vignette in this chapter is the brief description of a lesson observation carried out in a Year 9 class, where the emphasis has been to cover the content and the focus is on the national examinations.

7.6.1 Vignette 5 A Year 9 Science Lesson

I observed a Senior 3 (Year 9) Chemistry lesson that was conducted in a general-purpose classroom. The students are usually in this class for all subjects. Although new and well resourced compared to other schools in Rwanda, the school was not equipped for hands-on or practical science activities and laboratories are still being built. This was a high cost private school in the capital Kigali and student numbers were small in each class.

No examples of student work were posted on boards or walls. There were no science-related displays or posters. Essentially the classroom walls were bare. The classroom arrangement was not typical of Rwanda, in that students had a desk and chair for themselves and students were seated in rows. Students were free to choose their own seating.

This was a teacher centred classroom where didactic approaches were used to teach the students about the periodic table. The only resource used by the teacher was a chart prepared by the teacher herself. The teacher was highly qualified and experienced and claimed to be proficient in the use of student-centred approaches, however she uses teacher-centred methodologies in her classroom because of the curriculum overload, lack of textbooks and the influence

of the national examinations. She introduced the lesson and led the discussion and explanation about the 'periodic table' for the major part of the lesson. Towards the final 20 minutes of the lesson, students were selected to come to the board and solve problems related to the topic that had just been taught. She also asked if the students had any questions to ask. At the end of the lesson the students were given a homework assignment to do.

Immediately after the lesson, I had the opportunity to interview and talk to the science teacher. I knew her personally and was aware that she was extremely confident and talented. During the course of the academic year 1999-2000, she had organised a science fair and the fair had been extremely successful. She gave me her impressions of science teaching and the curriculum and said that the major focus of her teaching was student achievement and performance at examinations. In spite of the pressures of curriculum content and the lack of resources, she was extremely positive about the students and felt that they were capable and interested even under the difficult circumstances of learning. She emailed me in August 2001, informing me how well the students had performed in the Year 9 national exams and the International IGCSE exams. The head teacher of her school and the directors of the school were impressed.

7.6.2 Interpretive Commentary

In Rwanda, the teacher is required to keep the students interested and attentive in the classroom. A quiet and disciplined classroom is a sign that the teacher is in control. Students are passive learners. There is no room for manoeuvring or investigating a variety of materials, as there are never enough resources. Students have respect for the teacher, the teacher was rarely interrupted and there was no distraction of fellow students. The teacher's knowledge and the teaching methods were never questioned. Many a time even if they had difficulty in understanding the content they would rarely ask the teacher. Respect for the teacher existed among the students in Rwanda and was reflected and demonstrated through classroom behaviour and interactions between the students and their teacher.

7.7 Summary of the Chapter

The findings in this chapter support the constraints emerging from interview data analysis, field notes from school visits and observations of science classrooms. The constraints identified have implications for educational reform, change and teacher development. The Ministry of Education in Rwanda will have to address the constraints in order to improve the quality of teaching and learning in Rwanda. Although the constraints identified in this chapter are similar to those in other transitional societies, the constraints in Rwanda especially in the rural areas are unimaginably severe. In Chapter 9, some recommendations have been made to address the constraints identified in this chapter. Chapter 8 describes the status of teachers and students in Rwanda from the analysis of descriptive data.

CHAPTER EIGHT

THE STATUS OF TEACHERS AND STUDENTS IN THE STUDY SAMPLE

The combination of multiple methodological practices, empirical materials and perspectives in a single study is a strategy that adds rigor, complexity, richness and depth to any inquiry. (Flick, 1998, p. 231)

8.0 Introduction

As previously described in the Chapter 4 on research design and methodology, a questionnaire was administered to students and teachers in 12 schools in Rwanda. The purpose of the questionnaire was to encourage responses from the students and teachers in a range of areas including the school environment, beliefs about science teaching and students' attitude towards science. The percentage responses from the two groups for items in Part A of the questionnaire provided information on the students' and teachers' backgrounds. Areas covered included age, years employed in education, sex, qualifications of teachers and involvement in professional development activities. This chapter deals with the results of the descriptive data analysis of the questionnaire and responds to Research Question 5: What is the status of teachers and students in the study sample?

8.1 Overview of Descriptive Data Analysis

The students and teachers in the 12 schools in Rwanda appeared to enjoy the exercise of answering the questionnaire; during the administering of the questionnaire my interpreter and I were always present. However, we had to often explain the process of answering a questionnaire and sometimes also explain the meaning of individual items because the students and teachers were not used to answering questionnaires and the

level of English or French comprehension was also quite low. Frequency distribution for French and English students and teachers, as separate individual sample groups was also carried out with respect to age, sex profile, rural urban distribution, qualifications of teachers and the developmental aspects of science education. The results have been represented as graphs and included in this chapter, the results of the developmental aspects of science education have been included Chapter 9.

8.2 Profiles of Teachers' and Students' Ages

Teacher profiles indicated that the majority of the sample was below 30 years of age (See Figure 5). This profile is likely because a sizeable proportion of teachers were killed in the genocide reducing the percentage of qualified teachers from 60% to 33% (Ministry of Education, 1997). Many of the former teachers had been killed or had left the country causing a reduction of human resources (Ministry of Education, 1998). These results were supported by the World Bank, Human Development Report (2000) that stated that during the post-conflict emergency education period, 5600 new primary teachers were recruited to respond to the unconditional commitment of the government to reopen schools.

A senior educator within the Catholic Education Service in Rwanda, who was in Rwanda during the genocide, commented about the massive loss of teachers:

During the genocide there was massive destruction of schools. Books and school material were lost or burnt, school furniture was used as firewood, but most of all many teachers were killed and many went into exile. Today we need trained and qualified teachers, otherwise we cannot have quality and standards in our schools.
(F.H.EP20.06.00)

A Ministry of Education (2000) report indicated that the total population of students in secondary education was less than 20% of primary school leavers. At 3.8% of the entire student population, the secondary school enrolment rate is one of the lowest on the African continent. The population of students in tertiary education was barely 6000 in

2000, representing less than 1% of the population of the 18 to 24 years age group (Ministry of Education, Higher Education Sub-sector Policy 2000).

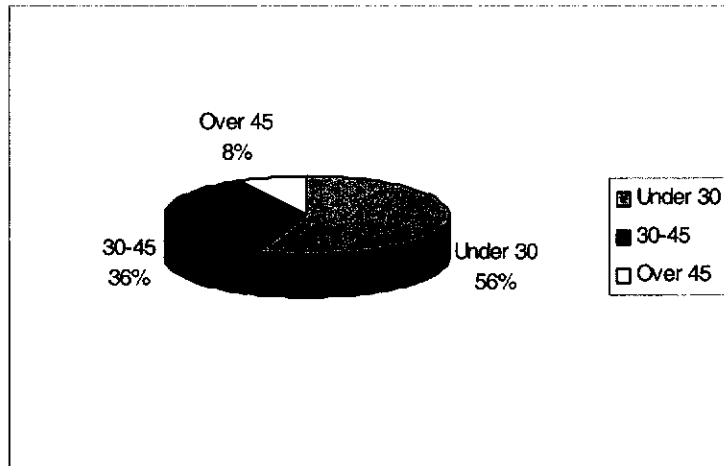


Figure 5: Age of Teachers in the Study Sample

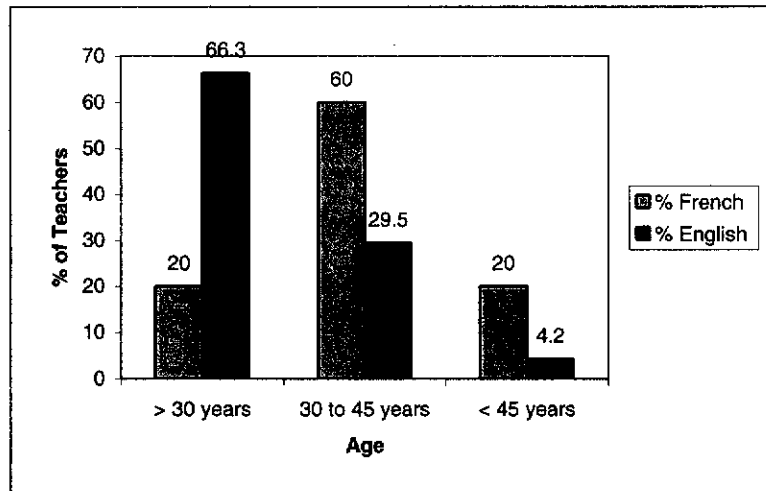


Figure 6: Age of French Teachers (n=30) and English Teachers (n=95) in the Study Sample

It was interesting to note that 66% of the English teachers were below 30 years of age and 60% of the French teachers were between 30 and 45 years. Only 4.2 % of the

The Status of Teachers and Students in the Study Sample

English teachers were above 45 years. Most of the English teachers are the returnees who have returned to Rwanda after the genocide and are young teachers.

The student profile showed that 17% of high school students in the sample were in the age group of 20 to 25 years and this profile can be attributed to the war and displacement of the population where there were no opportunities for schooling in the students' earlier years, especially secondary students (See Figure 7).

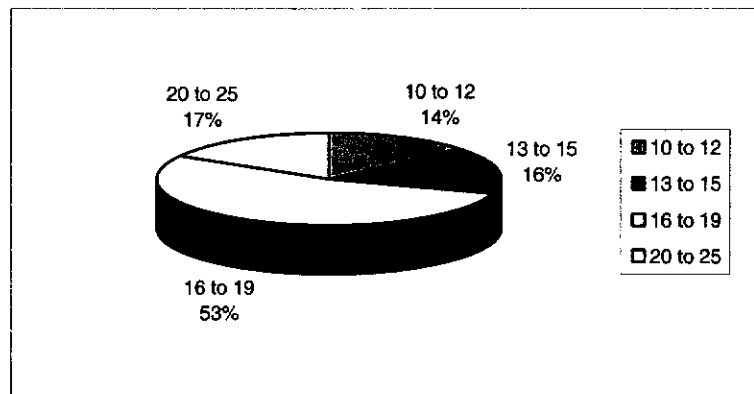


Figure 7: Age of Students (n=474) in the Study Sample

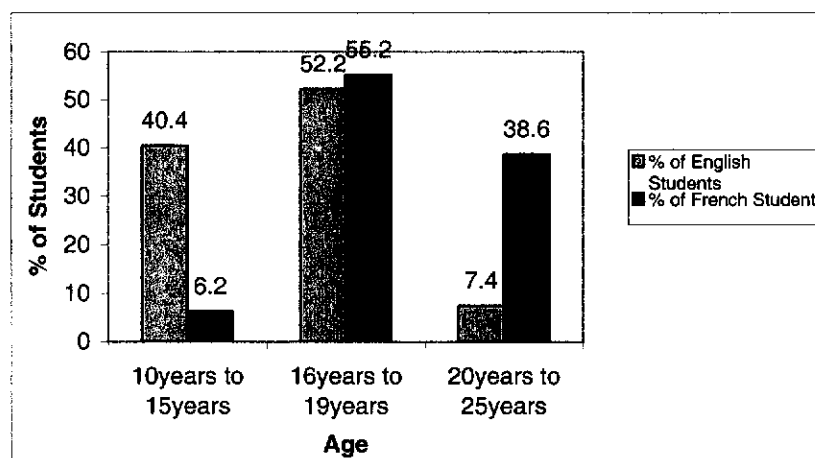


Figure 8: Age of French Students (n=142) and English Students (n=332) in the Study Sample

A breakdown of age of French and English students (See figure 8) indicated that there were 38.6 % of French students in the age group of 20 to 25 years. This high age of secondary school French students is a reflection of the instability in the whole Central African region. The Democratic Republic of Congo, Burundi, Rwanda and Congo-Brazzaville are Central African French speaking countries that have had political instability for more than 15 years (Reindrop, 1998). This political instability has drastically affected the life of civilian populations in these countries.

The Ministry of Education reports in 1997, 1998 and 2000, indicated the need to upgrade the qualification of primary and secondary teachers in Rwanda, to achieve universal primary education for all children in Rwanda, to increase access to secondary schooling and increase tertiary enrolments rates.

8.3 Sex Profiles of Students and Teachers

Analysis of items by sex showed that the male and female percentage of students in the study sample was 51.5% male and 48.5% female (See Figure 9). A Ministry of Education (1997) report indicated that net enrolment rates for primary education were about 68.4%, indicating that a substantial number of children never enter the school system. Although girls outnumber boys at the primary level, the dropout rate is higher for girls after the first three years of school.

Thus, a notable feature from the data of this study and supported by statistics from the Ministry of Education (1998) showed that there were minor sex differences at the primary level but that sex disparities were more apparent in secondary schools. At the tertiary level females were outnumbered by a ratio of 1:7 (Ministry of Education, Higher Education Sub-sector Policy, 2000).

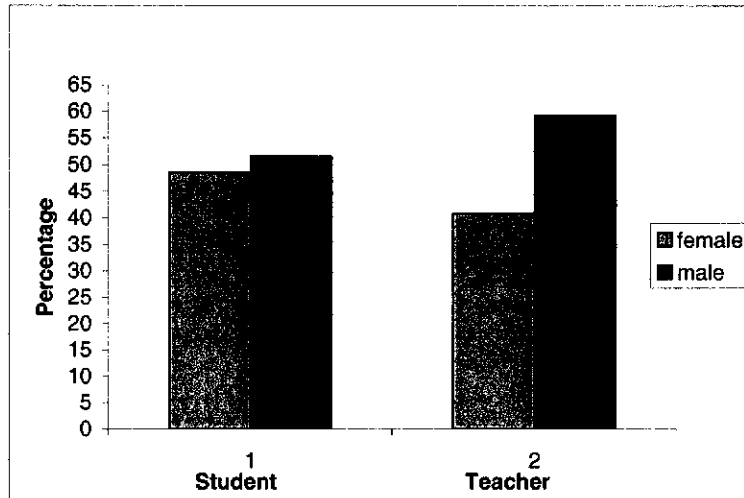


Figure 9: Sex Profile of Students (n=500) and Teachers (n=125) in the Study

In an interview with the Director of the National Examination Board, he commented about the disparity in females attending secondary school:

Accurate statistics are not available on female students attending school before or after the genocide. Many girls do not have the means to continue their studies. They have no sponsors and do not receive scholarships or bursaries to further their education. Some of the girls are heads of families and have to look after their younger siblings. Many are traumatised and some are forced into marriage. (E.A.EP1.05.00)

Sex profiles for teachers in the study sample indicated that 59.2% were males and 40.8% were females, even though 54% of the total population in Rwanda is female. However, as indicated in the above quote and from my personal observations over the two-year period I worked in Rwanda, many females had limited access to education and many have not studied beyond primary school.

The sex profiles for the French and English teachers in the samples indicated that only 16.7% of the French Teachers were female. From my personal observations over the two-year period I worked in Rwanda, I observed that most French science secondary

teachers are male. The English sample had a fairly equal number of male and female science teachers. (See Figure 10)

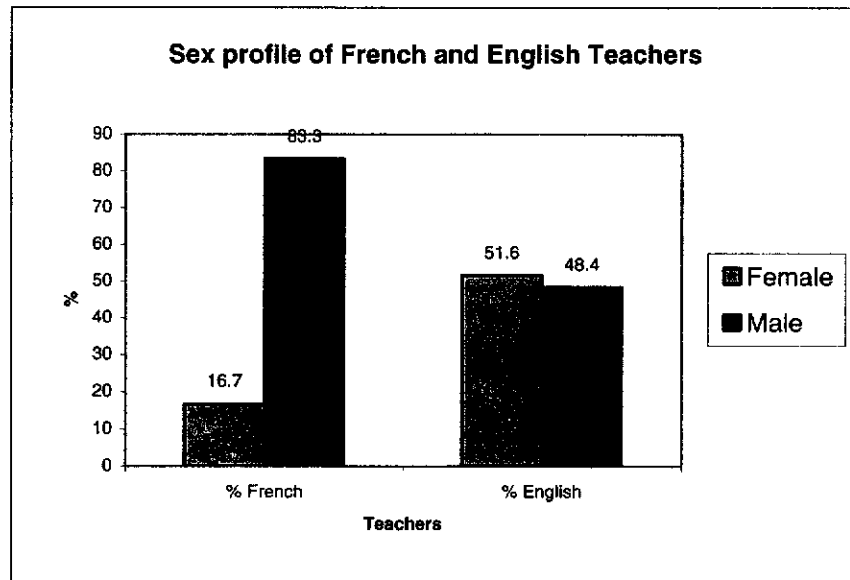


Figure 10: Sex Profile of French teachers (n=30) and English teachers (n=95)

In the higher education system in Rwanda, this sex imbalance is clearly reflected in the greater number of boys' schools and hostels as against similar educational facilities for girls in the existing higher education institutions (Ministry of Education, 1998). Even today, especially in the rural areas of Rwanda, there is limited access to education and in some cases no access to secondary education (Ministry of Education, 1998).

Figure 11 showing the sex profiles of French and English students indicates that the number of boys in the French and English students sample was only marginally higher than the number of girls. One of the mandates of the education policy of 1998 has been to increase the number of female students in secondary and tertiary education.

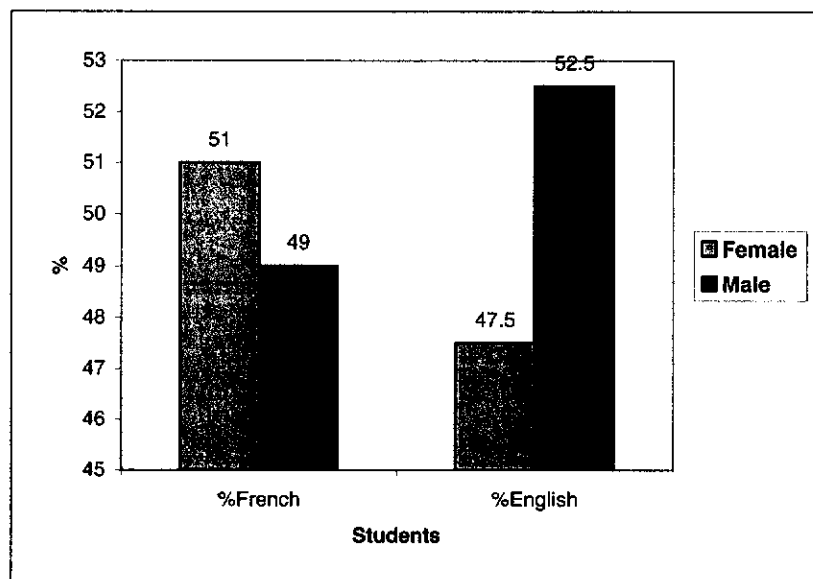


Figure 11: Sex Profile of French students (n=142) and English students (n=332)

From 1999, there has been a move to increase the number of female students at secondary and tertiary levels. Records from the Kigali Institute for Science and Technology, the Kigali Institute of Education and the National University of Rwanda indicate that female student enrolment had increased to twenty five percent in some disciplines (Ministry of Education, 2000a).

In the academic year 1999-2000, an African Women's Non Government Organisation called FAWE (the Forum for African Women Educationalists) established a Girls Secondary School in Gisozi, Kigali. Over half of the students in the school were orphans and were provided a scholarship through the initiative of the USAID. The school also had science laboratories and computer laboratories. I knew a few members of the women's NGO. A teacher from my school had joined the NGO and another teacher had left to teach at the school. I visited the school during my data collection phase in Rwanda. I have included an account of my visit to the school.

It took 30 minutes to reach the school from the centre of Kigali. Throughout my visits through the urban and rural areas of Rwanda, Anton, my driver, accompanied me. A young Rwandese, he gave me a commentary about the area

we are visiting. He too has never been through this area, but wants to contribute his thoughts. We are passing a massive memorial site where we see the construction of a genocide monument in remembrance of all who perished in the genocide.

We drive carefully through the hillside. The roads are made of mud and I am thankful it has not rained. Mud huts line the sides of the roads, I see women go about their daily chores and children playing and running around. Goats and chickens can be seen in the yards of some huts. We pass cattle and young boys looking after the cattle. They should be in school but are helping their parents in caring for the animals. I did not know how long we had to drive and where we were going. I was relieved when I saw the school to my left. I am impressed and so is Anton.

Rehabilitation had made a tremendous difference to the school and its buildings. The school is one of the few in the country to have a fence and gate. We park and I am led to the deputy's office. The head teacher has been called to a meeting in Kigali. The school buildings had a new coat of paint. We could over look the valley and the entire scene was magnificent.

I am told there were 160 students in the school, all female, and 67 students had lost either one or both parents during the genocide. The school has a capacity for 720 students. I tell the deputy principal, the purpose of my visit and she invites me to tour the school. I am told that it is the first public school in Rwanda that will take fee-paying students and students from disadvantaged families. It is a boarding school and all the students' board at the school. It also has a fully networked computer laboratory.

There is still no access by public transport to the school and the schoolteachers are usually picked up and dropped from a village near the school where they take a local connecting bus to and from the school. Although it's the school's first academic year, I am impressed by the infrastructure and planning and feel a great sense of hope that this school will provide quality education for the girls of Rwanda. (FN.SV12.06.00)

I hope in the years to come there will be further initiatives, such as the one mentioned above in secondary, vocational and tertiary education for the female students of Rwanda. The Ministry of Education needs to address the issue of increasing access to the education of girls, as currently many female students do not go to secondary school, have to do household chores or contribute to family income. Many are married off early to escape the cycle of poverty in rural home and after the genocide many young girls head households looking after their younger siblings.

8.4 Teacher Qualifications

Only 18% of the teachers in the study sample had a bachelor's degree and 3% a master's degree (See Figure 12). At the start of the civil war from 1990 to 1994, Rwanda had experienced a shortage of teachers. After the genocide in September 1994 the country faced a further critical shortage of teachers. Between 1990 and 1994, only 61% of primary teachers were qualified, this figure fell to 48% after the genocide (Philips, 1994).

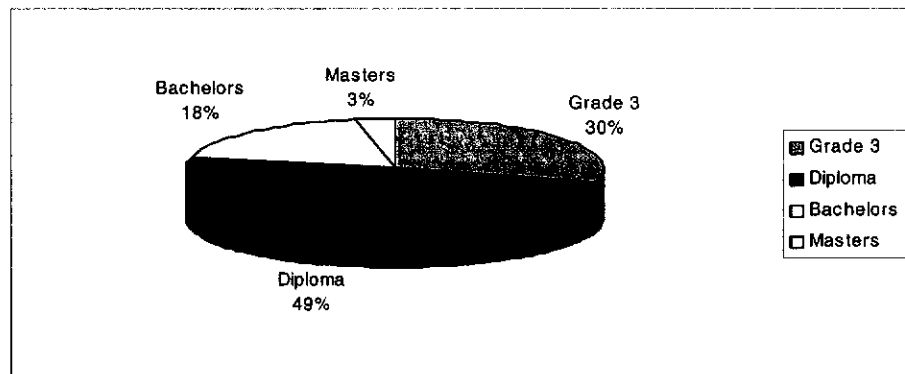


Figure 12: Teacher Qualifications of the study sample in Rwanda.

Statistical records of the Ministry of Education showed a very small percentage of science teachers had university degrees and few had undergone professional training in the last decade with respect to classroom practice or practical science skills (Ministry of Education, 1998). Many of the new teachers recruited for primary education during the post-conflict period had not completed more than primary education. There were few

qualified trainers left and most of the teacher-training infrastructure and materials had been destroyed during the war.

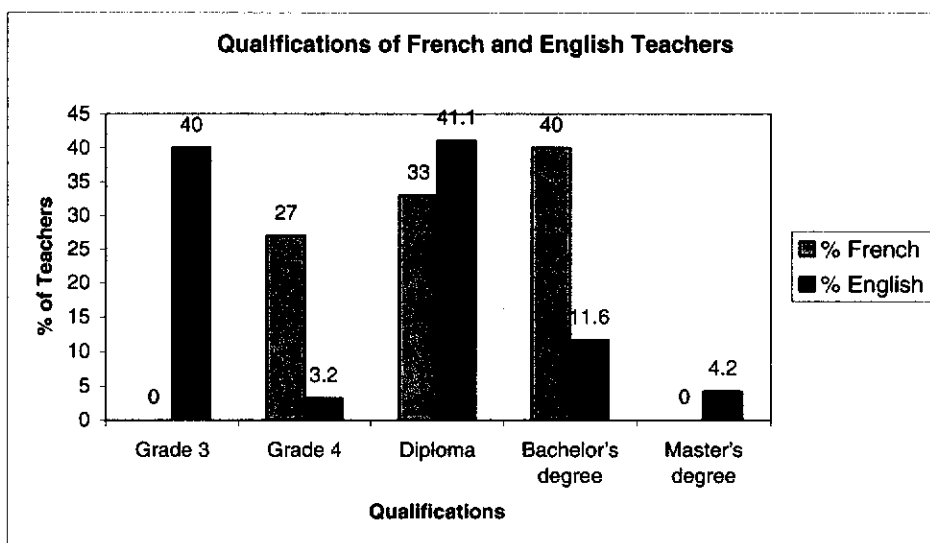


Figure 13: Teacher Qualifications of French teachers (n=30) and English teachers (n=95) in the study sample

Figure 13 indicates that 33% and 40% of the French teachers in the sample had a Diploma in Education and Bachelor's degree respectively, whilst only 11.6 % of the English teacher sample had degree. Majority of the teachers in Rwanda in the study sample had a Diploma in Education. 4.2 % of the English teachers had a master's degree. Despite the difficulty of the post-conflict phase, 12 senior inspectors in each of the prefectures and 155 sector inspectors were trained. An integrated teacher development program commenced only in March 1998, because the Ministry of Education decided to resume teacher training only after completing the revision of the curriculum (World Bank, 2000).

8.5 School Distribution in Rwanda

There is unequal access with respect to schools and resources throughout Rwanda because there are only a few secondary schools and this unequal distribution causes an imbalance of opportunity. Students in rural areas have lower access to schools, and this is especially significant in a country where only 12% of the total student population is

able to go to secondary school. The Ministry of Education intends to meet 100 percent enrolment for primary education by 2005. However, many teachers do not wish to relocate to the rural areas and teach in rural schools; even in areas around the capital Kigali, there are major problems with accessibility to water, electricity, postal services, transport, resources and facilities.

There was also a very visible difference in the urban and rural students and this was obvious in their way of approach, dress, comprehension and understanding. (FN.F.I.05.00). Students in rural schools were poorer and many were dressed in old and ill-fitting clothes. Most of them were quiet and were not given to asking questions. Even teachers in rural school were different, they did not have the same confidence and approach when answering the questionnaire as their counterparts from the urban areas. Many of the rural schools were also poorly constructed and maintained.

The government succeeded in making a major effort to rehabilitate and build schools during the post-conflict period but proper construction standards have not been applied due to difficult circumstances (World Bank, 2000). Consequently, many schools are already in need of repair; this is particularly evident in rural areas where many schools show signs of poor maintenance coupled with a lack of books and furniture. I have included an account of a report written by my interpreter and me after our visit to a rural Christian primary boarding school.

I know the principal of the school personally. He is a refugee returnee who lived in Uganda before the genocide, spoke English fluently and had returned to help rebuild his country. The school has 85 orphans, both boys and girls. We have administered questionnaires and observed a science lesson. We take a look at the boarding section and I am upset to see the children use dirty water and no soap to clean their lunch plates, there is no room where the children can have their lunch. I cannot go on and Cyprian completes the observation. The students try and find a space to eat lunch in the compound. The pit latrines are dug too close to the school. There is a common room to be used as a bathroom for all the students.

The major problem is related to water and sanitation and I am told there is a general water shortage in the entire area. There was no access to water for the students, teachers and boarders living in the boarding section. This had grave implications for sanitation and hygiene. I was informed that students trekked the two kilometres down the hill and to the lake to fetch water at the end of each day for their needs.

This upset me, because nearly all the students were primary school students. I also felt the trek up and down the hill was not only dangerous but drinking and using water straight from the lake was also unsafe. Having visited schools in rural and urban Rwanda I find that the condition of rural primary schools is in need of urgent improvement. (FN.SV3.05.00)

The rural school learning environments are therefore not very conducive to learning and many children in the rural areas drop out in the upper primary grades. According to a World Bank, 2000 report the quality of education in the rural areas remains poor raising serious doubts about the sustainability. As opportunities to apply language and numeracy skills are few in the rural areas, these skills erode rapidly in the rural areas. Consequently, in view of the pervasive poverty in rural areas, little can be done to support schools. Parents in poor areas are often too poor to pay for school uniforms, books or other support activities. Hence teacher salaries remain low. Nevertheless, one of the key objectives of the government has been to improve the equity, access and enrolment rates in all the prefectures of Rwanda (World Bank, 2000).

Figures 14 and 15 are a reflection of the rural, urban and semi-urban distribution of schools. More than 60% of the schools in the study sample were located in the urban areas. There is unequal access and distribution of schools especially in the rural areas in Rwanda.

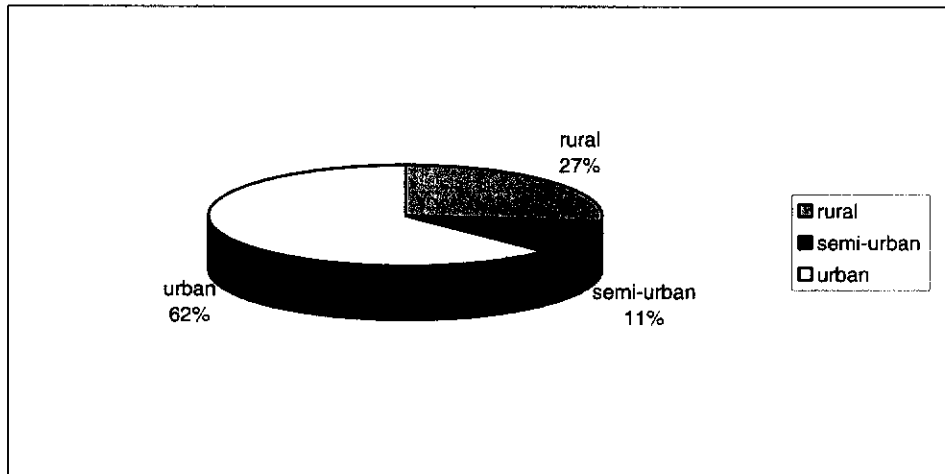


Figure 14: Rural-Urban Distribution of Students (n=500) in the Study Sample

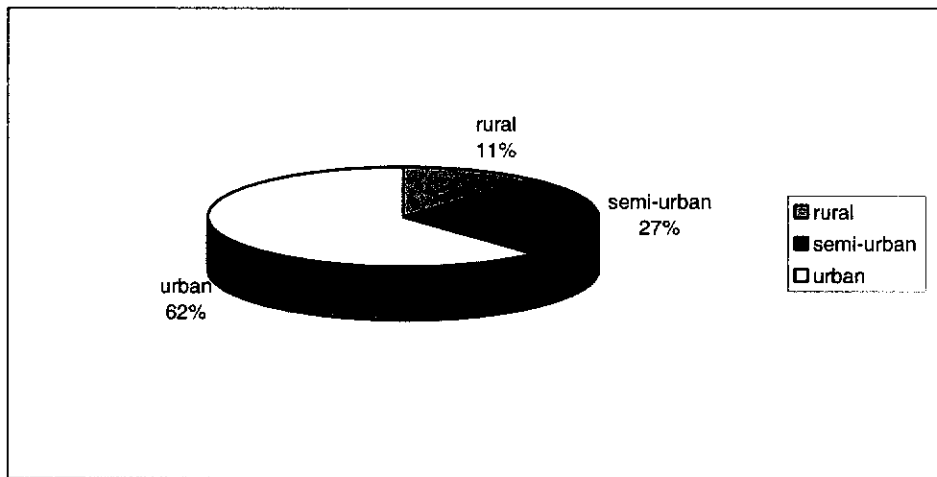


Figure 15: Rural-Urban Distribution of Teachers (n=125) in the Study Sample

An interesting feature that is reflected in Figures 16 and 17 is that the rural urban distribution of French schools is nearly equal which indicates that there are more French schools in the rural areas than English schools. It is important to note that most of the English schools were established after the genocide to meet the language needs of the refugee returnees, who have settled mostly in the urban areas rather than the rural areas (Reindrop, 1998).

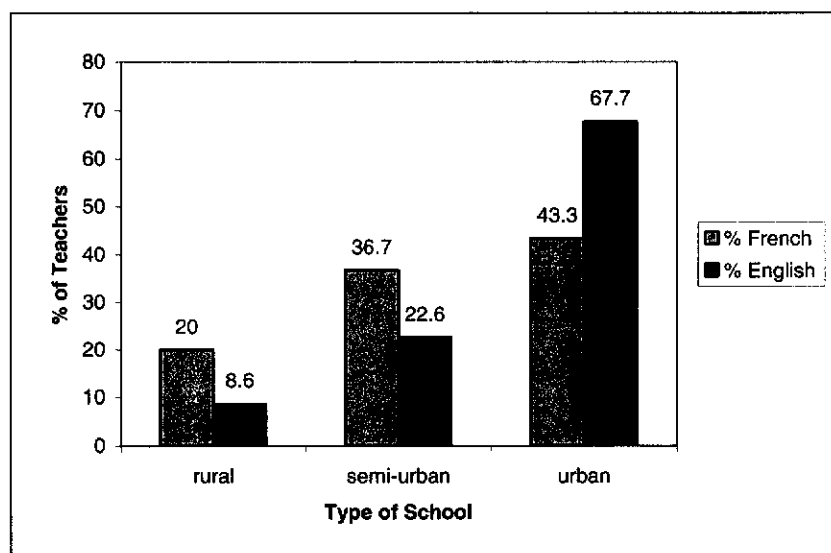


Figure 16: Type of School and Distribution of French teachers (n=30) and English teachers (n=95)

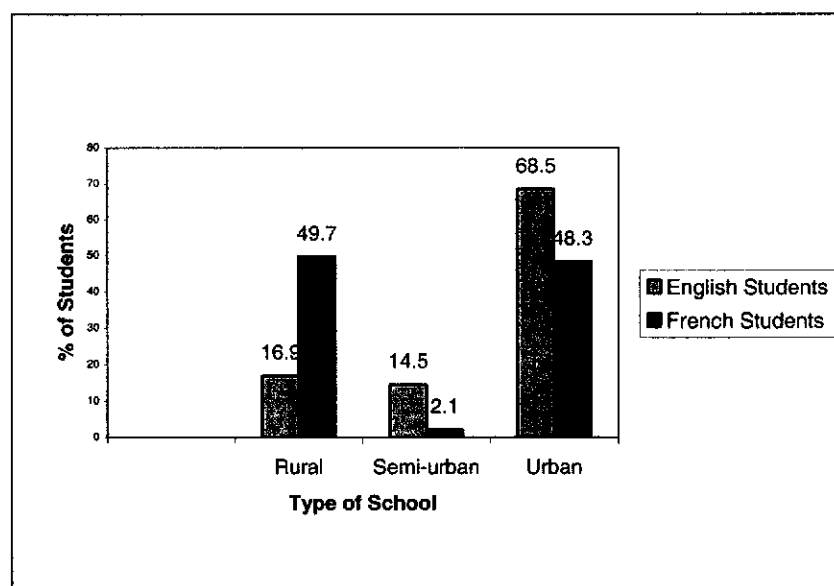


Figure 17: Type of School and Distribution of French students (n=142) and English students (n=332)

8.6 Science Subjects Taught by Rwandan Teachers

The Rwandan educational system follows a 6-3-3 model, a six-year primary cycle beginning at age six and culminating with a national examination in Year 6. For the national examinations at the end of Year 6, science as a subject is not examined.

Students proceed on to secondary school from Year 7 and learn chemistry, physics and biology. At the end of Year 9, students take the O-level examination known as *Tran comme*. After the O-level examination students are streamed into subject areas and choose from the mathematics-physics stream, biology-chemistry, humanities, vocational training and teacher training streams and have national examinations at the end of Year 12.

The percentage of Rwandan teachers in the study sample teaching science subjects shows that 49.6% of the teachers involved in the study taught General Sciences, 44% taught mathematics, only 9.6% taught physics, 27.2% taught biology and 16.8% chemistry (See Table 15). The teachers teaching physics, chemistry and biology taught more than one subject so the percentages total more than 100% and is the collective percentage of the teachers teaching science in the sample.

Table 15: Science Subjects Taught by Rwandan Teachers

Subject Area	% of Rwandan Teachers
General Science	49.6
Mathematics	44
Physics	9.6
Biology	27.2
Chemistry	16.8

My personal experience as a head teacher in Rwanda and observations undertaken during the study indicate that although most primary teachers taught general sciences to the students within the curriculum it was not emphasised as a subject, as science was not examined during the National examinations at the end of Year 6 (FN.SV1, SV2.05.00). This observation was further supported by a comment made by the Director of the National Examination Board during an interview.

At the end of Year 6, only Mathematics and English are examined and these marks are considered for the transition from primary to secondary. Many schools do not find it necessary to teach science at the primary level and many neglect science in Year 6. (E.A.EP.05.00)

In the junior secondary years of Years 7, 8 and 9, subject specialists teach students physics, chemistry, and biology as separate subjects. However, sometimes a biology teacher may teach chemistry and a physics teacher may teach mathematics. The deputy headmaster of a well-known rural government secondary boarding school shared his thoughts about science teaching after the genocide:

Before the war there were a certain number of qualified science teachers who taught science in French, but even then science teaching was theoretical. After the war, we need qualified English and French science teachers. Many teachers are under-qualified and most of them lack motivation, as they have to teach the subjects without textbooks and materials. Many students, particularly the girls are afraid of science and that they will fail at the exams. (F.H.ST2.05.00)

Analysis of data and reports from the Ministry of Education indicate that there is an acute shortage of science teachers in the country especially in the rural areas. Because education in Rwanda is bilingual at the secondary level, there is a further need for science teachers in English and in French. The analysis of the descriptive data has also indicated that most of the teachers in the sample have only a diploma in education and are under-qualified and poorly trained to teach sciences.

8.7 Years Employed in Education

The majority of Rwandan teachers in the sample were not very experienced as shown in Figure 11. 41% of the teachers had only 0 to 5 years of employment and 29% had 6 to 10 years of employment. The percentage of teachers with 11-15 years and 16-20 years of teaching experience was 18% and 12%, respectively. Most of the relatively new teachers (41%) were those who returned to Rwanda after the genocide; of these, some are very young and have trained in neighbouring English-speaking countries, others are older teachers (12%) who have had many years of teaching experience in other countries where they lived as refugees.

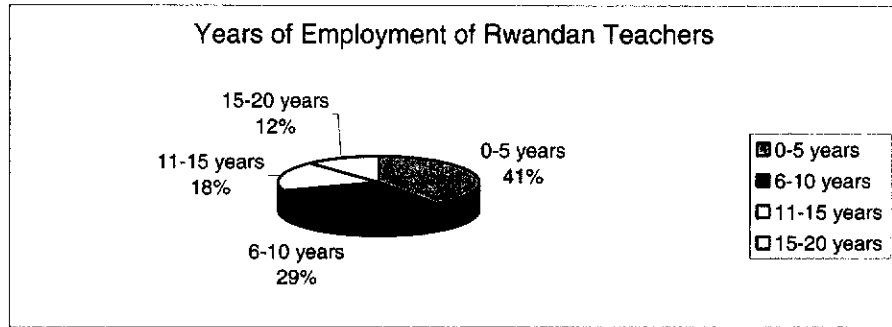


Figure 18: Years of Employment of the Rwandan Teachers in the sample (n=125)

8.8 In-Service Professional Development of Teachers in Rwanda

Of the 125 teachers who answered the survey, 43.9% were primary school teachers and 56.1% were specialist secondary teachers (see Figure 12). Fifty six percent of all teachers have had no in-service professional development in the last 10 years, although 44% stated that they had some kind of professional development. However, most of the professional development was restricted to professional meetings and some workshops or seminars usually carried at the start of the academic year or during the holidays. Rwanda does not have the capacity in terms of human, material and financial resources to conduct professional development as evidenced by 65.9% of the teachers stating that they get no support for professional development with 26.8% saying that schools do allow them to attend seminars, meetings.

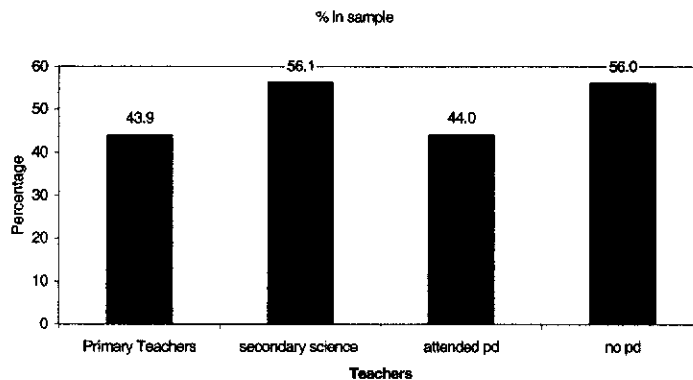


Figure 19: The percentage of primary and secondary teachers in the study sample and the teachers who have professional development [PD] in the study sample.

A new integrated teacher development program commenced in March 1998 so that the upgrading of 3500 unqualified teachers and recycling of 3000 underqualified teachers could take place. The Ministry of education hoped to establish teacher-training centres in each of the 12 prefectures of the country. At each of the teacher training colleges, equipped and furnished documentation centres, a libraries and an observation classroom would be established (World Bank, 2000).

In 1999, the Kigali Institute of Education was established to train teachers, especially Mathematics and Science teachers. The first batch of about 200 science teachers will graduate with degrees in 2003 and will be placed throughout the country to teach in government schools (Ministry of Education, 2000). A female head teacher of a Catholic rural government girls' secondary boarding school expressed her thoughts on the new teachers:

I feel unsure if the newly qualified teachers with degrees from the Kigali Institute of Education would like to be placed in rural government schools but may do so if they were given incentives like housing, food subsidies from the boarding section of the school, chances for promotion and regular salaries. Many of these young teachers will also be more qualified than the head teachers and have better knowledge of pedagogic issues. (F.H.EP4.06.00)

Many of the teachers interviewed in schools were unsure and pessimistic about professional development activities. I have included quotes by two teachers from well-known government schools:

Most teachers' work individually and are not motivated to do more than is necessary. They have become used to the difficulty of their situation. (F.H.T305.00)

Most teachers do not have the means to further their qualifications. Teachers hardly meet to exchange views. There is very little initiate because of the poverty. Teachers are looking for means to add to their earnings and hence have no time to enhance their knowledge (F.H.T6.05.00).

During interview many of the teachers and education personnel expressed a desire to further their education and upgrade their skills, unfortunately most of them did not have the means, the capacity or the resources to do so. The Ministry of Education does not have in place high quality programmes at the postgraduate level and education personnel expressed a need to further their skills in specific areas of education management.

8.9 Summary of the Chapter

The descriptive analysis provided informative data on students and teachers in the study sample in Rwanda. Information on age indicated that some students in high schools were over twenty years of age and the country had an extremely young teacher population. Gender differences indicated that there were many female students in school at the primary level with numbers dropping at the secondary and tertiary level. There are more male teachers in the teaching profession in the country, inspite of a higher female population in the country.

Based on my personal experience of teaching for a decade in East and Central Africa, there are multiple factors that affect the issues of disparity in terms of gender, age, urban-rural dichotomies and a high level of inexperienced teachers. The impact of political strife, civil war, economic situation, endemic malaria and the AIDS pandemic are some of the factors that affect the issues of disparity mentioned in the chapter.

Teacher qualifications and professional development frequencies indicated that teachers were relatively poorly qualified, had limited access to professional development and had no support for professional upgrading of their qualifications. Although the Ministry has made professional development a priority in the country, the acute lack of finances and manpower resources limits the improvements that are possible. A major initiative for the Ministry of Education will be to seriously address the issue of professional development for science teachers in Rwanda. Chapter 9 has provided the results of the quantitative data from questionnaires.

CHAPTER NINE

TEACHER AND STUDENT PERCEPTIONS OF THE SCHOOL ENVIRONMENT AND SCHOOL SCIENCE

Science educators often speak of a classroom's.....climate, environment, atmosphere, tone, ethos, or ambience and consider it to be both important in its own right and influential in terms of student learning (Fraser, 1994, p. 493).

9.0 Introduction

This chapter summarises the analysis from the quantitative data. The chapter details the results of the modified School Level Environment Questionnaire (SLEQ), the modified Science Teachers' Efficacy Beliefs (STEBI) instrument, two modified attitude scales from the Test of Science Related Attitudes (TOSRA) and the modified Development-Related Science Instrument. Finally, the chapter summarises the findings that emerged from the analysis.

In the initial stages of the design and development of this research study, my supervisor and I decided to conduct and carry out the research only in English schools in Rwanda. I was familiar with the English curriculum and also knew a number of English schools in Rwanda. When I arrived in Rwanda for the data collection and met the Minister of Education he requested me to carry out the research in French schools also and specifically named some well-known government French schools that he wanted me to visit.

This resulted in a frantic exchange of emails between Kigali, Rwanda and my supervisor at the Science and Mathematics Education Centre in Perth, Western Australia. I asked advice on the translation of the questionnaire and after following necessary protocol, I had the questionnaire translated by a bilingual teacher and then back translated by my

interpreter. I was unable to pilot test the questionnaire due to a limited time frame. In this chapter I have presented the results of the total sample of students and teachers.

Although individual analysis was carried out for the English and French teacher and student samples, only the individual results of the developmental aspects of science have been included in this chapter. For the teacher sample there were 95 English teachers and only 30 French teachers and the student sample consisted of 337 English students and 142 French students. This study was not a predominantly quantitative study and obtaining the validity of the questionnaires was not a mandate of the study. The individual results of the French and English sample for the Science Teachers Efficacy Beliefs Instrument (STEBI) and Test of Science Related Attitudes (TOSRA) have been included in Appendix Y and Z.

The results from the first part of the chapter respond to three Research Questions

- 6) What are teachers' perceptions of the school-learning environment?
- 7) What are teachers' beliefs about science teaching?
- 8) What are students' attitudes towards learning science?

9.1 Analysis of the Modified School-Level Environment Questionnaire

The first part of the chapter seeks to answer the research question: What are teachers' perceptions of the school-learning environment? A modified version of the School-Level Environment Questionnaire (SLEQ) was administered to 125 teachers in Rwanda. Principal components factor analysis followed by varimax rotation resulted in the acceptance of a revised version of the instrument.

The a priori factor structure of the final version that showed nearly all items having a factor loading of at least .30 on their a priori scale and no other scale (See Table 16). The results also showed that the modified version of the School Level Environment Questionnaire was successfully used in Rwanda.

Table 16 Factor Loadings for the School Level Environment Questionnaire (n=125)

Item No	Factor Loadings			
	Affiliation	Staff Freedom	Resource Adequacy	Work Pressure
1	.39			
2	.55			
3	.62			
4	.57			
5	.52			
6		.42		
7		.31		
8		.67		
9		.38		
10		.39		
11			.39	
12			.36	
13			.32	
14			.72	
15			.50	
16			.67	
17				.51
18				.64
19				.50
20				.43
Eigenvalue	2.38	1.51	3.11	1.77
%variance	12.54	7.94	16.38	9.31

To establish that each scale has satisfactory internal consistency, or that each item in a scale assessed a common construct, Cronbach's alpha coefficient was calculated. The internal consistency of each of the four scales ranged from 0.53 to 0.66 with mean correlations ranging from .10 to .21 for the four scales Affiliation, Staff Freedom, Resource Adequacy and Work Pressure (See Table 17). There was some overlap between the mean correlations but generally each scale measured a unique aspect of the school environment.

Table 17 Internal Consistency Reliability (Cronbach Alpha Coefficient), and Discriminant Validity (Mean Correlation With Other Scales) for the School Level Environment Questionnaire (n=125)

SLEQ scale	No. of Items	Alpha Reliability (internal consistency)	Mean Correlation (discriminant validity)
Affiliation	5	.66	.21
Staff Freedom	5	.53	.10
Resource Adequacy	6	.65	.16
Work Pressure	4	.61	.10

The average item mean and the standard deviation for each scale is shown in Table 18 and graphically displayed in Figure 13. Responses indicated that teachers perceived a limited amount of work pressure (a mean score between seldom and sometimes), the teachers felt that they had a limited amount of resources (a mean score of sometimes), there was high affiliation between staff members (a mean score between sometimes and often) and a great deal of staff freedom (a mean score of often).

In the following paragraphs, I have tried to explain each of the four scales in relation to the average item mean and the unique Rwandan school context. Thus the perceptions and responses to the four school environment scales are driven by the culture of the teachers in Rwanda.

Table 18 Mean and Standard Deviation with Respect to the Scales for Teacher Sample (n=125)

Scale	Mean	Standard Deviation
Affiliation	4.04	0.60
Staff Freedom	3.66	0.73
Resource Adequacy	2.99	0.88
Work Pressure	2.78	0.88

N.B.- The average item mean is the mean of each scale divided by the number of items

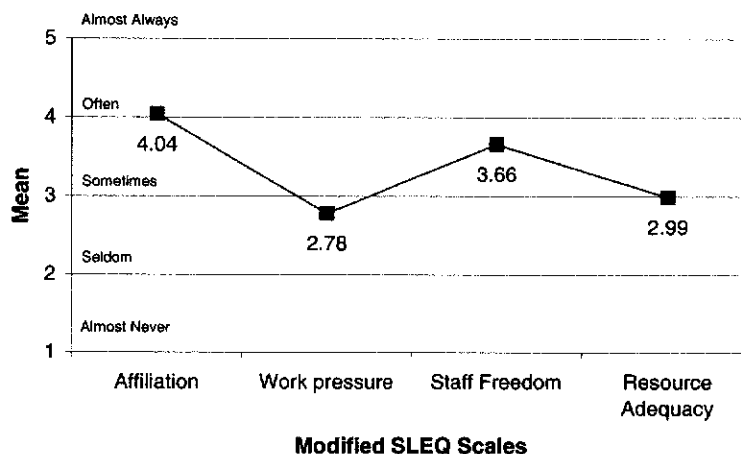


Figure 20: Average Item Mean for the Modified SLEQ.

The Affiliation scale had a mean score of 4.04, which indicated that the teachers in the study sample were often encouraged and felt accepted by colleagues. This finding showed that the teachers in Rwanda were indeed cohesive, at least in terms of helping each other and were often able to work as a group. As most of the teachers in Rwanda have experienced sorrow, death and trauma, they displayed a unique mechanism of support. All teachers shared in the joy of birth when a child was born to a staff member and sorrow in death of a family member of a teacher. In spite of their low salaries, they willingly contributed to any fund to help a colleague in need. My own experience in Rwanda showed that teachers and workers often liked to talk and advise each other on professional and personal issues. Thus the affiliation dimension of the school environment in Rwanda showed that teachers in the sample felt they could rely on their colleagues for assistance if the need arose.

The Work Pressure scale of the school environment had a mean score of 2.78, which indicated that teachers did not feel a great deal of work pressure. This dimension can be explained in the Rwandan context. Most Rwandans are extremely hard working and work both at home and at school. At home and in their small farm plots they are used to physical labour. Compared to teachers in western societies, the teachers in the study sample did not spend time making or arranging classroom displays, as most schools did

not have the resources to make displays. They were not overloaded with work and did not have to spend time making or arranging classroom displays.

The level of work pressure also varied from school to school. Private schools that paid higher salaries often had higher expectations of their teachers, including working longer hours and performing some extra duties. I had also observed that in most government high school teachers worked only a four-day week, teachers were expected to use the free day to research or gather information for their subject. Planning expectations were not high and teachers were allowed the freedom in the classroom as long as content was completed and the students were well behaved and disciplined in the classroom.

The Staff Freedom scale with a mean of 3.66 indicated that teachers in the study sample experienced considerable staff freedom. Teachers are allowed enough freedom to carry out their tasks independently as long as their classes are disciplined, the course content is completed, examinations are held and examinations marks are submitted on time. The teachers were provided the freedom to design their own scheme of work. Although teachers often experienced pressure at examination time when examination papers had to be set and marked. When students copied notes from the board, teachers did not feel the need to check their work for accuracy. The teachers in most schools very rarely had staff meetings and often class work did not provide opportunities for individual student needs. Thus teachers in Rwanda carried out their work, did not have a great deal of supervision and hence felt they had considerable freedom to do their work.

The scale mean score of 2.99 for Resource Adequacy seemed unusual because most schools in the study had only the basic amount of resources. Most of the schools in Rwanda have very poor infrastructure and do not have teaching and material resources. However, teachers in Rwanda had never experienced working with a high amount of resources were used to working in difficult circumstances and with few resources. The result of this dimension revealed that if teachers had chalk, a chalkboard, a few supplies, pens, pencils, and a few textbooks, they felt this was enough for them to carry out their tasks.

9.2 Analysis of the Modified Science Teaching Efficacy Belief

Instrument

This part of the chapter seeks to answer the research question: What are teachers' beliefs towards science teaching? The original version of the STEBI instrument has been well established by Enoch and Riggs (1990) and has been adapted for use in Israel and Denmark. My intent was to develop a modified version of the Science Teaching Efficacy Belief Instrument (STEBI) that would be useful in the Rwandan context. After the instrument was administered to teachers in Rwanda, principal components factor analysis followed by varimax rotation resulted in the acceptance of a revised version of the instrument.

There are two separate constructs evaluated by the original STEBI instrument, both of which are used in the modified instrument, which assess a science teacher's estimates of personal effectiveness in teaching science. The two scales, Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE), are interwoven in the STEBI instrument. The a priori organisation of the instrument has a factor structure with nearly all items having a loading of at least .30 on their a priori scale and not on the other scale (See Table 19).

Table 19: Factor Loadings for the Science Teacher Efficacy Belief Instrument

Item No	Factor Loadings	
	Self-Efficacy	Outcome Expectancy
1	.63	
2	.58	
3	.30	
4	.50	
5	.38	
6	.44	
7		.41
8		.34
9		.80
10		.57
11		.50
%variance	14.05	13.86

Research has shown that teaching behaviours such as persistence at tasks, risk-taking and the use of innovations are all related to levels of self-efficacy. In science teaching, teachers with high self-efficacies are more likely to use inquiry and student-centred and interactive teaching methods while those with low self-efficacies are more likely to be teacher-directed and didactic. Recent research has found that a teacher's self-efficacy beliefs strongly influence the nature of a teacher's role, planning and student learning (Tobin et al., 1994).

To establish that each scale has satisfactory internal consistency, or that each item in a scale assesses a common construct, Cronbach's alpha coefficient was calculated for the two teacher beliefs scales. The internal consistency was 0.62 for the self-efficacy scale and 0.61 for the outcome expectancy scale with mean co-relation measuring .10 for both scales (See Table 20).

Table 20 Internal Consistency Reliability (Cronbach Alpha Coefficient), and Discriminant Validity (Mean Correlation With Other Scales) for the Teacher Beliefs instrument (n=125)

Teacher Beliefs scale	No. of Items	Alpha Reliability (internal consistency)	Mean Correlation (discriminant validity)
Self-Efficacy	6	.62	.10
Outcome Expectancy	5	.61	.10

The average item mean and the standard deviation for the two scales of the modified Science Teachers Efficacy Beliefs instrument are shown in Table 21 and graphically represented in Figure 14.

Table 21 Mean and Standard Deviation with respect to the scales for the Teacher Beliefs instrument (n=125)

Scale	Mean	Standard Deviation
Self-Efficacy	3.74	0.66
Outcome Expectancy	2.28	0.64

Responses indicated that teachers in the study sample had high Self-Efficacy but the average item mean for the Outcome Expectancy scale was quite low. In the following paragraphs, I have tried to explain the two scales of the modified STEBI instrument in relation to the average item mean and the unique Rwandan school context.

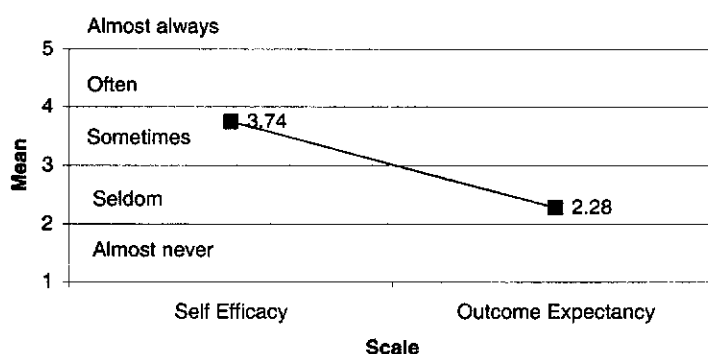


Figure 21: Average Item Mean for the Modified STEBI

The Personal Science Teaching Efficacy (PSTE) scale in the STEBI instrument had an average item mean of 3.74. This mean score indicated that teachers in the study sample sometimes and often used student-centred and interactive strategies, especially when it was possible and conducive for them to do. In some of the science lessons that I had observed, teachers had tried to use group work and some interactive strategies. Because a teacher’s self-efficacy beliefs strongly influence the nature of her/his planning, it appears that the teachers in the study sample had a belief in their ability to use different strategies in their science teaching. Science teachers in the study sample had an above average mean score on the personal science teaching efficacy belief scale.

The Science Teaching Outcome Expectancy (STOE) scale had an item mean average of 2.28. This mean score indicated that the teachers were not confident and that their teaching seldom produced the desired outcomes. The low mean for this scale can most likely be attributed to the system of assessment and evaluation of students. Student learning is measured in Rwanda only through examinations and tests although the curriculum documents of the Ministry of Education state that teachers should use a combination of diagnostic, summative and formative evaluation at primary level. National examination papers are not developed or marked by teachers. The average item mean indicated that teachers in the study sample with high self-efficacy might intensify efforts to use interactive strategies when they can. However, if this effort is coupled with low outcome expectancy then teachers will intensify these efforts only for a short period and will eventually become frustrated with the system that does not reward this kind of teaching.

9.3 The Developmental Aspects of Science included in the New Curriculum

As mentioned in Chapter 5 the developmental aspects of science have been included in the new science curriculum implemented in most schools in September 1998. Included in this section are the individual analyses of the data for French and English teachers and students, that established the extent to which English and French science teachers and students perceived that the development-related functions of science education had been incorporated into the new curriculum.

Most teachers perceived that the new curriculum prepared students for further study in the areas identified in Table 7 in Chapter 5 and as indicated in Figure 22. Landmine awareness had low perception of 30% by French teachers and 58.9% by English teachers, it is an area that could be further addressed and improved in the science curriculum. It was also interesting to note that more than 75% of French and English teachers felt that HIV/AIDS has been adequately addressed in the curriculum.

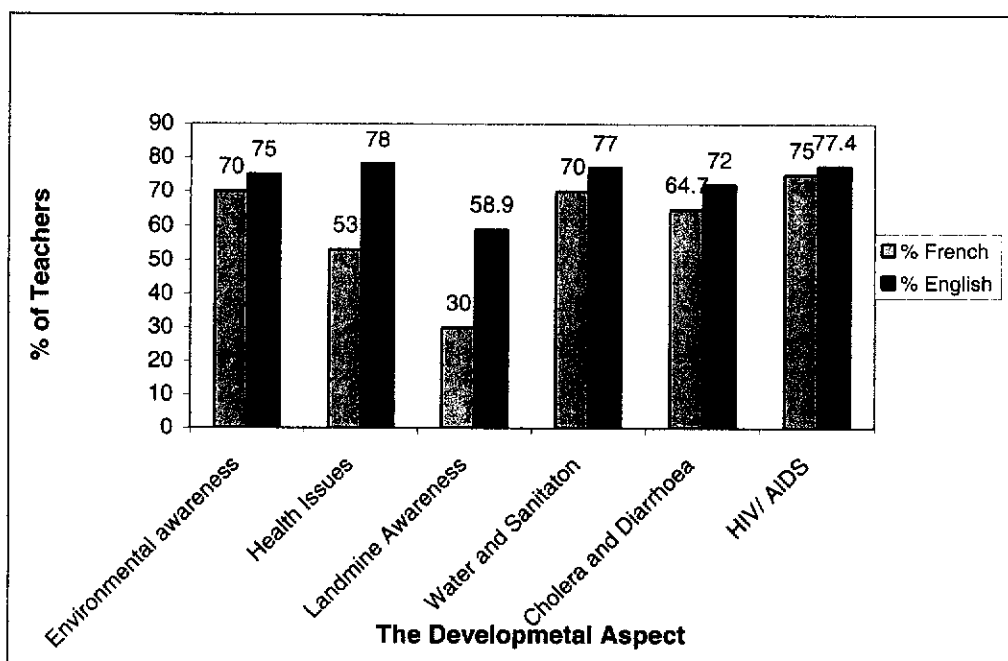


Figure 22 The Developmental Aspects of Science included in the New Curriculum as perceived by French teachers (n=30) and English teachers (n=95)

Students similarly perceived that they were taught the development related topics as indicated in Figure 23, but the perceptions of the French students in the developmental issues ranged between 46.2 % and 68.3 %. The perceptions of the incorporation in the areas of landmine awareness (50 %), water and sanitation (51 %) and cholera and diarrhoea (46.2 %), indicated that about 50 % of the students felt that these issues were not taught in the classroom. This could be attributed to the lack of professional development especially of French teachers and a lack of resources and textbooks for teaching the content of these issues of the developmental aspects.

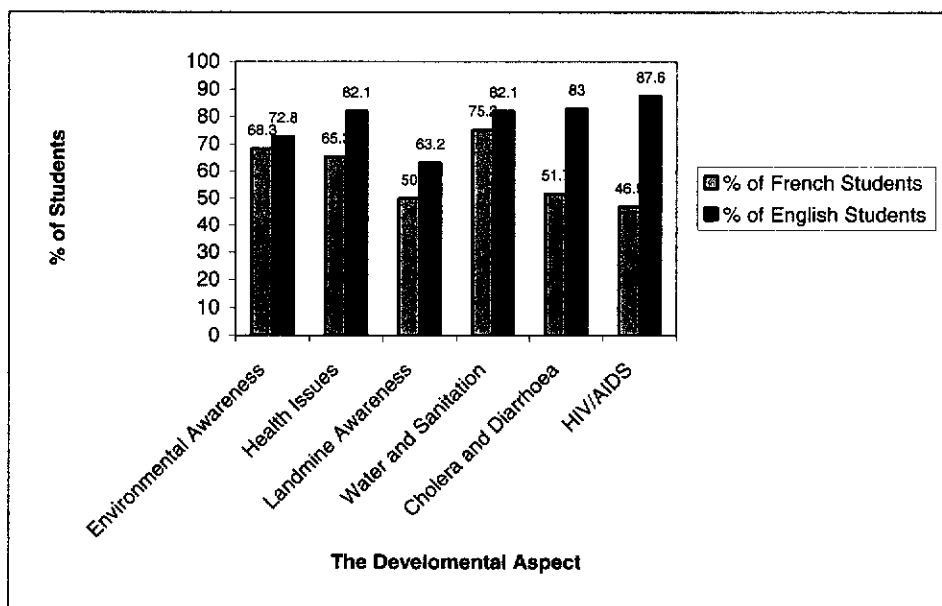


Figure 23 *The Developmental Aspects of Science included in the New Curriculum as perceived by French and English Students*

9.4 Analysis of Two Science-Related Attitudes scales among School Students

This part of the chapter seeks to answer the research question: What are students' attitudes towards science? Two scales of the Test of Science-Related Attitudes (TOSRA) were administered in Rwanda to students from classes Year 6 to Year 12 in twelve different schools. The two attitudes measured were Enjoyment of Science Lessons and Attitude to Scientific Enquiry.

Statistical analysis was performed on the data in order to calculate the mean, standard deviation, reliability, and scale inter-correlation. Principal components factor analysis followed by varimax rotation resulted in the acceptance of the revised and modified version of the instrument. The factor structure of the final version showed nearly all items having a factor loading of at least .30 on their a priori scale and no other scale (see Table 22).

Table 22 Factor Loadings for the Test of Science-Related Attitudes

Item No	Factor Loadings	
	Enjoyment of Science Lessons	Attitude to Scientific Enquiry
1	.51	
2	.57	
3	.64	
4	.53	
5	.53	
6		.42
7		.50
8		.36
9		.63
10		.53
%variance	16.85	13.79

To establish that each scale has satisfactory internal consistency, or that each item in a scale assesses a common construct, Cronbach's alpha coefficient was calculated for the two Student Science-Related Attitude Scales. The internal consistency of each of the scales was 0.71 for the Enjoyment to Science Lessons Scale and 0.63 for the Attitude to Scientific Enquiry scale with mean co-relation measuring 0.10 for both scales (see Table 23).

Table 23: Internal Consistency Reliability (Cronbach Alpha Coefficient), and Discriminant Validity (Mean Correlation With Other Scales)

SLEQ scale	No. of Items	Alpha Reliability (internal consistency)	Mean Correlation (discriminant validity)
Enjoyment of Science Lessons	5	.71	0.10
Attitude to Scientific Enquiry	5	.63	0.10

The average item mean and the standard deviation for each scale are shown in Table 24. These responses indicate that Rwandan students enjoyed science lessons and had a positive attitude towards scientific enquiry inspite of the limitations in the system.

Table 24 Mean and Standard Deviation with respect to the Scales for Science-Related Attitudes.

Scale	Mean	Standard Deviation
Enjoyment of Science Lessons	4.05	0.74
Attitude to Scientific Enquiry	3.38	0.86

N.B.- the average item mean is the mean of each scale divided by the number of items

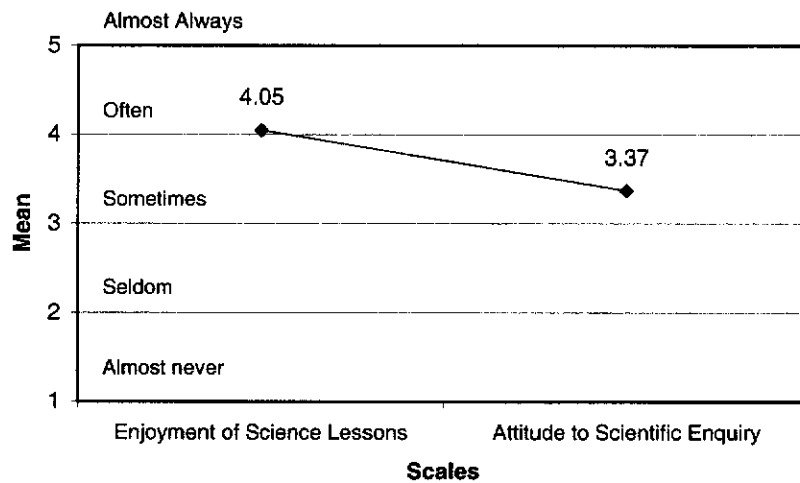


Figure 24 Average Item Mean for two scales of the modified TOSRA

The Enjoyment of Science lesson scale had a high mean of 4.05 that indicated that students in the study sample enjoyed science lessons. These perceptions are also influenced by culture because students are supposed to respect the teacher and respect the knowledge they learn and gain. Students were capable of learning and achieving in Rwanda even without textbooks and teaching resources.

The average item mean of the attitude to scientific enquiry was 3.37 which indicated that the students in the study sometimes or often enjoyed practical science lessons. Interestingly, these students enjoyed investigations although there was a severe lack of running water, electricity and gas in most schools in Rwanda. Students displayed a sense of curiosity and were able to follow the instructions of the teacher in the practical lessons that I had observed. To illustrate this point, two practical lessons have been described in Chapter 5 on curriculum implementation.

9.5 Summary of the Chapter

This chapter has provided an analysis of the quantitative data from the questionnaire administered to 125 teachers and 500 students in Rwanda. The results have indicated that the modified School Level Environment Questionnaire (SLEQ), the modified Science Teachers Efficacy Beliefs Instrument (STEBI) and the two modified scales from the Test of Science Related Attitudes (TOSRA) have the potential for further use and application in Rwanda.

The next chapter used vignettes to examine the influence and effect of socio-cultural and political factors on the lives of teachers and students in Rwanda. The vignettes were designed to enable the reader to experience the social, cultural, environmental and political influences on life in this transitional society.

CHAPTER TEN

THE IMPACT OF SOCIO-CULTURAL FACTORS ON THE LIVES OF STUDENTS AND TEACHERS IN RWANDA

Humans are storytelling organisms who, individually and socially, lead storied lives. The study of narrative therefore is the study of the ways that humans experience the world. This general notion translates into the view that education is the construction and reconstruction of personal and social stories; teachers and learners are storytellers and characters in their own and other's stories. (Connelly & Cladinin, 1990, p.2)

10.0 Introduction

As the present study progressed, I became aware of the importance of examining social and cultural factors that have an influence on the science education reform process in Rwanda. I was an integral part of the science education reform process in Rwanda for two years and have examined my personal journey over the course of the study in this chapter. I have used vignettes to speak on a variety of agendas that include the social, cultural and practical aspects of life in Rwanda. After many of my observations, I wrote stories of real life situations that affected me personally both as a researcher and a human being. The stories attempt to bring out the human dimension in the transitional Rwandan society and the difficulties that people encounter living in transitional societies.

Storytelling as cultural representation and as a sociological text emerges from many traditions and is becoming more disciplined through narrative enquiry (Denzin, 2000). Stories can provide a means by which we represent a way of knowing and thinking (Carter, 1993; Casey, 1995) and are useful in providing us with special access in

understanding the learning and teaching processes. According to Polkinghorne (1995), people understand and explain their lives through stories which features plot, characters, times and places. Stories in this chapter are used to represent a way of knowing and thinking (Casey, 1995) and make use of my personal images, understanding and interpretations.

The vignettes took into account social action that was “locally distinct and situationally contingent” (Erickson, 1998, p. 1155) and helped develop a clearer picture of the interplay of social, cultural and practical factors. In this study, vignettes were used to corroborate the findings from quantitative data, interviews, and classroom observations. The vignettes also helped me understand the relations between the physical, structural, cultural constraints discussed in Chapter 7 and possibilities for the future development of science education in Rwanda (Giroux, 1988, 1991; Goodson, 1992, 1997).

The six vignettes involve students, teachers and citizens in Rwanda and were analysed using two perspectives—the socio-cultural and practical perspective for interpretation and analysis. The socio-cultural perspective is concerned with the relationships between human beings, namely, the teachers, parents and students, my interactions with my interpreter and my impressions of Rwandan children. From a socio-cultural perspective, I have taken into account the family background and the circumstances of the teachers and students in Rwanda. The practical perspective refers to the challenges that teachers face with changing their own knowledge and skills. Teachers require opportunities to experience observation, training, feedback and practice so that they can develop new skills and use these skills as an integral part of their classroom routines to implement the new curriculum.

The six vignettes are designed to enable the reader to experience the socio-cultural aspects of life in this transitional society. The vignettes in this chapter respond to Research Question 9:

What is the influence and effect of socio-cultural and political factors on the lives of teachers and students in a transitional society like Rwanda?

10.1 Vignette 1 About a Teacher and a Parent

I arrived in Rwanda in October 1997 and took up position as headmistress of a new private school. One of my responsibilities was to hire teachers, one of whom was a young Rwandan woman, I will call her Beatrice, who was one of the few teachers in the school with a degree in Education. She and her husband were well-qualified professionals. They had lived in Uganda as refugees before returning to Rwanda after the genocide. I appointed Beatrice as a primary teacher because she was aware of interactive strategies and child-centred teaching methodologies, having worked in a well-known private school in Kampala.

Beatrice was popular among her fellow teachers and was liked by the students. In early 1998, Beatrice began to experience frequent bouts of illnesses that included coughing, headaches, vomiting and diarrhoea and she lost a considerable amount of weight. Beatrice continued to be ill frequently and eventually suspected that something was seriously wrong with her health.

Friends and colleagues advised her to have an HIV test but she did not go immediately for fear of finding out that she was seropositive. One day in mid-1999, Beatrice had a severe bout of coughing and was rushed to the hospital where she was diagnosed with tuberculosis; she also was tested for HIV and her results were positive. It takes courage and determination to face life when one has been diagnosed with an illness for which there is no known cure and which is likely to be fatal. Nevertheless, Beatrice remained positive and continued coming to school. In the beginning, when she was not consistently bedridden and her physical strength varied, she came to school and taught. Eventually, Beatrice was too sick to come to school and had to be cared for at home. She passed away leaving two young children to be cared for by her husband.

I had experienced having teachers and students with AIDS in school whilst teaching in Uganda and Rwanda. Every experience was different and sad. In school, we had to develop a policy to attend to children after an accident in the school compound, so that teachers or the school nurse would not directly touch

an open wound. Teachers learned how to support a colleague when he or she was diagnosed as having AIDS.

Included in this vignette is another incident about Asterie. Asterie was a dynamic mother of four children and the manager of a company. A supportive parent, she also became a friend in the years I was in Rwanda. Having a child in the school, she was a regular visitor to the school and represented a young successful woman: a mother and a professional. Whilst on a meeting overseas she was struck by malaria. In a few days, her brain was affected and Asterie died of Cerebral Malaria. I was deeply shocked and saddened by Asterie's death. Two successful and professional women are represented in this vignette. Beatrice and Asterie had access to medical help, but were affected by illnesses that proved to be fatal. What happens to the millions of Rwandans who are too poor and cannot afford medical help?

10.1.1 Interpretive Commentary

Malaria and HIV/AIDS are the major killer diseases in Rwanda. An estimated 11 percent of Rwandans (9 percent of men and almost 14 percent of women) are infected with HIV (UNAIDS, 2002a, 2002b). It is especially striking that the seroprevalence rate is almost the same in rural as urban areas (11 percent) in Rwanda. One of the major problems in Rwandan community is that there is a high level of stigma around HIV/AIDS and a low level of support for those infected with the virus. Unfortunately, medical services are inadequate and many people cannot afford to pay for them. As a result, emphasis is on home-based care and creating associations for people living with HIV/AIDS with the objective of improving their conditions through the provision of material resources, moral support, education and income-generating activities (Kornfield, et al. 2002).

On a daily basis teachers have to face and work with the reality that some of the children in the class and colleagues in the school may be HIV positive. During the wet season there is high absenteeism due to malaria. Head teachers have to be prepared for teachers coming down with malaria at any time. Because of these issues learning about

HIV/AIDS, malaria, cholera and diarrhoea is now part of the Rwandan secondary school science curriculum.

Teachers also are trained to be community counsellors, and school students have performed dramas to increase community awareness about HIV/AIDS. People of all ages have attended seminars in their neighbourhoods. Students and adults are aware that HIV/AIDS can be transmitted through unprotected sexual intercourse, though fewer understand that HIV can also be transmitted from an infected mother to an unborn child, through contact with or transfusion with infected blood or through use of infected needles. (See Appendix U5 for a photo and photo essay of an AIDS billboard)

The high incidence of HIV among the rural and urban population of Rwanda affects the socio-cultural fabric of life in this transitional society, including teachers and students as nearly every family has a relative affected by the disease that reduces life expectancy. From a practical perspective, schools learn to cope with having staff and students who are seropositive. Teachers learn to be supportive and sensitive of children who have lost family to the disease. Head teachers learn how to cope when teachers were absent due to illness and if they suddenly die.

10.2 Vignette 2 The Journey to Visit Schools

Making the journey to each of these schools during the phase of data collection was an interesting experience. It was Anton the car driver's first visit to many of the places too and there were several occasions when I felt that we were lost and I had absolutely no sense of direction as to where we were going. Only the main road arteries are bitumen in Rwanda, the rest mud roads which created a dilemma as access roads to the schools were often poorly constructed and were filled with potholes and the markings on the roads were non-existent.

Sometimes we would drive around the same route stopping and asking for directions. At times, the school was not known to the villagers we passed. They were more curious about the car and its occupants. Anton told me that many of

the villagers never see vehicles, because they only walk to different places. On many occasions, I would hope that nothing would happen to our little car and that we would not be stranded in the Rwandan wilderness. Even so, a few times we were lost and had to ask and go around in circles before we reached the school.

I had spent an entire day at a rural school in Byumba, an hour away from the capital Kigali, and it was late afternoon when I was returning home to Kigali. My interpreter Celestin was not with me and I was alone with Anton, my driver. Rwanda is known as the Switzerland of Africa and on the drive back, the journey through the mountains was spectacular. This tiny land-locked country of intensely cultivated, terraced banana fields, tea plantations, volcanoes and rainforests is beautiful, rustic and rural. A photograph of the beauty of the landscape is included in Appendix A. It was soon dusk and darkness descends swiftly on the mountain roads and valleys. There were no lights on the mountain roads and I was suddenly scared although it was not very late. I had been told of the mists on the mountains but had never encountered any mist as I avoided travelling at night when I lived in Rwanda.

All of a sudden I found Anton reducing speed and swirls of mist all around us. Visibility was reduced to a few metres and I regretted my decision to stay at the school for so long. Although we were just 20 minutes away from the outskirts of Kigali where there are lights, the drive was slow and demanded all the skill of the driver. I arrived in Kigali and heaved a sigh of relief. I felt that had anything happened to our car on the mountain road there would have been nothing I could have done. This was a frightening thought.

10.2.2 Interpretive Commentary

After this incident my admiration for the tenacity of the Rwandans increased. Most Rwandans do not have a car and have no access to public transport. In rural areas there was access to public transport only near the main markets. Rwandans were used to walking long distances. It was a common sight to see a mother with a baby on her back and balancing a load on her head walking along the dusty Rwandan roads.

As mentioned in earlier chapters, teachers and students walk long distances to reach school. In many of the government schools in Kigali and the rural areas most of the students do not have shoes to wear on their feet and walk barefoot. My experiences on my many journeys through the 12 schools in Rwanda during data collection period have given me a unique glimpse of rural life, of life of the urban poor, of students in boarding school and the practical realities of travel in Rwanda.

10.3 Vignette 3 A Visit to a Rural School

Its 6.45 am in the morning and I am getting ready to leave to visit a school in rural Rwanda. I am slightly apprehensive. The school is an hour and a half away and both my interpreter Celestin and driver Anton have never been to the area. The school is supposed to be one of the best government high schools in Rwanda. My driver arrives on time to pick me up and I am pleased he has kept time. The drive takes us through the Rwandan countryside-hills upon hills of spectacular forests pass by.

As we drive on we come upon clusters of identical basic houses that do not resemble a village but have been built with a purpose. All have iron sheets as roofs and many have no windows. I ask Celestin about the houses and he says, that this is the '*villagization*' scheme also known as '*imudugudu*' of the government for the purpose of reconciliation and security. The refugee returnees have been assigned these houses for the purpose of security. I am dumbstruck. Can people be forced to live where they don't want to and be happy? The returnees have often been forced to live in these houses. There is no access to water, electricity, sanitation, health and education facilities. I feel terrible and try hard not to think about the situation that I am seeing.

We drive on and surprisingly the road is good. In the distance I see a sea of green tents. The military presence is visible. We will be passing a refugee camp says my driver. This is my first glimpse of a refugee camp at such close quarters. Celestin says the refugees are better off than the returnees as they have access

to water, food, health facilities and education. I am amazed by the irony of the situation.

We arrive at the school and Celestin and I are ready to tackle the day. The school is indeed good structurally and has not been destroyed by the war. I have included a picture of a school in Appendix U1. It has a capacity for 400 students but is currently accommodating 1000 teenagers, both girls and boys. The school has an inclusive program for blind students and I am impressed. Celestin and I administer the student questionnaire and then observe a practical biology lesson. I realize that there is no running water or electricity, nor a laboratory assistant. The teacher has to do everything from preparing the samples, getting out the apparatus and organising the paraffin for the kerosene stove. The practical biology lesson has been described in detail in Chapter 5.

I then interview a British Volunteer teacher who is the director of science in the school. He has a degree in biology and is the only teacher in the school with a university degree. He speaks positively about his experience inspite of the difficulties. He talks of the overcrowding of classes, the lack of facilities, inadequate teaching material, a school environment that may not always be conducive to learning and the constant drive to achieve at national examinations and teachers who are trying their best despite the difficulties. He mentions that teachers have no professional development programme in the school and their pay from the Ministry of Education is also erratic.

I feel for the 1000 students living in this co-educational residential school. There are no water or sanitation facilities at the school. However, I realize that the students are happy and learning in spite of the circumstances. I see the smiling faces of children who are surprised and intrigued by me. I see hope and determination in the faces of the teachers, the students, and head teacher inspite of an undetermined future. The teachers and the school headmaster realise the complexity of the problem in terms of the language, the curriculum, and are not sure of long-term sustainable goals. Questions work through my mind. Will things change? Is the situation going to improve? I have no answers.

10.3.1 Interpretive Commentary

From a political and socio-cultural perspective, the Ministry of Education in Rwanda is trying to ensure universal primary education for the children of Rwanda by 2005. Yet there are severe regional disparities with respect to access to schooling, especially in the rural areas. Specifically, there are insufficient teachers in rural areas, many of the teachers are poorly qualified, conditions for teaching and learning are not conducive and there is also a severe lack of educational and material resources.

The vignette described above provides a glimpse of a rural school. In previous chapters, of the thesis I have provided several descriptions of my visits to schools. In all schools in Rwanda, teachers and head teachers face the practical realities of implementing the new curriculum that contains learner-centred and interactive strategies but which has to be implemented without adequate support, resources and finances. Will the Ministry achieve the goals of the new science curriculum from its current state of dependency to self-sustainability? Will the Ministry achieve the aim of universal primary education by 2005 and increase access to secondary, non-formal and vocational education?

10.4 Vignette 4 Rwanda's *Mayibobos*: The Genocide Orphans

One of the saddest and most distressing sights for me during my stay in Rwanda was the sight of the increasing number of street children. When I lived in Rwanda from 1997 to 1999, whenever I went to the markets and shops it was a familiar sight to see the street children converge on my car at a traffic lights and ask for money, to see them follow me into the market asking to carry my bag, to see them at night trying to find shelter in an alley or a shop front or under a tree.

The number of children living or working on Rwanda's streets has increased dramatically since the massacres in 1994. With families fractured and living conditions deteriorating, thousands of children are left with few options other than joining the growing throngs of street children. According to a recent UNICEF (2000) report, around 6,000 children in Rwanda live and work on the streets, most of them in the capital of Kigali. Another UNICEF report said that more than 85 percent of those children have ended up on the streets since the genocide.

Although there are a variety of reasons that force children to the streets, most are rooted in the after-effects of the genocide.

Apart from the street children are the unaccompanied minors who have been separated from their parents after the genocide. These children are placed in centres through out the country. I had visited several centres and orphanages in and outside Kigali during my stay in Rwanda. The country director of an International non-governmental organisation commented about the thousands of unaccompanied minors who live in orphanages and centres.

There are roughly 4500 unaccompanied minor children still in centres throughout. The government is trying to integrate those children into the community. But again, it's a community that's living in extreme poverty. They have been able to absorb hundreds of thousands of children, but there's still this leftover group of 4500 and they are now working with the community to foster those children. (FN.PC.06.00)

The street children in Kigali are called '*mayibobos*' and are looked upon by the local population with contempt and distrust. Most of them come from the rural areas and have family but choose to live on the street. Some of the prefectures and communes in Rwanda are extremely poor, so children have left home, as a means to survive. Many of the '*mayibobos*' have lost one or both parents to the genocide, AIDS or illness and leave home due to abuse and poverty. Most distressing for me as a mother and a teacher was the increasing number of young girls on the streets. Many of the street children have been physically abused and neglected. They felt that they were a burden for their already impoverished parents. They complain of neglect and not being able to go to school.

One of the sights that filled me with sadness but my seven-year-old son with fascination was to always see the street children foraging through the overflowing garbage dump outside the market in Central Kigali. The street children gather items from the dump to survive. According to a photographic journalist, the children at the dump have a highly organized society of their own. The children must get permission from an older street child to collect material from the dump –

food, metal, wood or plastic - or they are beaten up. This elder collects everything gathered by the boys, selling what they have gathered and distributing the money.

On most days during the period of data collection from April to June 2000, in Kigali I had a routine, I would visit and spend time at the documentation centre of the World Bank, the Internet café of the Kigali Institute of Science and Technology and then meet Celestin or Anton at a café in the centre of Kigali. I would always walk around this area and got to know two young street boys. They would initially follow me around asking for money, but I knew from experience that the money would be used to buy petrol. Most street children are addicted to petrol and glue and constantly sniff and inhale the fumes. They have small plastic bottles with them filled with petrol and they often take turns sniffing. I started carrying banana and bread so that I could give some food to the children instead of money. I would also buy them a soda sometimes.

Walking beside Celestin and me, the two boys talk to us, and tell us that sleeping on the street is initially a horrible experience but then they get used to street life. During the daytime they spend their time around the market helping people carry their vegetable bags and getting some money. The street is not a secure place for the very young street children, some of whom were as young as six years and are girls. The '*mayibobos*' are constantly hungry, they have no shelter, and also face abuse from the police and the local population. Many of the children hesitate going to the shelters for street children because they lose the freedom they have on the street and feel they will be treated like dirt. Many of the children bear the scars of living on the street. They wear rags, have scabs, wounds, are dirty, sick and unhealthy.

Despite this scenario, in Rwanda children are considered god's gifts and the wealth of a family. A proverb in Kinyarwanda, Rwanda's national language: is "*Umwana mi Umwami*", which translates as "a child is king" (Rayan, 2002). What is to happen to these future citizens of Rwanda? They will grow bearing the scars and legacy of life on the streets. How can the Ministry of Education meet the needs of thousands of children that live on the streets of Rwanda?

10.4.1 Interpretive Commentary

From the socio-cultural perspective the genocide destroyed the social fabric of life in Rwanda. One of the horrific outcomes of the genocide was the massive number of orphans and children who had been separated from their parents during the massive flight of the population after the genocide and the return of displaced in November 1997. The unaccompanied children were placed by UNHCR into centres and orphanages so that the process of reunification could take place. International organisations, such as the UNHCR and the ICRC were trying to reunite children with families but it was simply not possible to reunite all the children of Rwanda's genocide with their relatives.

Social workers, teachers, and humanitarian organizations often become surrogate parents to these children. An official with UNICEF says that while most of the girls are more likely to cry over the trauma they've experienced, many of the boys are at risk of becoming violent themselves, raising important concerns for Rwanda's future. From a practical perspective, can the Ministry of Education provide non-formal and community education for the street children, so as to equip them with a better chance for the future. The idea of non-formal education for the out of school young population has been suggested in previous chapters and has been recommended in the concluding chapter.

Celestin, who was my constant companion during the data collection phase has written the next vignette that represents his story of life in Rwanda as a teacher in Rwandan schools from 1988 to 2000.

10.5 Vignette 5 The Story of a Rwandan Teacher

I am a qualified teacher and have a university degree. I have worked in Rwanda since 1988. This is my personal account of teaching and learning in the years between 1988 and 2000. Before 1988, I was a student at university, but used to work part-time. This was helpful for me, as I did not have a scholarship. Life was very hard and soon after I graduated in October 1988, I was told of the need for teachers at rural private schools in Rwanda.

As soon as I arrived at the school, the headmaster gave me the timetable without any interview or orientation. So great was the need that I was immediately hired as a fulltime teacher. The school had two sections: the mathematics and physics section and the pedagogy section that trained students to be primary teachers. On my first day itself I had contact with different classes.

During the school year, I sometimes had opportunities to discuss various teaching issues with colleagues. Although I was a new teacher, the teachers were friendly and welcomed and encouraged me. As the school was a rural school, the teachers and students expressed themselves in Kinyarwanda. I was the only teacher in the school who spoke English. Kinyarwanda was generally used to facilitate teaching and learning in all classrooms

Teachers did not talk and discuss about pedagogical issues. Many of the teachers were not qualified and were puzzled by such discussions. My school was a rural private one. There was no laboratory and not a single tool or equipment inspite of having the mathematics-physics section. The teachers managed to make as many drawings as possible on the black board but the teachers kept complaining that the quality of their work was affected by a lack of resources. This was the general case in most of the private schools, especially the rural private ones. Throughout the time I have been a teacher, I did not have the opportunity to attend a single seminar. The rural private schools were ignored and neglected. Even inspectors did not visit the schools. The head teachers usually trusted the teacher and would seldom visit the classes. The head teacher would sometimes ask the students if they understood what was taught and if they were happy with a teacher.

Although there were school curricula, there were not enough textbooks in the school. In many subjects there were no books at all. Very few schools had libraries, so the few books that the school had were usually kept in the school deputy's office. There was no order for maintaining the books and many books would disappear with teachers borrowing books and not returning them.

I always remember the agriculture subject scheduled in the classes. Every teacher was given some hours of agriculture so that students would grow a

variety of crops and this would contribute food to the stock in the boarding section of the school. Each school also participated in 'Tree day'. The teachers went with the students to plant trees around the school, in the school compound and in the community. In addition to this, there was time allocated into the timetable when students could go and clean the school compound, the bathroom and the latrines.

Even though schools were poorly resourced, teachers were regularly paid and the Rwandan franc was not as devalued as it is now and teachers were able to look after their needs and the needs of their family. The main problem was lack of medical facilities for the vast majority of the Rwandans. As medical services are not free in Rwanda, access to adequate and prompt healthcare is not common.

Unfortunately things began to change towards the end of 1990. Teachers started to work in more than one school to survive. At the start of the civil war in 1991 the country faced a terrible famine. The monthly salary did not help you to get food and teachers started taking loans. The situation was also very hard for the rural poor and villagers who were subsistence farmers. The rural poor increased and the number of beggars increased. Most of the rural poor were women and children, young girls who had children. Many of the rural female secondary students had babies and this affected their studies. This period was extremely difficult for most Rwandese.

Few people could further their studies during this period of time. Many could not meet the criteria of admission to university. Admission was not given on merit. The family, the ethnic group, the region you came from played a great role in obtaining admission for higher studies. Then came the civil war and genocide, many teachers and students I personally knew perished in the genocide. I was in Rwanda during the genocide and what I witnessed is so horrible that I cannot find appropriate words to describe the tragedy.

Seven months after the genocide, schools re-opened, students came back to school but most of the students and teachers had experienced trauma and grief and this affected their performance. There were many displaced children. The displaced population that had left the country in the aftermath of the genocide

returned. The returnees were relocated into settlements known as '*Imidugudu*'. The settlements were built far away from public places, schools, hospitals, and markets. Thus the returnees lived in difficult conditions making their children's schooling very difficult. They were confronted daily with water and food shortages, lack of medicines and poor sanitation facilities. Due to lack of transport they had to walk very long distances to get a job.

The education system in Rwanda has always been weak. The civil war and the subsequent genocide left the education system in ruins. Although action has been taken to rehabilitate the schools and implement a new curriculum, teacher salaries are still not paid on time, there are still no books in schools and there is an acute lack of resources. To conclude, as a teacher working in Rwanda, I feel that it is important to improve the living conditions of the family where the students come from. Teaching and learning will improve only when the living conditions of the teachers and students improve.

10.5.1 Interpretive Commentary

I have known Celestin, who has written this vignette and have also visited his home. He lives in Kigali but his home is far from the centre and there is no access to water and sanitation. He has to buy water each day in jerry cans. He cannot meet the schooling needs of his five children and has often to borrow money at the start of the school year. This scenario is common to teachers and students in the whole of Kigali. This social reality has not improved in the eight years after the genocide. Gradual impoverishment of teachers has increased, making their life more difficult and complex.

From a practical viewpoint, how are teachers to move from a chalk and talk approach to a learner centred approach and improve their skills for discussion and facilitation if their socio-economic situation does not improve? The poor socio-economic context of the teachers and learners is further exacerbated by the lack of school infrastructure, resources and lack of funds needed to improve conditions and sustain training.

The final vignette is about the gradual degradation of the environment in Rwanda and the effect of this degradation on the natural flora and fauna of the environment.

10.6 Vignette 6 The Degradation of the Environment

Rwanda is a land of immense natural beauty. Every morning when I lived in Rwanda, I would look out from the patio of my house, see the hills and valleys and be filled by the immense beauty of this land. Hills and valleys can be seen from each direction in Rwanda. This tiny land-locked Central African country is called the 'Land of a Thousand Hills' - its mostly mountainous landscape includes the volcanic Virunga range in the fertile northwest of the country.

Today most of Rwanda's terrain has fallen victim to massive deforestation and over-farming. The degradation of Rwanda's resource base is closely tied to pressure exerted on a limited arable land area by a large and rapidly growing population, 90 percent of whom are engaged in agriculture. Until the recent civil war, Rwanda's population was growing at a rate of 3.7 percent per year resulting in relentless pressure on lands for farming, raising livestock, and other agricultural production. In many areas of the country, intensive crop cultivation is practiced on land that cannot sustain such practices (Percival & Homer-Dixon, 1995).

Population pressures have already drastically reduced the land area of the natural forests of Rwanda from approximately 30 percent at the turn of the century to presently 7 percent of the total land area. The deforestation of Rwanda's remaining natural forests is also the result of high fuel-wood consumption. Prior to the 1990 civil war Rwanda was annually using 2.3 million cubic meters of wood more than it was producing, where 91 percent of wood consumption was for domestic use.

A lot of Rwanda's ground cover has been manually introduced in the form of tea and banana plantations, which are littered along numerous terraces carved haphazardly (and, in terms of water usage, inefficiently) out of the hillsides and the lower slopes of the country's volcanoes. This trend is most evident in hilly areas, where every slope is intensively cultivated, even the very steep slopes. Experts suggest that in the north-western territory, where the potential for agricultural productivity is high, the expansion of agriculture onto marginal lands is resulting in serious slope failures. Soil erosion is further exacerbated by a majority

of Rwanda's population farming and living at high elevations (Percival & Homer-Dixon, 1995).

Due to the large size of Rwandan families, Rwanda's farmers inherit farm lots averaging less than 1.2 hectares that are too small to support a family. The fragmentation of family holdings through generational transfers has led to a severe decline in agricultural production. As a result, families attempt to compensate having small lots by growing more than one crop on the same land in very short cycles, often without adding natural fertilizers to enrich the soil. This fragmentation of family holdings through generational transfers has led to a severe decline in agricultural production, resulting in malnutrition and soil exhaustion.

Rwanda's has a number of remaining natural forests, the Nyungwe Forest, the Gishwati Forest and the Mukara Forest. The forests used to boast a high degree of biological diversity and rare animal species, such as mountain gorillas, rwenzori colobus monkeys and golden chimpanzees. Heavily populated and cultivated areas adjacent to the natural forests, as well as the on-going civil war, has resulted in massive deforestation and a loss of genetic diversity within Rwanda's natural forests. The high degree of biodiversity and rare animal species of Rwanda's remaining natural forests are threatened by the encroachment of refugees fleeing conflict (Percival & Homer-Dixon, 1995).

Rwanda is home to some beautiful but endangered species of flora and fauna; the most prominent examples are the mountain gorillas of Parc Nacional des Volcans (the Volcanic National Park) and the black-and-white Colobus monkeys of Nyungwe Forest. The Nyungwe National Forest Reserve, haven to at least 190 species of trees and 275 species of birds and 12 species of primates, has felt the effects of population pressure and civil war with the cutting down of trees for firewood and poaching of animals for food. Virtually all land that is available in Rwanda is already being used with the exception of two subregions, the Nyabarngo Valley and Akagera National Park. Systematic game hunting has wiped out all the buffalo and most of the forest antelopes known as duikers. After

two decades of slaughter, there are at most six elephants left in the Nyungwe Forest. (See Appendix U7 for a photo and photo essay of the Mountain Gorilla.)

Rwanda's high population density and large number of internally displaced refugees has pushed an ever-increasing number of people onto ecologically sensitive areas, such as Rwanda's remaining natural forests. The degradation of Rwanda's forests results from demand for its products, for fuel wood, for building posts, for cassiterite, for livestock grazing, wildlife and other products valued by local populations and the international community. As population pressures push farmers onto increasingly fragile lands, more and more farming is being done on slopes more than a 10 percent inclination, where rainfall often washes away both the soil and the crops.

The Rwandan Wildlife Club is a non-government organisation run by a young Rwandese, whom I had had the opportunity to meet when working in Rwanda. This club was involved with conservation work in Rwanda, and has started a new reforestation project that will benefit several Rwandan communities. The club now teaches Rwandan students firsthand how to manage a conservation project.

Enthusiasm for a more environmentally aware Rwanda has motivated university students to seek out a way to make a significant change to their own environment. In 2001, the Rwandan Wildlife Club completed their first reforestation project by planting several species of native trees at four schools around Kigali. The school I worked at in Rwanda was one of the schools where species of native trees were planted.. Students from different schools in Rwanda were taught how to water the seedlings during their summer and winter holidays; how to coordinate enough assistance from other schools to care for and transfer the seedlings; how to form contingency plans to care for the native saplings. The students at these schools now care for the plantings themselves and have understood the need for conservation and reforestation.

10.6.1 Interpretive Commentary

From a socio-cultural perspective this vignette highlights the grave environmental concerns faced by Rwanda and her population due to scarcity of land, deforestation and

the effects of destruction of flora and fauna. The new science curriculum does not include or highlight these grave aspects of the environment. Students and communities in Rwanda need to be made aware of the gravity of the situation and the need for conservation and reforestation. From a practical perspective teaching students about conservation and reforestation will make them aware of the gravity of the environmental problems facing Rwanda and the need to reforest. Learning about their environment and its destruction will empower students and make them work with communities to grow native species of trees, to help conserve endangered species of flora and fauna.

10.7 Summary of the Chapter

The vignettes in this chapter have drawn on my experiences and reflections of socio-cultural factors that affect the life of teachers, students and people in Rwanda. The vignettes have been interpreted from a socio-cultural and practical perspective and have explored the complex issues faced by teachers, students and citizens in Rwanda. Through creating the vignettes and my reflections of the vignettes I have explored the continuity and change of life in Rwanda after the genocide. Through this chapter I have responded to the last Research Question 9, the last research question and the chapter provides evidence that the political, environmental, social and cultural factors play an important role in not only the everyday life of the Rwandese but also have an affect on the educational system. Chapter 11 is the final chapter of this thesis and discusses the conclusions, recommendations, implications and future directions of the study.

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APPENDICES

APPENDIX A

A PHOTOGRAPH OF THE HILLS AROUND KIGALI



Photo Essay

Rwanda is a land of immense beauty and is called the land of the thousand hills or in French *Mille Colline*. As you drive from the International airport into the city centre, you pass a tapestry of hills, valleys and houses on the terraces of the hills.

At night from any point in the city it is possible to see hills and valleys and a kaleidoscope of lights. Most of the land on the terraced hillsides has been used up for building houses or has been converted into small farms.

As one walks through the streets, the market place is full of colour, with Rwandese women wearing garments made from coloured African fabric, and the surrounding hillsides are green, interspersed with the flowers in bloom during the season.

Many of the hillside-terraced farms are filled with banana plantations, maize fields and have also been planted with beans and groundnuts. At dusk, when the weather starts getting cooler you sometimes have mists covering the mountains and the home of the mountain gorilla is then called mountains in the mist.

APPENDIX B

Chronology of Key Events in Rwanda

(from BBC's online country profiles)

1300s	Tutsis migrate into what is now Rwanda, which was already inhabited by the Twa and Hutu peoples.
1600s	Tutsi King Ruganzu Ndori subdues central Rwanda and outlying Hutu areas.
Late 1800s	Tutsi King Kigeri Rwagugiri establishes a unified state with a centralised military structure.
1858	British explorer Hanning Speke is the first European to visit the area.
1890	Rwanda becomes part of German East Africa.
1916	Belgian forces occupy Rwanda.
1923	Belgium granted League of Nations mandate to govern Ruanda-Urundi, which it ruled indirectly through Tutsi kings.
1946	Ruanda-Urundi becomes UN trust territory governed by Belgium.
1957	Hutus issue manifesto calling for a change in Rwanda's power structure to give them a voice commensurate with their numbers; Hutu political parties formed.
1959	Tutsi King Kigeri V, together with tens of thousands of Tutsis, forced into exile in Uganda following inter-ethnic violence.
1961	Rwanda proclaimed a republic.
1962	Rwanda becomes independent with a Hutu, Gregoire Kayibanda, as president; many Tutsis leave the country.
1963	Some 20,000 Tutsis killed following an incursion by Tutsi rebels based in Burundi.
1973	President Gregoire Kayibanda ousted in military coup led by Juvenal Habyarimana.
1978	New constitution ratified; Habyarimana elected president.
1988	Some 50,000 Hutu refugees flee to Rwanda from Burundi following ethnic violence there.
1990	Forces of the rebel, mainly Tutsi, Rwandas Patriotic Front (RPF) invade Rwanda from Uganda.

- 1991** New multiparty constitution promulgated.
- 1993** President Habyarimana signs a power sharing agreement with the Tutsis in the Tanzanian town of Arusha, ostensibly signalling the end of the civil war; UN mission sent to monitor the peace agreement.
- 1994 April** Habyarimana and the Burundian president are killed after their plane is shot down over Kigali; RPF launches a major offensive; extremist Hutu militia and elements of the Rwandan military begin the systematic massacre of Tutsis. Within 100 days around 800,000 Tutsis and moderate Hutus are killed; Hutu militias flee to Zaire, taking with them around 2 million Hutu refugees.
- 1994-96** Refugee camps in Zaire fall under the control of the Hutu militias responsible for the attempted genocide in Rwanda.
- 1995** Extremist Hutu militias and Zairean government forces attack local Zairean Banyamulenge Tutsis; Zaire attempts to force refugees back into Rwanda.
- 1995** UN-appointed international tribunal begins charging and sentencing a number of people responsible for the Hutu-Tutsi atrocities.
- Intervention in the Democratic Republic of Congo**
- 1996** Rwandan troops invade and attack Hutu militia-dominated camps in Zaire in order to drive home the refugees.
- 1997** Rwandan and Ugandan backed rebels depose President Mobutu Sese Seko of Zaire; Laurent Kabila becomes president of Zaire, which is renamed the Democratic Republic of Congo.
- 1998** Rwanda switches allegiance to support rebel forces trying to depose Kabila in the wake of the Congolese president's failure to expel extremist Hutu militias.
- 2000 March** Rwandan President Pasteur Bizimungu, a Hutu, resigns over differences regarding the composition of a new cabinet and after accusing parliament of targeting Hutu politicians in anti-corruption investigations.
- 2000 April** Ministers and members of parliament elect Vice-President Paul Kagame as Rwanda's new president.
- 2000 November** International donors meeting in Kigali to discuss aid to Rwanda, urge the country to withdraw its troops from the Democratic Republic of Congo.
- 2001 February** President Kagame says Rwandan troops are ready to leave the DR

APPENDIX C

Evolution of Secondary and Post-Secondary Enrolments (1980-1987)

(Ministry of Education in Rwanda, 1980)

Note: For copyright reasons Appendix C has not been reproduced.

**(Co-ordinator, ADT Project (Bibliographic Services), Curtin University of
Technology, 21/11/03)**

APPENDIX D

Data on Literacy Centres

 Data on Literacy Centres

Prefecture	Number of centres			Teaching and administrative personnel		
	Operational	Partially damaged	Totally damaged	Teaching personnel	Administrative personnel	Total
Kigali City	38	28	10	35	3	38
Kigali Ngari	592	30	-	592	19	611
Gitarama	-	169	-	169	3	172
Butare	207	7	200	207	4	211
Gikongoro	60	-	60	120	-	120
Cyangugu	56	-	-	70	4	74
Kibuye	401	-	452	452	4	456
Ruhengeri	90	90	43	726	19	745
Byumba	139	-	222	400	9	409
Kibungo	300	-	495	-	10	-
Umutara	-	-	-	-	-	-
Gisenyi	60	40	66	102	3	105

APPENDIX E

Statistical Data on the Development of the Education System

The Formal Education System 1990-1997

	1990/91	1991/92	1992/93	1993/94 ¹	1993/94 ²	1994/95	1995/96 ³	1996/97 ³
Primary Education								
Number of students	1030529	1100437	1134540	1174448	820232	941012	1-39657	1154768
Number of schools	1671	1747	1747	1882	1283	1882	1845	1918
Students per teacher	57.1	57.3	57.6	59.0	48.0	53.0	54.9	57.1
Qualification rate of teachers	55.0	56.7	60.1	60.1	45.6	39.0	40.2	32.5
Number of graduates	60556	60249	101603 ⁴	-	60714	53844	68442	-
Public and Private subsidised Secondary Education								
Number of students	26251	28162	30094	36815	3077	20533	50100	55641
Number of schools	82	83	82	112	10	85	111	132
Students per teacher	15.3	15.3	14.7	15.8	10.0	12.0	28.8	-
Qualification rate of teachers	66.5	62.9	58.3	58.0	70.0	33.3	33.0	-
Number of graduates	2269	2158	2952	-	1968	3385	4775	-
Private secondary education								
Number of students	-	-	-	18000 ⁵	-	-	23667	35230
Number of schools	93	95	128	168	-	65	99	123
Students per teacher	-	-	-	-	-	-	-	19 ⁶
Qualification rate of teachers	-	-	-	-	-	-	-	57.4 ⁶
Higher Education								
Number of students	-	-	-	-	-	-	4131	-

APPENDIX F

Education Performance Indicators 1997-99

	1997	1998	1999
Primary education			
Gross enrolment, total	1154768 (80%)	1270733 (88%)	1288617 (88%)
Male	574642	635765	644430
Female	580126	634968	644187
Completion	71017 (28%)	60361 (22%)	
Transition	10304 (18%)	12503 (21%)	14151 (22%)
Number of qualified teachers	6574 (33%)	10463 (46%)	14860 (51%)
Student-teacher ratio	56	56	55
Student-qualified teacher ratio	175	121	109
Books per class			
Books per pupil		0.56	
Teachers provided with materials			
Teachers trained in-service	2210	2568	7116
Students at TTCs			2611
Number of classes			30866
Number of classrooms			23395
Classrooms constructed	1243	576	89
Repetition rate			30%
Drop-out rate			20%
Percent passing national exam			(22.6)
Secondary education			
Gross enrolment, total	82224	90840	103222 (9.7%)
Male	41588	45054	50919
Female	40636	45786	52303
Completion	8133	10500	
Transition to higher education	(11%)		
Number of qualified teachers	1115 (28%)	1188 (31%)	1098 (31%)
Books per class			
Books per pupil			
Teachers provided with materials			
Teachers trained in-service			836
Students at KIE		299	400
Classrooms constructed		30	44

APPENDIX G

International Development Targets for Rwanda

(Specified by World Bank and International Monetary Fund)

Note: For copyright reasons Appendix G has not been reproduced.

**(Co-ordinator, ADT Program (Bibliographic Services), Curtin University of
Technology, 21/11/03)**

APPENDIX H

Student Enrolment Rates by Gender

Primary Enrolment Rates by Gender

Children	Gender	1996	1997	1998
School age children (7-12 years)	Male	563165	713857	661837
	Female	661071	738635	776939
	Total	1224236	1452492	1438776
Primary students	Male	515882	574642	636678
	Female	523775	580126	636729
	Total	1039657	1154768	1273407
Primary students (7-12 years)	Male	426846	460479	457989
	Female	46847	487736	470063
	Total	853693	948215	928952
Enrolment Rates				
Gross enrolment rate	Male	92%	80%	96%
	Female	79%	79%	82%
	Total	85%	80%	89%
Net enrolment rate	Male	76%	65%	69%
	Female	65%	66%	61%
	Total	70%	65%	65%

Primary Completion Rates by Gender

Children		1996	1997	1998
Primary students in P6 (primary year 6)	Male	35306	40761	30786
	Female	33580	39232	29578
	Total	68886	79993	60364
Primary students in P1 (primary year 1) Six years before	Male	119905	141908	129310
	Female	11502	138029	124239
	Total	235107	279937	253549
Completion Rates				
	Male	29%	29%	24%
	Female	29%	28%	24%
	Total	29%	29%	24%

Primary Examination Rates by Gender

Children		1996	1997	1998
Primary students in P6 (primary year 6)	Male	35306	40761	30786
	Female	33580	39232	29578
	Total	68886	79993	60364
Primary students passing P6 exams (national exams at the end of primary year6)	Male	5937	7670	6126
	Female	5705	7369	6376
	Total	11642	15039	12502
Success Rates				
	Male	17%	19%	20%
	Female	17%	19%	22%
	Total	17%	19%	21%

Literacy Rates by Gender

Age	Gender	Read and write	Read only	Neither read nor write
6-14	Male	37	4	57
	Female	39	4	55
15-29	Male	71	2	27
	Female	70	3	27
30+	Male	53	4	44
	Female	28	4	67
Total	Male	52	3	44
	Female	45	4	51

Secondary Transition and Enrolment Rates by Cycle and Gender

Children		1996	1997	1998
School age children (13-18 years)		n.a	n.a	1571679
Primary P6 students in previous year	Male	n.a	35306	40761
	Female	n.a	33580	39232
	Total	n.a	68886	79993
Government secondary students	Male	26050	28797	37145
	Female	24048	26843	34287
	Total	50098	55640	71432
Government S1 secondary students	Male	n.a	n.a	n.a
	Female	n.a	n.a	n.a
	Total	9300	10500	11200
Private secondary students	Male	11597	17210	18847
	Female	12070	18020	19616
	Total	23667	35230	38463
Private S1 secondary students	Male	n.a	n.a	n.a
	Female	n.a	n.a	n.a
	Total	n.a	n.a	n.a
Total secondary students	Male	37647	46007	55992
	Female	36118	44863	53903
	Total	73765	90870	109895
Secondary students aged 13-18 years	Male	n.a	n.a	n.a
	Female	n.a	n.a	n.a
	Total	n.a	n.a	n.a
Enrolment Rates				
Gross enrolment rate		n.a	n.a	7%
Net enrolment rate		n.a	n.a	n.a
Transition rate from primary school		n.a	n.a	n.a

APPENDIX I

**UNESCO-PEER
(Emergency Education Programme for Rwanda)**

(Retamal, et al., 1998 & Baxter & Hoffman, 1998)

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**(Co-ordinator, ADT Program (Bibliographic Services), Curtin University of
Technology, 21/11/03)**

APPENDIX J

UNESCO's Project 2000+

On a global scale, in 1990 at the United Nations World Conference in Thailand, there was unanimous adoption of the World Declaration on Education for All. This has been the strongest call on action to address globally the basic learning needs of all children, youth and adults. In the 1980s various initiatives began to change the goals of science education to make them more aligned with the individual needs of each country and the needs of the society in those countries. UNESCO has over the past decade been on the frontline in the promotion and development of Science and Technology Education (STE) as well as Technical and Vocational Education and Training (TVET). In 1992, UNESCO launched UNEVOC, an international project on Technical and Vocational Education.

Project 2000+ was launched in 1993 and is the main channel through which the UNESCO programs relating to scientific and technological literacy are developed. The project is based on the philosophy that science and technology increasingly affects our daily life and everyday world. The developmental aspects of science education help provide knowledge and skills adapted to societal needs. These developmental aspects and emergency themes have the potential to promote critical thinking abilities and sense of civic responsibility and motivate boys and girls towards scientific and technological studies and careers. The program is UNESCO's commitment to the promotion of science and technology education (STE) around the world and is based on the principle that the world is increasingly shaped by science and technology and all human beings— young and adult— must understand complex principles and the basics of science and technology to successfully compete, survive and contribute to sustainable development. The program addresses key societal issues, especially those having a bearing on people's quality of life, the environment, health and development, emphasizing the science and technology involved with a gender sensitive, integrated/interdisciplinary and problem solving approach. Project 2000+ takes into account local culture and values, as well as socio-economic needs and aspirations of each country and its people.

The spread of science and technology are narrowly perceived as means to achieving short-term material gains neglecting the most important consideration that it is a means to objective knowledge helping man to understand nature. Project 2000+ encompasses a multi-disciplinary approach to understand the relationship that exists between science and technology and its link to economic development. The sharp separation of science and technology in teaching and learning is harmful to learners as it ignores the underlying interdependence of knowledge, action and society (Kerre, 2001). The Science, Technology and Society themes presented in figure 16 shows a distinct link to the development related functions of the science curriculum.

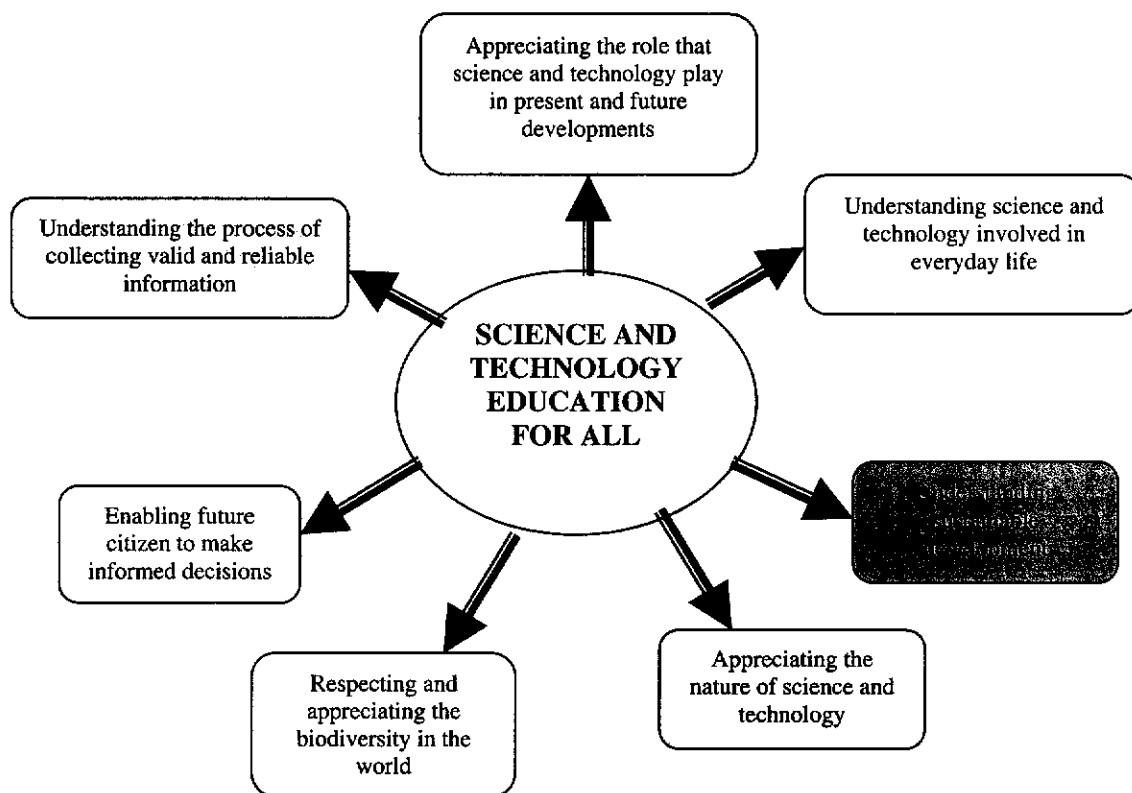


Figure 16: UNESCO's themes in Science, Technology and Society

The majority of the students in developing countries and especially in the case of Rwanda will not study any science after secondary schooling, as opportunity and access to secondary schooling are extremely limited. STS themes are introduced in science classrooms as either enrichment material and may become the organizing focus of the course (UNESCO, 2001).

APPENDICES K AND L

**Letter of Introduction from the
Science and Mathematics Education Centre
Curtin University of Technology
Perth, Western Australia**

**Letter of Introduction in Kinyarwanda
from the
Ministry of Education
Kigali, Rwanda**

NATIONAL KEY CENTRE FOR SCHOOL SCIENCE AND MATHEMATICS



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3-04-2000

To whom it may concern

This is to introduce **Mrs. Jaya Earnest**, who is a full-time Ph. D student at the Science and Maths Education Centre. She is travelling to Rwanda from 24-04-2000 to 15-07-2000 to collect data as part of her research study. Any assistance rendered to her will be appreciated.

Yours Sincerely,

David Treagust
Professor in Science Education
Science and Maths Education Centre

APPENDIX L

**Letter of introduction in Kinyarwanda from the Ministry of Education
Kigali, Rwanda**

Note: For copyright reasons Appendix L has not been reproduced.

**(Co-ordinator, ADT Program (Bibliographic Services), Curtin University of
Technology, 21/11/03)**

APPENDIX M

English Teacher Questionnaire

Curtin

UNIVERSITY OF TECHNOLOGY

Science and Mathematics Education Centre (SMEC)

Teacher Questionnaire

This questionnaire is part of my research to study science education reform in Rwanda.

This survey consist of questions about your background, the science curriculum and your attitude to science lessons.

The information contained in this questionnaire will be treated confidentially.

**THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.
YOUR ASSISTANCE AND COOPERATION IS HIGHLY VALUED.**

Jaya Earnest
Science and Mathematics Education Centre
Curtin University of Technology
GPO Box U1987, Perth
Western Australia

Phone +61 8 9266 2989
Fax +61 8 9266 2503

SCIENCE AND MATHEMATICS
EDUCATION CENTRE



PART A BACKGROUND

Place a tick in the box opposite the question that best applies:

1. Are you male or female? Male ₁ Female ₂
2. How old are you? Under 30 ₁ Between 30-45 ₂ Over 45 ₃
3. How many years have you been teaching?
4. What is your qualification?
- Grade 3 ₁
 Grade 5 ₂
 Diploma ₃
 Bachelor's Degree ₄
 Master's Degree ₅
5. The type of school you are teaching in is?
- Rural ₁ Semi-urban ₂ Urban ₃
6. You teach: Primary ₁ Lower secondary ₂ Upper secondary ₃
7. The subjects you teach are:
- General science ₁
 Maths ₂
 Physics ₃
 Biology ₄
 Chemistry ₅
8. During the last 12 months have you attended any in-service training?
- Yes ₁ No ₂
9. If yes, then the type of training was?
- Professional meetings ₁
 Workshops ₂
 Seminars and conferences ₃
 Refreshers courses ₄
10. What type of support did you receive when attending in-service training?
- None ₁
 Released time from teaching ₂
 Travel allowance ₃
 Per diem expenses ₄
 Promotion ₅

PART B Curriculum Survey for Teachers

1. Has the new curriculum been implemented in your school? Yes ₁ No ₂

2. Do you teach environmental awareness to the students? Yes ₁ No ₂

3. If yes, then do you teach:

- | | |
|---------------|---------------------------------------|
| Soil erosion | <input type="checkbox"/> ₁ |
| Conservation | <input type="checkbox"/> ₂ |
| Tree planting | <input type="checkbox"/> ₃ |
| Recycling | <input type="checkbox"/> ₄ |
| Others | <input type="checkbox"/> ₅ |

Specify _____

4. If no, then explain

5. Do you teach health issue to the students? Yes ₁ No ₂

6. If yes, then do you teach:

- | | |
|----------------------|---------------------------------------|
| Water & sanitation | <input type="checkbox"/> ₁ |
| Cholera prevention | <input type="checkbox"/> ₂ |
| HIV & AIDS awareness | <input type="checkbox"/> ₃ |
| Personal hygiene | <input type="checkbox"/> ₄ |

7. If no, how do students learn about these health issues?

8. Is any aspect of landmine awareness included in the curriculum? Yes ₁ No ₂

The following sections of the questionnaire require you to indicate your level of agreement or disagreement with a number of statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Draw a circle around your response, 1, 2, 3, 4 or 5.

1. If you *strongly disagree* with the statement.
2. If you *disagree* with the statement.
3. If you *neither agree or disagree* with the statement, or are unsure.
4. If you *agree* with the statement.
5. If you *strongly agree* with the statement.

The Current Curriculum

		Strongly Disagree			Strongly Agree	
1	Prepares you for further studies in science.	1	2	3	4	5
2	Promotes healthy diet.	1	2	3	4	5
3	Promotes the avoidance of drugs.	1	2	3	4	5
4	Promotes human population control.	1	2	3	4	5
5	Promotes rural development.	1	2	3	4	5
6	Instils an understanding of modern technology.	1	2	3	4	5
7	Prepares young people to become self-employed.	1	2	3	4	5
8	Equips young people with skills to be self-employed.	1	2	3	4	5
9	Promotes active interest in preserving the natural environment.	1	2	3	4	5

PART C

The following sections of the questionnaire require you to indicate your level of agreement or disagreement with a number of statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Draw a circle around your response, 1, 2, 3, 4 or 5.

1. If you *strongly disagree* with the statement.
2. If you *disagree* with the statement.
3. If you *neither agree or disagree* with the statement, or are unsure.
4. If you *agree* with the statement.
5. If you *strongly agree* with the statement.

**School-Level Environment Questionnaire
(SLEQ)**
will bring to light the various factor that influence change/reform

		Strongly Disagree			Strongly Agree	
1	Teachers frequently discuss teaching methods and strategies with each other.	1	2	3	4	5
2	I am often supervised to ensure that I follow directions correctly.	1	2	3	4	5
3	It is very difficult to change anything in this school.	1	2	3	4	5
4	The school or department library includes an adequate selection of books and periodicals.	1	2	3	4	5
5	There is constant pressure to keep working.	1	2	3	4	5
6	I feel accepted by other teachers.	1	2	3	4	5
7	I am not expected to conform to a particular teaching style.	1	2	3	4	5
8	The supply of equipment and resources is inadequate.	1	2	3	4	5
9	It is considered very important that I closely follow syllabuses and lesson plans.	1	2	3	4	5
10	There is a great deal of resistance to change.	1	2	3	4	5
11	I feel that I could rely on my colleagues for assistance if I needed it.	1	2	3	4	5
12	Adequate duplicating facilities and services are available to teachers.	1	2	3	4	5
13	I feel that I have many friends among my colleagues at this school.	1	2	3	4	5
15	Teachers are keen to learn from their colleagues.	1	2	3	4	5
15	Facilities are inadequate for a variety of classroom activities.	1	2	3	4	5
16	Seldom are there datelines to be met.	1	2	3	4	5
17	I am expected to maintain very strict control in the classroom.	1	2	3	4	5
18	Text books and teacher resource books are available when needed.	1	2	3	4	5
19	It is hard to keep up with your workload.	1	2	3	4	5

PART D TEACHERS' BELIEFS ABOUT SCIENCE TEACHING AND LEARNING

		Strongly Disagree			Strongly Agree		
1	When the science grades of students improve, it is often due to a more effective teaching approach by their teacher.	1	2	3	4	5	
2	I know the steps to teach science concepts effectively.	1	2	3	4	5	
3	I am not very effective in monitoring science experiments.	1	2	3	4	5	
4	If students are underachieving in science, it is most likely due to ineffective science teaching.	1	2	3	4	5	
5	Increased effort in science teaching produces little change in some students' science achievement.	1	2	3	4	5	
6	The teacher is usually responsible for student achievement.	1	2	3	4	5	
7	Students' achievement is directly related to their teachers' effectiveness in science teaching.	1	2	3	4	5	
8	If parents feel that their child is showing more interest in science, it is probably due to the performance of the teacher.	1	2	3	4	5	
9	I find difficult to explain to students why experiments work.	1	2	3	4	5	
10	I am typically able to answer students' science questions.	1	2	3	4	5	
11	I wonder if I have the necessary skills to teach science.	1	2	3	4	5	

APPENDIX N

**Questionnaire Pour Les Enseignants
(French Teacher Questionnaire)**

Curtin

UNIVERSITÉ DE TECHNOLOGIE

Centre d'Éducation des Sciences et Mathématiques Questionnaire pour les Enseignant

Ce questionnaire fait partie de ma recherche sur la réforme d l'éducation des sciences.
Les informations contenues dans ce questionnaire seront traitées confidentiellement.

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SCIENCE AND MATHEMATICS
EDUCATION CENTRE



SECTION A PRÉSENTATION DE L'ENSEIGNANT

Cochez la réponse correcte:

1. Votre sexe: Masculin Féminin
2. Votre âge: Moins de 30 ans entre 30 et 45 ans plus de 45 ans
3. Nombre d'années d'expérience dans le domaine de l'enseignement
4. Votre qualification: D4 D6 G3 L2
5. L'école où vous enseignez est:
Rurale Demi-urbaine Urbaine
6. Vous enseignez à l'école : Primaire
Secondaire (degrés inf.)
Secondaire (degrés supér.)
7. Les matières que vous enseignez sont :
Sciences générales
Mathématiques
Physique
Biologie
Chimie
8. Au cours des derniers 12 mois avez-vous participé à une formation pédagogique ?
oui non
9. Si oui, quel genre de formation était-il ?
Rencontre pédagogique
Atelier
Séminaires et conférences
Cours de perfectionnement
10. Quel type d'assistance avez-vous reçu au cours de cette formation pédagogique ?
Aucun
Dispense d'enseigner pour certaines heures
Indemnité de transport
Perdiem
Promotion

SECTION B QUESTIONS SUE LE CURRICULUM (PROGRAMME SCOLAIRE)

1. Est-ce que le nouveau programme scolaire est mis en application dans votre école?

Oui

Non

2. Est-ce que dans votre école on vous enseigne à prendre conscience de l'importance de l'environnement? Oui No

3. Si oui, est-ce que on vous enseigne:

Erosion du sol Conservation Plantation d'arbres Recyclage

D'autres

Spécifiez _____

4. Si non, expliquez _____

5. Est-ce que vous apprenez les sujets concernant la santé: Oui Non

6. Si oui, est-ce que vous apprenez les sujets concernant:

Eau et assainissement

Prévention contre le Choléra

HIV et SIDA

Hygiène personnelle

7. Est-ce que à l'école on vous parle des mines terrestres? Oui Non

8. Combien de leçons de sciences avez-vous par semaine? _____

Dans les sections suivantes vous êtes priés d'indiquer votre degré d'accord ou de désaccord avec certaines affirmations. Encerchez le numéro qui correspond à votre opinion.

1. Si vous êtes fortement en désaccord avec l'affirmation.
2. Si vous êtes en désaccord avec l'affirmation.
3. Si vous n'êtes ni d'accord ni en désaccord avec l'affirmation, ou si vous n'êtes pas sûr.
4. Si vous êtes d'accord avec l'affirmation.
5. Si vous êtes fortement en accord avec l'affirmation.

Le Programme Scolaire en cours

		Fortement en désaccord			Fortement en accord	
1	Vous prépare à des études supérieures en sciences.	1	2	3	4	5
2	Promeut une saine alimentation.	1	2	3	4	5
3	Encourage à éviter les drogues.	1	2	3	4	5
4	Promeut le développement rural.	1	2	3	4	5
5	Instille une compréhension de la technologie moderne.	1	2	3	4	5
6	Prépare les jeunes à être employés.	1	2	3	4	5
7	Donne aux jeunes des compétences pour avoir un travail autonome.	1	2	3	4	5
8	Promeut un intérêt actif dans la préservation de l'environnement naturel.	1	2	3	4	5
9	Promeut un intérêt actif dans la préservation de l'environnement naturel	1	2	3	4	5

SECTION C :

Dans les sections suivantes vous êtes priés d'indiquer votre degré d'accord ou de désaccord avec certaines affirmations. Encerchez le numéro qui correspond à votre opinion.

6. Si vous êtes fortement en désaccord avec l'affirmation.
7. Si vous êtes en désaccord avec l'affirmation.
8. Si vous n'êtes ni d'accord ni en désaccord avec l'affirmation, ou si vous n'êtes pas sûr.
9. Si vous êtes d'accord avec l'affirmation.
10. Si vous êtes fortement en accord avec l'affirmation.

QUESTIONNAIRE SUR LE NIVEAU DE L'ENVIRONNEMENT SCOLAIRE

		Fortement en désaccord			Fortement en accord	
1	Les enseignants discutent souvent des méthodes et des stratégies de l'enseignement entre eux	1	2	3	4	5
2	On me contrôle souvent pour s'assurer que je suis correctement les directives	1	2	3	4	5
3	C'est très difficile de changer quelque chose dans cette école.	1	2	3	4	5
4	La bibliothèque de l'école comprend une collection suffisante de livres et journaux.	1	2	3	4	5
5	On est constamment sous la contrainte dans l'exécution du travail.	1	2	3	4	5
6	Je sens d'être accepté par les autres enseignants.	1	2	3	4	5
7	On n'exige pas que je me conforme à une méthode particulière d'enseignement.	1	2	3	4	5
8	Le matériel et les ressources sont insuffisants.	1	2	3	4	5
9	On considère très important que je suis minutieusement la répartition de matières et la planification des leçons.	1	2	3	4	5
10	Il y a une grande résistance aux changements.	1	2	3	4	5
11	Je sens que je peux compter sur mes collègues si j'ai besoin d'assistance.	1	2	3	4	5
12	Les services de duplicateur sont disponibles pour les enseignants.	1	2	3	4	5
13	Je sens que j'ai beaucoup d'amis parmi mes collègues d'école.	1	2	3	4	5
14	Les enseignants aiment apprendre de leurs collègues.	1	2	3	4	5
15	On n'a pas assez de possibilités pour faire des différentes activités dans la classe.	1	2	3	4	5
16	Rarement il y a des dates limites à respecter.	1	2	3	4	5
17	On me demande de garder un contrôle très sévère dans la classe.	1	2	3	4	5
18	Les manuels classiques et les textes de référence pour les enseignants sont toujours disponibles, quand nécessaire.	1	2	3	4	5
19	C'est dur d'aller de pair avec la charge du travail.	1	2	3	4	5

SECTION C :

L'OPINION DES ENSEIGNANTS SUR L'ENSEIGNEMENT DES SCIENCES

		Fortement en désaccord			Fortement en accord	
1	Quand un élève améliore ses cotes en sciences, c'est parce-que il y a eu une amélioration dans la méthode d'enseignement utilisée par l'enseignant.	1	2	3	4	5
2	Je connais les étapes nécessaires pour enseigner les sciences efficacement.	1	2	3	4	5
3	Je ne suis pas très capable de contrôler les expériences scientifiques.	1	2	3	4	5
4	Si les élèves ne réussissent pas en sciences, c'est parce-que l'enseignement de la matière n'est pas donné de façon efficace.	1	2	3	4	5
5	Un effort accru dans l'enseignement des sciences produit un petit changement dans le travail des élèves en sciences.	1	2	3	4	5
6	Généralement l'enseignant est responsable des résultats des élèves .	1	2	3	4	5
7	Les résultats des élèves en science sont en rapport avec l'enseignement efficace de la part des enseignants.	1	2	3	4	5
8	Si les parents remarquent que leur enfant montre plus d'intérêt en science, c'est dû probablement aux capacités d'enseignement de l'enseignant.	1	2	3	4	5
9	Je trouve des difficultés à expliquer aux élèves pourquoi les expériences marchent.	1	2	3	4	5
10	Je suis capable de répondre aux questions des élèves en sciences.	1	2	3	4	5
11	Je me demande si j'ai les capacités nécessaires pour enseigner les sciences.	1	2	3	4	5

APPENDIX O

English Student Questionnaire

Curtin

UNIVERSITY OF TECHNOLOGY

Science and Mathematics Education Centre (SMEC) Student Questionnaire

This questionnaire is part of my research to study science education reform in Rwanda.

This survey consist of questions about your background, the science curriculum and your attitude to science lessons.

The information contained in this questionnaire will be treated confidentially.

**THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.
YOUR ASSISTANCE AND COOPERATION IS HIGHLY VALUED.**

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SCIENCE AND MATHEMATICS
EDUCATION CENTRE



PART A BACKGROUND

Please tick in the box opposite the question that best applies:

1. Are you a male or female? Male ₁ Female ₂
2. How old are you? Between 10-12 ₁
 Between 13-15 ₂
 Between 16-19 ₃
 Between 20-25 ₄
3. The school you study in is:
 Rural ₁
 Semi-urban ₂
 Urban ₃
4. Which grade/class are you in? _____
5. Which country do you come from? _____

PART B Science Curriculum Survey For Students

1. Has the new curriculum been implemented in your school? Yes ₁ No ₂
2. Do you learn environmental awareness in your school? Yes ₁ No ₂
3. If yes, then do you learn about:
 Soil erosion ₁
 Conservation ₂
 Tree planting ₃
 Recycling ₄
 Others ₅
 Specify _____
4. If no, then explain

5. Do you learn about health issues? Yes ₁ No ₂
6. If yes, then do you learn about:
 Water & sanitation ₁
 Cholera prevention ₂
 HIV & AIDS awareness ₃
 Personal hygiene ₄
7. Is any aspect of landmine awareness taught to you? Yes ₁ No ₂
8. How many classes of science do you have per week? _____

The following sections of the questionnaire require you to indicate your level of agreement or disagreement with a number of statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Draw a circle around your response, 1, 2, 3, 4 or 5.

6. If you *strongly disagree* with the statement.
7. If you *disagree* with the statement.
8. If you *neither agree or disagree* with the statement, or are unsure.
9. If you *agree* with the statement.
10. If you *strongly agree* with the statement.

The Current Curriculum

		Strongly Disagree			Strongly Agree	
1	Prepares you for further studies in science.	1	2	3	4	5
2	Promotes healthy diet.	1	2	3	4	5
3	Promotes the avoidance of drugs.	1	2	3	4	5
4	Promotes rural development.	1	2	3	4	5
5	Instils an understanding of modern technology.	1	2	3	4	5
6	Prepares young people to become self-employed.	1	2	3	4	5
7	Equips young people with skills to be self-employed.	1	2	3	4	5
8	Promotes active interest in preserving the natural environment.	1	2	3	4	5

PART C

The following sections of the questionnaire require you to indicate your level of agreement or disagreement with a number of statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted. Draw a circle around your response, 1, 2, 3, 4 or 5.

1. If you *strongly disagree* with the statement.
2. If you *disagree* with the statement.
3. If you *neither agree or disagree* with the statement, or are unsure.
4. If you *agree* with the statement.
5. If you *strongly agree* with the statement.

ENJOYMENT OF SCIENCE LESSONS

Strongly		Disagree					Strongly Agree	
1	I dislike science lessons.	1	2	3	4	5		
2	Science lessons bore me.	1	2	3	4	5		
3	Science lessons are a waste of time.	1	2	3	4	5		
4	The material covered in science lessons is not interesting.	1	2	3	4	5		
5	I would enjoy school more if there were no science lessons.	1	2	3	4	5		

ATTITUDE TO SCIENTIFIC INQUIRY

Strongly		Disagree					Strongly Agree	
1	Doing experiments is not as good as finding out information from teachers.	1	2	3	4	5		
2	I rather agree with other people than do an experiment to find out for myself.	1	2	3	4	5		
3	I prefer to find out things by asking an expert than by doing an experiment.	1	2	3	4	5		
4	It is better to ask the teacher the answer than to find it out by doing experiments.	1	2	3	4	5		
5	It is better to be told scientific facts than to find out from experiments.	1	2	3	4	5		

APPENDIX P

Questionnaire Pour Les Elèves (French Student Questionnaire)

Curtin

UNIVERSITÉ DE TECHNOLOGIE

Centre d'Éducation des Sciences et Mathématiques Questionnaire pour les Elèves

Ce questionnaire fait partie de ma recherche sur la réforme d l'éducation des sciences.
Les informations contenues dans ce questionnaire seront traitées confidentiellement.

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SCIENCE AND MATHEMATICS
EDUCATION CENTRE



SECTION A PRÉSENTATION DE L'ÉLÈVE

Cochez la réponse correcte:

6. Votre sexe: Masculin Féminin
7. Votre âge: Entre 10 et 12 ans Entre 13 et 15 ans
 Entre 16 et 19 ans Entre 20 et 25 ans
8. L'école où vous étudiez est:
 Rurale Demi-urbaine Urbaine
9. En quelle classe êtes-vous? _____
10. Quel est votre pays d'origine? _____

SECTION B QUESTIONS SUR LE PROGRAMME DE SCIENCES

9. Est-ce que le nouveau programme scolaire est mis en application dans votre école?
 Oui Non
10. Est-ce que dans votre école on vous enseigne à prendre conscience de l'importance de l'environnement? Oui No
11. Si oui, est-ce que on vous enseigne:
 Erosion du sol Conservation Plantation d'arbres Recyclage
 D'autres
- Spécifiez _____
12. Si non, expliquez _____
13. Est-ce que vous apprenez les sujets concernant la santé: Oui Non
14. Si oui, est-ce que vous apprenez les sujets concernant:
 Eau et assainissement Prévention contre le Choléra
 HIV et SIDA Hygiène personnelle
15. Est-ce que à l'école on vous parle des mines terrestres? Oui Non
16. Combien de leçons de sciences avez-vous par semaine? _____

Dans les sections suivantes vous êtes priés d'indiquer votre degré d'accord ou de désaccord avec certaines affirmations. Encerchez le numéro qui correspond à votre opinion.

11. Si vous êtes fortement en désaccord avec l'affirmation.
12. Si vous êtes en désaccord avec l'affirmation.
13. Si vous n'êtes ni d'accord ni en désaccord avec l'affirmation, ou si vous n'êtes pas sûr.
14. Si vous êtes d'accord avec l'affirmation.
15. Si vous êtes fortement en accord avec l'affirmation.

Le Programme Scolaire en cours

		Fortement en désaccord			Fortement en accord	
1	Vous prépare à des études supérieures en sciences.	1	2	3	4	5
2	Promeut une saine alimentation.	1	2	3	4	5
3	Encourage à éviter les drogues.	1	2	3	4	5
4	Promeut le développement rural.	1	2	3	4	5
5	Instille une compréhension de la technologie moderne.	1	2	3	4	5
6	Prépare les jeunes à être employés.	1	2	3	4	5
7	Donne aux jeunes des compétences pour avoir un travail autonome.	1	2	3	4	5
8	Promeut un intérêt actif dans la préservation de l'environnement naturel.	1	2	3	4	5

SECTION D JOUISSANCE DES COURS SCIENCES

		Fortement en désaccord			Fortement en accord	
1	Je n'aime pas les cours de sciences	1	2	3	4	5
2	Les cours de sciences m'ennuient	1	2	3	4	5
3	Les cours de sciences sont une perte de temps	1	2	3	4	5
4	Les sujets étudiés en sciences ne sont pas intéressants	1	2	3	4	5
5	J'aimerais plus l'école s'il n'y avait pas de cours de sciences	1	2	3	4	5

ATTITUDE VIS-À-VIS D'UNE ENQUÊTE SCIENTIFIQUE

		Fortement en désaccord			Fortement en accord	
1	Les renseignements donnés par les enseignants sont plus valables que faire des expériences.	1	2	3	4	5
2	J'aime accepter les idées des autres plutôt que faire une expérience pour découvrir par moi même.	1	2	3	4	5
3	Je préfère découvrir les choses en posant des questions à des experts plutôt qu'en faisant des expériences.	1	2	3	4	5
4	C'est mieux de demander la réponse à l'enseignant plutôt que la découvrir à travers une expérience.	1	2	3	4	5
5	C'est mieux d'entendre parler de faits scientifiques plutôt que les découvrir à travers des expériences.	1	2	3	4	5

APPENDIX Q

The Classroom Observation Schedule.

Name:

School:

Designation:

Subjects taught:

Date:

Observation of:

Classroom Ethos

1. Did the class start on time?
2. Were there any posters/displays of science topics in the classroom?
3. Are the displays teacher or student produced?
4. How are students organized in the classroom: in groups, in pairs or singly?
5. Are there any rituals before commencement of the lessons?

Teaching and Learning

1. What was the objective of the lesson?
2. How did the teacher facilitate learning?
3. Was there teacher led discussion demonstration and explanation?
4. Were investigations teacher-initiated?
5. Did students copy notes from the blackboard?
6. Did the students have textbooks?
7. Did students carry out practicals following instructions provided?
8. Did the students ask questions?
9. Did the teacher praise or encourage the students?
10. Did the teacher ask questions about content and procedure?

Lesson Planning

1. Does the teacher have a lesson plan?
2. Did the plan include objectives and activities?
3. Was the plan followed?
4. What was the general classroom climate?
5. Did the teacher make any attempt to evaluate learning through questioning or pupil work?
6. What was student participation in the lesson?
7. How did the lesson conclude?

Additional Comments and Observations

APPENDIX R

The Semi-Structured Interview Schedule.

Name :

School:

Designation:

Subjects taught:

Date:

1. Can you tell me something about your educational background and work experience?
2. What are your feelings about science teaching before and after the war in Rwanda?
3. What are your general feelings about science teaching?
4. What are your feelings about students learning in science?
5. How important is it for you to cover the science curriculum? Explain.
6. Is it important for students to do well in examinations? Explain.
7. What influence do examinations have on your teaching?
8. Does the school have facilities or provide for teacher development activities?
9. What opportunities are there for you to pursue further studies?
10. Are there laboratories in the school?
11. If not, how do you perform practical lessons?
12. In your opinion, what are the major barriers in your school to student learning in science?
13. What do you see as the future of education in Rwanda?

Personnel from the Ministry of Education, National Examination Board, the Kigali Institute of Science and Technology and Kigali Institute of Education had questions similar to the ones written above, but further questions relevant to their context and position were asked.

The Director of the National Examinations Board was asked:

1. How are examination question papers developed in Rwanda?
2. Can you explain the marking process?
3. What are the subjects that are examined at the end of Years 6, 9 and 12?
4. When and how practicals would be assessed?

The Director of Secondary education was asked:

1. What was being done by the Ministry of Education to increase the access to secondary education?
2. How is the Ministry improving quality and quantity of science teachers?
3. Can you explain the process of building community schools in rural areas?

Personnel at the Kigali Institute of Education were asked:

1. How are science teachers being trained?
2. How are teachers being trained in practical science?
3. What is your opinion about the issue of bilingualism so that teachers can teach in both French and English?

APPENDIX S

An Example of a Transcribed English Interview with a Senior Education Personnel from the National Examination Board.

(E.A.EP.1.05.00)

This was an audiotaped English interview conducted by me. The Education Personnel was a very senior official in the National Examinations Board. He was a former high school teacher who had taught in a neighbouring English speaking country and had returned to Rwanda after the war.

Good Morning, thank you for making the time to see me. I would like to give you some background about my study. I will be asking you a few questions related to science education and the examination process in Rwanda.

1. What was the status of primary science teaching before the war in Rwanda?
Well, from records and meetings I have had during the harmonizing of the current curricula, there was no teaching of science at the primary level before the war. It was not easy to convince the commission of teachers designing the primary curriculum about the importance of teaching science at all levels.

2. Do you mean to say that science was not taught at the primary level before the war?
Yes, science was not taught at all. Schools and the Ministry of Education just concentrated on Mathematics and Languages, what you would call numeracy and literacy.

3. What is the process for National Examinations at the end Year 6 the final year of Primary School?
Around the 3rd. term of the academic year in June of each year the P6 (Year 6) students have to appear for a centralised exam in Mathematics and Languages. The examinations papers are prepared and distributed by this board. The results of these exams are used as a bench mark for promotion in to secondary school.

4. Currently you test only Mathematics and Languages at the end of the Primary years, is this likely to change in the near future?

Yes, I am very keen to see Sciences and Social Sciences introduced in the examinations. I have discussed this with the inspectorate and the school inspectors will talk to head teachers and teachers in schools. I am waiting for a response from them and am hoping to introduce the examinations of additional 2 subjects in June 2001.

5. What was the number of students who appeared for the P6 (Year 6) examinations in June 1999?

The number of students who appeared for the examinations last year was about 70,000.

6. What number then went onward to secondary school?

Currently, [this was in May 200] only 14,000 students get admission in to government schools, as there are insufficient government schools. An equal number or even slightly more gain admission into private schools, although accurate statistics are not available on the number of students who go to private school.

7. This means that more than 65% of the students are unable to go on the secondary schools?

Yes, many students are unable to go to secondary school and the Ministry of Education is aware of the problem. There are many reasons why students are not able to continue onwards into secondary schools.

- There are insufficient schools in the country
- Many students do not have the means to pay fees and some do not find sponsors.
- Due to the poverty of their situations they have to assist in helping their family.
- Many students are also traumatised and also find it difficult to cope with studies.
- Many girls are forced into early marriages and cannot continue their studies.
- Some girls are also heads of households and have the additional burden and responsibility of looking after their siblings.

8. From Year 7 (Senior 1) the first year of secondary school, science is taught as pure sciences (Physics Chemistry and Biology), at the time of preparing the science curriculum was there any discussion about integrating sciences at the lower secondary level?

No, there was no discussion about integrated sciences, infact there was an intense debate about teaching sciences at Senior 1 and 2 (i.e. Years 7 and 8). Many of the teachers were not even sure about teaching sciences at this level. Ultimately it was decided to have the pure sciences at 2 hours per week for each science. The commission of teachers designing the curriculum also felt it would be easier to teach pure sciences [separate sciences], so the concept of integrated sciences is new and has not been looked at all.

9. Could you tell me something about the examination at the end of Senior 3 (Year 9)? Are sciences going to be tested and is there a practical exam?

Since the schools re-opened after the genocide, there has not been a centralised national examination at the Senior 3 (Year 9) level. Each school conducted examinations within the school itself, there was no uniformity and quality control. From 2000, there will be a national examination at the end of Senior 9. Yes, all the sciences will be tested but there will only be a simple theory paper.

10. Are students tested for practical science at the National examinations held at the end of Senior 6 (Year 12)?

Even for the Senior 6 examinations, practical science is not tested. This is because teachers are not trained, confident and competent enough in teaching sciences and especially in conducting practicals; there are no laboratories in many schools and most school do not have resources or laboratory reagents or chemicals. It is not possible to assess students for science practicals. But in the Senior 6 science examination we include questions that have a practical orientation.

11. What is the Ministry of Education's stance on science teaching and learning?

The Ministry has acknowledged that it must accelerate the teaching of sciences. We are hoping by the start of the academic year 2001 to have 12 model science schools or centres. Each school will be located in a prefecture of Rwanda and through these schools teachers will be given competency in practical science skills.

At the primary level, the ministry is negotiating obtaining micro-science kits from South Africa which will be made available to all schools and teachers would be able to easily perform experiments in their classrooms.

12. Can you comment about the *Groupe Scolaire* schools and the catholic schools that have good laboratories and if these laboratories are used by students?

Yes, the *Groupe Scolaire* schools indeed have well-equipped laboratories. In some of the schools, the laboratories are effectively used but in some schools they cannot be used if the teachers are not confident and competent. Teachers do try to perform experiments but need more training.

13. Is the Ministry of Education trying to make science contextually relevant to the needs and realities of Rwanda?

The curriculum that was given to schools in September 1998 is only a draft and will be revised. I too feel that the science curriculum should be relevant to the situation and context of Rwanda, but the government has acknowledged the importance of science.

I would like to give the example of Korea, which was a developing country about 30 years ago. The government then decided to give incentives to students who learn science and to teachers who teach science. Special science schools were created. People were sensitised to learning science and the government made use of the resources available in the country like grass and bananas. Today Korea is an industrialised country whose per capita income has increased more than 10 fold due to this emphasis on science and technology.

14. What is your vision for the future of science education in Rwanda?

After the genocide when the Ministry of Education was re-started we had to start from scratch, it was a complete new beginning. The National Examination Council has taken off well. We have to study and take examples of our neighbour like Kenya or Uganda. I am confident that if we have the availability of funds in about five years we should be able to achieve our targets. We are also looking at the working of the examination boards in Cambridge and London. But the testing of practical science is a long way off and we will have to work very hard at training quality science teachers.

Thank you very much for your time and I wish you every success.

APPENDIX T

An Example of a Transcribed French Interview with a Senior Teacher at a Rural Government Secondary School.

(F.H.ST.S3.05.00)

This interview was conducted and transcribed by my interpreter. The interviewee was the deputy headmaster of a well-known rural government school that had students studying in the French and English streams.

1. Could you tell me something about your educational background?

I studied at the National University in Rwanda in the faculty of pedagogy and I completed the first cycle of studies at Nyakimana in Ruhegiri in Northwestern Rwanda.

2. Were you in the country during the war?

No, I left the country and went abroad and came back only after the genocide.

3. What are your feelings about science teaching?

I do not have a positive attitude towards science teaching because I feel that science is not always taught according to the realities and needs of Rwanda.

4. What about science teaching before the war?

Before the war science teaching depended on the qualification of the teachers and their motivation. Although there were a certain number of science teachers before the war, teaching was more theoretical.

5. What is your opinion about student learning in science?

Before the war, the ministry used to impose science on the student. It was compulsory and obligatory. The student's choice was not taken into consideration even at the senior secondary level. After the war I find that many students are afraid of learning science. Many of them fail because there is a scarcity of qualified teachers and textbooks. The girls particularly avoid learning science.

6. Is it important for the students to do well in examination? What is your position about this?
The students must master the material covered in the curriculum. Examinations are important but I am not sure if they are essential. The examinations help to evaluate the student's performances and understanding of the lessons. I also feel that examinations bring out the difficulties in the course and related to the course.
7. How important is it to cover the science curriculum?
It is good to cover the science curriculum but it is more important that the students learn and understand the material that is being taught.
8. What influence do examinations have on your teaching?
Examinations help the teachers to evaluate their own teaching and to make plans for the future. I feel that examinations should only be a reference point for further improvement but must not be the total aim of teaching.
9. What role do you have in providing teacher development activities for teachers in the school?
The majority of the teachers in the school work individually and are interested in only their subject areas I am more busy with administrative and discipline duties. Due to their work conditions and low wages many of the teachers are not motivated and are frustrated.
10. What opportunities are available for you to pursue further studies?
There are no opportunities since getting a scholarship is somehow a mystery. It does not depend on the choice, knowledge, capacity or capability of the candidate. I am not sure how the ministry grants scholarships. Before the war scholarship were not given and after the war I feel it is the same.
11. Are there laboratories in your school?
Yes, we are fortunate enough to have laboratories. Some schools have laboratories but in many schools there are no laboratories. But many teachers are not qualified enough and confident enough to perform practicals in schools.
12. What do you think are the major barriers to science learning in your school?
The major barriers are the lack of well-qualified science teachers, the lack of laboratory equipment and the students fear that they will fail at examinations.

13. What do you see as the future of education in Rwanda?

I am optimistic about the future of education in Rwanda. I feel solutions must be provided to a few problems faced the school system:

- Many school head teachers are not trained to run the schools
- I feel the field of education is neglected
- People are not so concerned about schools and education as survival is more important to the people in the rural areas.
- There must be greater co-operation between parents and schools
- Student discipline is the teacher's responsibility
- There are no resources in the school
- Teachers are poorly paid, not paid on time and are thus not motivated.

Thank you for your time and for allowing us to carry out this study in the school.

APPENDIX U

Photographs and corresponding Photo Essays

APPENDIX U1

A PRIMARY SCHOOL IN THE HILLS AROUND KIGALI

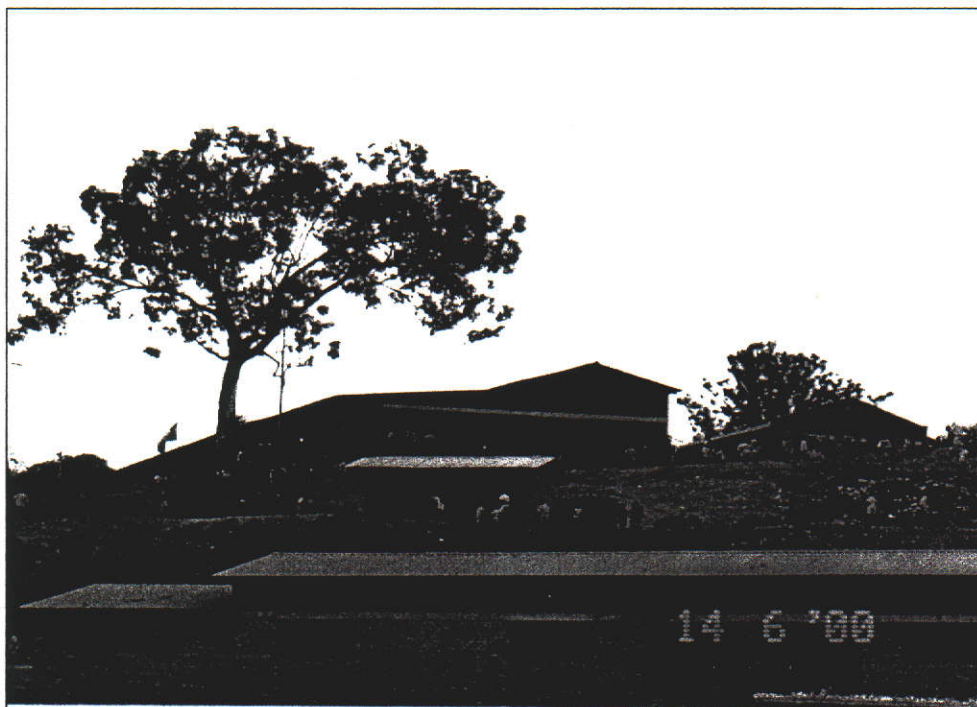


Photo Essay

The above photograph taken by me in June 2000 is of a primary school in Central Kigali. Most of Rwanda is made up of hills and valleys and this school is typical of a many primary schools in the country. The schools will usually consist of several single storied buildings. Many may not have doors or windows. There will usually be a block of pit latrines in the school compound as indicated in the small block between the top and lower block of classrooms.

Usually the school will not have a fence or play fields and there is no supervision of students during the lunch break. School starts at 8.00 am each morning with a long break for lunch and students then come back and stay at school until 5.00 pm.

Some schools operate only the morning session starting at 7.30 am and ending at 1.30 pm with only a small mid-morning break. This is because the school premises are used in the morning as a primary school and in the afternoon as a secondary school. Thus most schools in Rwanda operate only with basic infrastructure and resources and usually do not have access to water and electricity. Food prepared for teachers or students in the schools is usually cooked on wood or charcoal stoves. Most of the students at the government schools will not have footwear and will only have the basic books.

APPENDIX U2

A PRACTICAL SCIENCE LESSON IN A PRIMARY 5 CLASS IN A SCHOOL IN RURAL RWANDA



Photo Essay

The school I was visiting was a very poor Christian rural school and I was told that many of the students were orphans, had lost one parent in the genocide and had experience trauma. As seen in the photograph above were older than 10-11 years, some had had an interruption to their schooling due to the war and subsequent displacement.

The teacher carried out an extremely interesting practical lesson on floating and sinking and although there was an acute lack of resources in the school, she not only demonstrated but also involved the students in the lesson.

The students did not have desks and there were only benches to sit on. The students at first shy and quiet in my presence gradually opened up and began answering questions asked. The practical science lesson has been described in Chapter 5.

APPENDIX U3

A BIOLOGY PRACTICAL LESSON IN A SECONDARY SCHOOL IN RWANDA

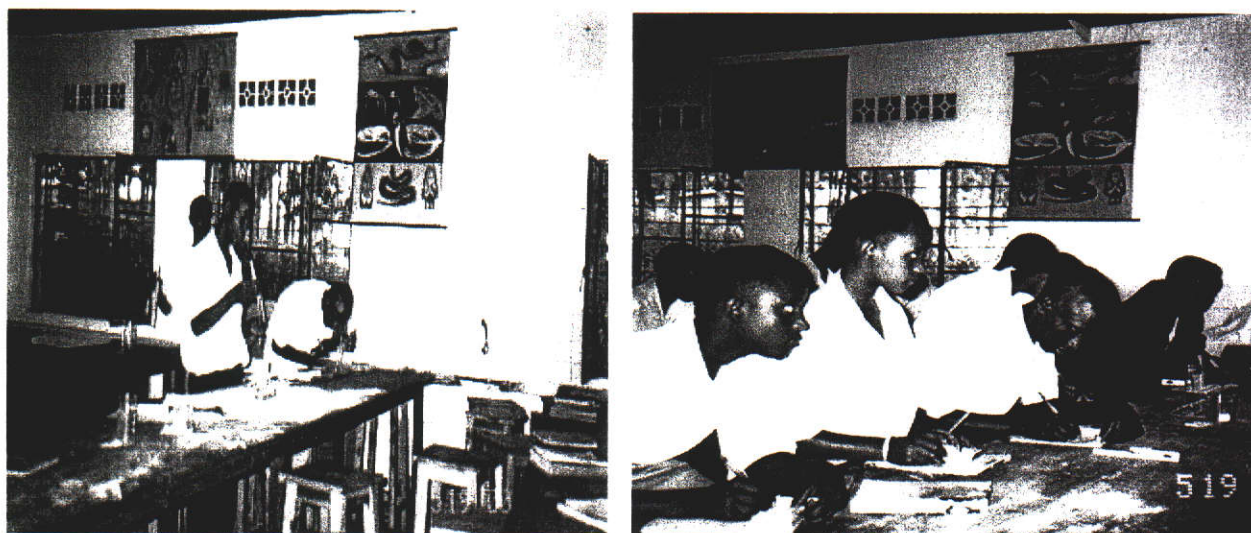


Photo Essay

I took the above photograph during the data collection phase in Rwanda. This laboratory was a well-equipped laboratory in a well-known rural government school and I observed a biology practical lesson conducted in the laboratory. This lesson has been described in detail in Chapter 5 on curriculum intention and implementation.

Year 9 students performed the experiment on food samples. The teacher gave instructions at the beginning of the lesson and most of the students were able to follow instructions and carry out the experiments. Although the laboratory had gas and water lines installed into the laboratory. There was no access to gas or water.

The students appeared well dressed in their uniforms and displayed a positive attitude to scientific enquiry. I had administered the student questionnaire to the students before the practical laboratory lesson. Results of the questionnaire have been included in the chapter 9

The well-equipped laboratory and infrastructure in this school indicated that there were indeed a few schools in Rwanda that had good infrastructure and were equipped with some resources. Many of these schools were either the catholic schools or the *Groupe Scholaire* schools that are well-known government high schools and admission to these schools is highly competitive.

APPENDIX U4

USE OF A PARAFFIN STOVE FOR A LABORATORY PRACTICAL LESSON IN A RURAL GOVERNMENT SECONDARY SCHOOL IN RWANDA



Photo Essay

The above picture was taken in May 2000 and is of the same practical biology lesson in the rural government secondary school. As mentioned in my note on the practical lesson, the laboratory did not have access to running water or gas or electricity.

The teacher had set up the paraffin stove at the front of the class near the teacher's desk. Students were expected to come to the front to heat up their sample. I noticed the students had access to laboratory coats and safety goggles although there weren't enough for all the students.

As seen on the blackboard the teacher had drawn out a table and the columns had procedure, observation and conclusion written. Students copied the table and the procedure listed in the table on the blackboard. Only after they had written the instructions from the blackboard did they start performing the experiment.

At times, I was nervous on seeing the paraffin stove and feared there might be an accident but the students were careful, not worried and were familiar with the set-up in the laboratory.

APPENDIX U5

HIV/AIDS EDUCATION IN RWANDA



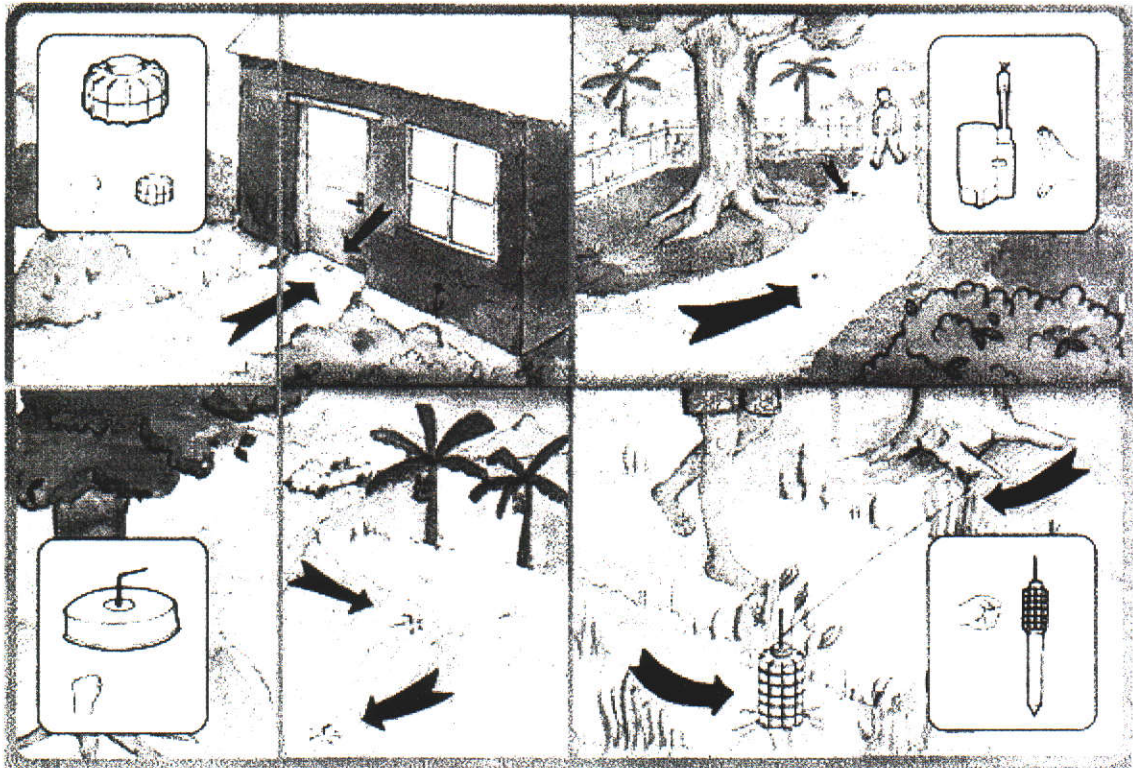
Photo Essay

According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), Rwanda is one of nine African countries most severely affected by the HIV/AIDS. At the end of 2001, an estimated 500,000 Rwandans were living with HIV/AIDS. AIDS is one of the three leading causes of death in Rwanda and officials in the Ministry of health were working in the spring of 2002 to develop a national strategic framework and a national sectoral plan for HIV/AIDS.

A recent report by the USAID states that people living in Rwandan refugee camps endured overcrowding, violence, poverty, despair-conditions, rape-inside and outside refugee camps and this has played a part in spreading HIV/AIDS in Rwanda. There are also high rates of mother-to-child transmission and this has led the Rwandan government to introduce prevention of mother-to-child transmission programs in a growing number of hospitals and health centres.

Immediate challenges to a community based HIV/AIDS program is the constant threat of violence, the daily struggle to subsist, the vulnerability of women and children, the illiteracy of the country's women and men. The above billboard displayed all over Rwanda is a warning to the people of Rwanda. It reads that the inhabitants of Rwanda must realise that AIDS is on the doorstep, there is no way out and AIDS is affecting the people of Rwanda.

APPENDIX U6

MINE AWARENESS POSTER

Photo Essay

The above poster is a 100 cm x 65 cm colour poster showing possible locations and signs where mines could be hidden. Made by UNESCO-PEER and UNICEF-RWANDA, this poster has been distributed during the emergency education phase and teachers were trained in using the poster in the refugee camps.

One of sad legacies of war and destruction is that the armies both rebel and government plant landmines all around the country. This legacy continues long after the war has ended and statistics from most post-conflict countries indicates that land mines pose an extreme post-conflict danger. Thus the UNESCO and UNICEF along with the governments in the post-conflict countries have focussed on mine-awareness education targeting the most significantly affected groups, using a non-formal methodology aimed at schools and young people in the community.

Children are the most unprotected victims of landmines. Their natural curiosity and love of play in open areas leaves them highly vulnerable to landmines. In Rwanda, the UNICEF, UNESCO and UNHCR jointly introduced a mine awareness campaign with an instructional package for teachers, a video for public education and a road show.

APPENDIX U7

THE ENDANGERED MOUNTAIN GORILLA OF RWANDA



Photo Essay

The mountain gorillas live in the Virunga Volcano mountains, which are spread across the borders between Rwanda, the Democratic Republic of the Congo, and Uganda. The forests where the mountain gorillas live are often cloudy, misty and cold. Typically, mountain gorillas live in groups that contain one or two adult males (called silverbacks), several younger males (called blackbacks), adult females, and infants. The dominant silverback (so named for the gleaming silver saddle of hair on his back) is in charge of the group's daily travels in search of food, and mediates conflicts within the group. The silverback also protects the group from outside dangers, such as intruding silverbacks from other groups, poachers, and other animals.

Mountain gorillas can communicate in a variety of ways, including facial expressions, sounds, postures and gestures. One of the nicest sounds is heard when the group is resting after a period of feeding. This sound is something like a soft purring and is called a "belch vocalization." When the gorillas feel threatened, they can make a variety of loud sounds, like roars or screams. Facial expressions are also used for communication. And, of course, there's the classic chest beating by male gorillas, which is used to show stature, scare off opponents or even to prevent a fight.

When Dian Fossey started observing the mountain gorillas in the late 1960s and established the Dian Fossey International Gorilla Fund, she estimated there were about 250 mountain gorillas in the Virungas. Today it is estimated that there are about 355 mountain gorillas. The future of the gorillas is most dependent on the protection and survival of the forests in which they live, but the forests are often in danger from growing human populations, and from ongoing civil war in the region.

APPENDIX V

Subject Time Allocation

Maths-Physics Option

Specific Subjects	4 th Form (Year 10)	5 th Form (Year 11)	6 th Form (Year 12)
Maths	8	8	10
Physics	6	6	8
Chemistry	3	3	3
Geography	2	2	2
Biology	2	2	-
Scientific Drawing	-	3	3
General Subjects			
French	3	2	2
English	3	2	2
Political Education	2	1	1
Religion/Ethics	1	1	1
Sport and Physical Education	1	1	1
Kinyarwanda	2	2	-
Total: 12 Subjects	33	33	33

Biology-Chemistry Option

Specific Subjects	4 th Form (Year 10)	5 th Form (Year 11)	6 th Form (Year 12)
Biology	6	7	8
Chemistry	6	7	8
Maths	4	5	5
Physics	3	3	3
Geography	2	2	2
General Subjects			
French	3	2	2
English	3	2	2
Kinyarwanda	2	2	-
Religion/Ethics	1	1	1
Political Education	2	1	1
Sport and Physical Education	1	1	1
Total: 12 Subjects	33	33	33

APPENDIX W

Higher Secondary Curriculum

Types of Teaching	Options
General Secondary Education	Science sections Maths/Physics Biology/Chemistry Latin/Sciences
	Literary sections Literature Latin and Modern Languages Greco-latin
Teacher Training Sections	Primary Teacher Training D ₆ Primary Teacher Training A ₃ (D ₄) Technical Teacher Training D ₆ (for girls) Technical Teacher Training D ₆ (for boys) Fine Arts Teacher Training A ₃
Vocational Training Sections	Agriculture A ₂ Agriculture A ₃ Rural Engineering A ₂ Social Actions A ₂ Socio-economic Action for the Youth A ₃ Economics A ₂ Commerce and Accounting A ₂ Law and Administration A ₂ Secretariat A ₂ Secretariat Accounting A ₃ Nursing A ₂ Nursing A ₃ Lab Technicians A ₃ Nutrition and Dietetics A ₂ Hostelry and Tourism A ₃ Hygiene and Sanitations A ₂
Technical Training Sections	Electricity A ₂ Electricity A ₃ Electromechanics A ₂ Electronics A ₂ General Mechanics A ₃ Automobile Mechanics A ₃ Public Works and Building A ₂ Building A ₃ Plumbing and Welding A ₃ Wood Work Heavy Machines and Lorries A ₂
Artistical Training Sections	Technical Drawing A ₃ Sculpture A ₃ Graphical Arts A ₃

APPENDIX X

**Student Profile as Specified by Science Curriculum Documents of the
Ministry of Education**

Note: For copyright reasons Appendix X has not been reproduced.

**(Co-ordinator, ADT Program (Bibliographic Services), Curtin University of
Technology, 21/11/03)**

APPENDIX Y

Results of the Science Teachers Efficacy Beliefs Instrument (STEBI) for French and English Teachers

Table 25: Factor Loadings for the Science Teacher Efficacy Belief Instrument for French Teachers (n=30)

Item No	Factor Loadings	
	Self-Efficacy	Outcome Expectancy
1	.59	
2	.30	
3	.42	
4	.83	
5	.60	
6	.74	
7		.30
8		.66
9		.80
10		.84
11		.47

To establish that each scale has satisfactory internal consistency, or that each item in a scale assesses a common construct, Cronbach's alpha coefficient was calculated for the two teacher beliefs scales. The internal consistency was 0.52 for the self-efficacy scale and 0.62 for the outcome expectancy scale (See Table 26). The average item mean and the mean standard deviation for the two scales of the modified Science Teachers Efficacy Beliefs instrument are shown in Table 26.

Table 26 Internal Consistency Reliability (Cronbach Alpha Coefficient), Mean and Standard Deviation with respect to the scales for the French Teacher Beliefs instrument (n=30)

Teacher Beliefs scale	No. of Items	Alpha Reliability	Mean	Standard deviation
Self-Efficacy	6	0.52	3.29	0.52
Outcome Expectancy	5	0.62	2.36	0.65

Table 27: Factor Loadings for the Science Teacher Efficacy Belief Instrument for English Teachers (n=95)

Item No	Factor Loadings	
	Self-Efficacy	Outcome Expectancy
1	.64	
2	.74	
3	.55	
4	.58	
5	.45	
6	.58	
7		.57
8		.36
9		.78
10		.60
11		.65

The internal consistency was 0.63 for the self-efficacy scale and 0.55 for the outcome expectancy scale (See Table 28). The average item mean and the standard deviation for the two scales of the modified Science Teachers Efficacy Beliefs instrument are shown in Table 28.

Table 28 Internal Consistency Reliability (Cronbach Alpha Coefficient), Mean and Standard Deviation with respect to the scales for the Teacher Beliefs instrument (n=95)

Teacher Beliefs Scale	No. of Items	Alpha Reliability	Mean	Standard deviation
Self-Efficacy	6	0.55	3.89	0.61
Outcome Expectancy	5	0.63	2.26	0.67

APPENDIX Z

Results of the Test of Science Related Attitudes Instrument (TOSRA) for French and English Students

Table 29 Factor Loadings for the Test of Science-Related Attitudes for French Students (n=142)

Item No	Factor Loadings	
	Enjoyment of Science Lessons	Attitude to Scientific Enquiry
1	.63	
2	.65	
3	.53	
4	.53	
5	.36	
6		.55
7		.52
8		.48
9		.56
10		.74

To establish that each scale has satisfactory internal consistency, or that each item in a scale assesses a common construct, Cronbach's alpha coefficient was calculated for the two Student Science-Related Attitude Scales. The internal consistency of each of the scales was 0.42 for the Enjoyment to Science Lessons Scale and 0.53 for the Attitude to Scientific Enquiry scale (See Table 30). The average item mean and the standard deviation for the two scales of the modified Test of Science Related Attitudes instrument are shown in Table 30.

Table 30: Internal Consistency Reliability (Cronbach Alpha Coefficient), Mean and Standard Deviation with respect to the scales for the Test of Science Related Attitudes instrument for French Students (n=142)

Test of Science Related Attitudes Scales	No. of Items	Alpha Reliability	Mean	Standard deviation
Enjoyment of Science Lessons	5	0.42	1.74	0.50
Attitude to Scientific Enquiry	5	0.53	2.29	0.74

Table 31 Factor Loadings for the Test of Science-Related Attitudes for English Students (n=332)

Item No	Factor Loadings	
	Enjoyment of Science Lessons	Attitude to Scientific Enquiry
1	.60	
2	.70	
3	.76	
4	.70	
5	.73	
6		.54
7		.62
8		.57
9		.73
10		.66

To establish that each item in a scale assesses a common construct, Cronbach's alpha coefficient was calculated for the two Student Science-Related Attitude Scales for English students. The internal consistency of each of the scales was 0.75 for the Enjoyment to Science Lessons Scale and 0.63 for the Attitude to Scientific Enquiry scale (See Table 32). The average item mean and the standard deviation for the two scales of the modified Test of Science Related Attitudes instrument are shown in Table 32.

Table 32: Internal Consistency Reliability (Cronbach Alpha Coefficient), Mean and Standard Deviation with respect to the scales for the Test of Science Related Attitudes Instrument for English Students (n=332)

Test of Science Related Attitudes Scales	No. of Items	Alpha Reliability	Mean	Standard deviation
Enjoyment of Science Lessons	5	0.75	2.03	0.81
Attitude to Scientific Enquiry	5	0.63	2.76	0.87