Voices from the Classroom: Teachers' and Students' Perceptions and Experiences on Science Education Reform in a Transitional Society

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Abstract

Rwanda is a society in transition, which has been adversely, affected by major social, political, economic, cultural and ethnic upheaval and is one of the world's poorest countries. Rwanda has now adopted national goals of eradication of illiteracy, national capacity building in science and technology and reinforcing the teaching of mathematics and sciences. This study utilized quantitative and qualitative methods to examine how teachers' and students perceptions and experiences impact upon the ongoing education reform process within a transitional society. Interviews with teachers, students and administrators are used to describe and analyse their views and experiences during a period of turmoil. Caselets of teacher and student experiences and critical reflection by the researcher provide a dramatic insight into the lives of Rwandans. This paper forms part of a larger study and has made use of teachers' knowledge and experiences to examine the effect of socio-cultural, economic and political factors on the lives of teachers in a transitional society. The findings identified factors, which influence the education rebuilding and reform process in a volatile transitional society.

Objectives of the study

The objective of this study is to describe, discuss and analyse information on the status of the current science education in Rwanda, from the perspective of primary and secondary science teachers and the first author's observations and analysis. In the larger study, of which this is a part, data were also collected from primary and secondary students.

The study 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. 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 education research .

This paper focussed on one major research question:

How do teachers' and students knowledge and experiences impact upon science education reform in Rwanda, a transitional society?

Significance

A review of related literature shows that 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 of financial aid. It is expected that the study will 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 Rwanda. This study pioneered the use of an instrument in a non-western country, where English and French are the languages of instruction, but not the students' or teachers' first languages.

Context of the study

Personal background of the first author

The study examined the science education reform process in the transitional Rwandan society and economy with its complex cultural, historical and educational background. To enable an interpretation of the quantitative data from questionnaires in a meaningful manner in Rwanda, the socio-cultural, gender and ethnic perspectives of policy makers, teachers and students were examined. Of particular interest was the first author's personal experience in her challenge to understand the reform process in science in Rwanda, a country with a shattered economic, social and political fabric where she had worked for two years as a school principal. She has lived and worked in four different developing countries of the world and brought with her the experiences of having lived in these countries. She recently spent 9 weeks gathering data in Rwanda for the purpose of this study. During this period, she spent many hours in deep discussion with her interpreter, a refugee teacher himself who was a survivor of the 1994 genocide and had experienced the war firsthand. He went to great lengths to assist her in her understanding of the pain and helplessness of the Rwandese during the wars.

Background Variables to the Research in Rwanda

As one of the world's poorest countries, Rwanda is 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 . The major background variables to the study are as follows:

Social Indicators*:* The war and genocide in 1994 killed as many as one million people and almost half of a population of 7.7 million people was displaced. It paralysed the country's socio-economic infrastructure and disrupted cultural values. Nearly 53% of the population is illiterate and the secondary school enrolment rate is 20% .

Population and Ethnicity*:* The population of Rwanda is 94% rural. Three ethnic groups make up the population: the Hutu (90%); the Tutsi (9%); the Twa (1%), a pygmoid people.

The official languages are Kinyarwanda (a Bantu language) and French. 75% of the population is Christian, 9% Muslim and 17% follow traditional religions.

***Gende**r:* Women constitute 54% of the total population and 34% of the households are female-headed. The government and the UN is ensuring that women are fully involved in the development process and are being enskilled through income generating and capacity building activities. It is a known fact that the poorer households are female or child-headed .

***Ethnicity and Education**:* In Rwanda, the Ministry of Education and the Ministry of Reconciliation are trying to ensure that majority and ethnic minorities are involved in the reform process.

***Education**:* It is within this context that education is expected to play an important role in social reconciliation, reconstruction and economic development. Rwanda has now adopted the following national goals - eradication of illiteracy, universal primary education, teacher training, national capacity building in science and technology and reinforcing the teaching of mathematics and sciences .

The Ministry of Education in Rwanda: The current government in Rwanda regards science as a national project for the achievement of national development. The Ministry of Education is focussing on the expansion of equitable access to education, the improvement of the relevance and the quality of education and the development of capacities for the effective delivery of education. Education is the only factor that is likely to support the sustained modernization and diversification of systems of production in developing countries. The role of education in re-establishing and training human resources required for socio-economic development, promoting peace and tolerance is well known. The education reform must embody ethnic assimilation, the recognition of multiculturalism, cultural differences and a safeguarding of linguistic and cultural identity . This is crucial in the Rwandan context where ethnicity played a part in the 1994 genocide. The Ministry of Education in Rwanda came up with a comprehensive plan for the complete restructuring and re-organising of the education system with the help of the UNDP and UNESCO in 1998 and is trying to implement the plan of action and strategies laid out in the policy document. Currently, the Ministry has to work with inadequate material and human resources that greatly affect the access and quality of the delivery of the science curriculum .

Theoretical Underpinnings

Science Education and the Developing World

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. An education in science should enhance developing countries capacity to find ways to provide crucial essential services that are environmentally sound, socially equitable and economically affordable . Earlier, noted that school science education in underdeveloped societies should direct its efforts more at meeting the basic needs such as clean water, health and sanitation, nutrition and environmental issues. The challenge lies in improving the quality of education in mathematics, sciences, technology and incorporating the potential development-related functions of science education in rapidly evolving transitional societies. In this way enhanced rural subsistence-based activities can equip 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 . Oginniyi (1986) adopted a similar development-oriented approach, stating that

> The needs of different cultures and economies are not the same…….some topics are more relevant to the African setting than many topics that feature in the science curricula of industrialised nations (p. 119).

Science Education and National Development

Science and technology education leads to a scientifically and technically skilled labour force and such skilled personnel enable economic progress in low developing countries . Science education plays an important role in economic development. Science and technology have often 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 . 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 science and technology education (Kothari, 1970 p.16). The leaders in Rwanda have realised this and are trying to ensure that an education in science facilitates development, environmental sustainability and enables the young to change, transform and work collectively to create a better future.

Theoretical and Conceptual framework for the study

A case study is both a process of enquiry about the case and the product of that enquiry. It may be simple or complex. As a case researcher, the first author sought what is common and particular about the case and portrayed something of the uncommon and this particular study drew elements from the following; the nature of the case, the historical background, the physical setting, other contexts through which the case is recognized.

In the context of Rwanda, the study was an enquiry into a complex society. A case study like research of all kinds has a conceptual structure organized around a small number of research questions. These may be information questions, questions on issues or revolving round themes. Issues in Rwanda were complex and invited attention to varied experiences and also drew attention to related common disciplines of knowledge such as science education, historical research and education reform.

As the study progressed, the study began to involve a more interpretative approach that included the combination of multiple research methods including critical reflexivity. The critical theory perspective implies that reality is shaped over time by social, political, cultural, ethnic and gender factors (Guba & Lincoln, 1994). This case is true of Rwanda where all these factors have shaped the destiny of this tiny, land-locked Central African nation.

This case study was both qualitative and quantitative and analysed four common commitments by bringing expert knowledge to bear upon the phenomena studied, studying relevant data, examining rival interpretations and probing the degree to which the findings have implications elsewhere. Research into socio-cultural, ethnic, gender and economic aspects makes an important contribution to the field of science education as, firstly, the sample usually provides greater variation in teaching methods, student attitudes, school and classroom environments.

During the progress of the present study, the researcher became aware of the importance of examining social and cultural factors that influence the learning environment in each country. Culturally sensitive methods of data collecting such as in-depth interviews, narratives written by the researcher and classroom observations, that would take into account social action

that is "locally distinct and situationally contingent" (Erickson, 1998, p.1155) were used. This study thus looked at education reconstruction and reform from a number of perspectives: studying the historical aspect, the current political situation, the socio-economic factors and the emerging trends in human development.

Research Design and Procedures

The culturally sensitive nature of the present study led to a multi-method approach to allow triangulation of the methods and cross validation of the data. The data collected using the different methodologies complemented each other and together formed a more coherent and complete picture (Denzin & Lincoln, 2000). Quantitative and qualitative methods were used to identify constraints in the implementation of education policies in Rwanda. The approaches were combined in order to provide an in-depth general picture.

The quantitative approach conceptualised reality in terms of selected variables and the relationship between them, rested on measurement and the pre-structuring of data. The qualitative approach dealt more with the case in hand and was sensitive to the context, the process and the lived experience . In this study, a survey questionnaire was administered to teachers and students and interviews, classroom observations, study of historical documents and personal reflections were the qualitative instruments used to back the results of the quantitative survey. The present case study contains interpretative and ethnographic analysis from multiple research methods.

***Quantitative Data**:* A quantitative probe was used to provide an overview of the science education reform in Rwanda. The first author developed, adapted amd modified from existing instruments, separate questionnaires for students and teachers. This paper deals with the questionnaire administered to teachers. The English version of the questionnaire was translated into French by a bilingual teacher and then back translated by an independent third party. The back translations were checked by two French teachers who were also bilingual, to ensure that the French version maintained the original meanings and concepts in the original English version. The back translation ensured that the French version maintained the original meanings and concepts in the original English version .

The Schools

In all 12 schools were used in this case study. The schools were government and private, single sex and co-educational schools. They were urban, semi-urban and rural schools and displayed a conflicting mixture in terms of resource adequacy, infrastructure, governance, student make-up, the quality and qualification of teachers and the remuneration offered to teachers.

The Teacher questionnaire

English and French versions of the combined questionnaire were administered to 125 English and French teachers in twelve different schools in rural, semi-urban and urban Rwanda. The teacher questionnaire was made up of four parts, three of which have been documented in this paper.

Part A of the questionnaire contained 10 questions designed to elicit basic background information from the participants.

Part B included 17 statements on stated development-related functions of science education, these questions were a modified version of a similar questionnaire used by Vlaardingerbroek, (1998) in Botswana. Examples of the statements used in the instrument

are: does the new science curriculum promote the avoidance of drugs and HIV, does it equip young people with skills to be self-employed, and does it promote rural development.

Part C was a modified version of the School-Level Environment Questionnaire (SLEQ) developed by Fisher & Fraser (1983) was used to assess four dimensions of the school environment: affiliation which assesses the advice, encouragement, and acceptance teachers receive from their colleagues; staff freedom which assesses teacher freedom to set rules and guidelines and ensure rule compliance; resource adequacy which assesses adequacy of facilities, support and equipment and work pressure which assesses the extent to which pressure dominates the school environment.

The student questionnaire

The student questionnaire contained 70 items. It was administered to 500 French and English students in 12 different schools from class 6 to class 12.

Interviews

Interviews with teachers, senior education personnel and head teachers provided a better understanding of the system in existence. The interviews ranged from unstructured to semi-structured, depending largely on the situation and covered a number of areas including feelings about science teaching, the curriculum, examinations, professional development activities and their feelings about the future of the education system in Rwanda.

Classroom Observations

Non-participant observation of five theoretical and practical science lessons in four different schools gave deep insight into teaching practices and methodology in Rwanda. Most of the teachers were known to the first researcher and were willing to be involved in the study. As the observations were made in normal classroom settings, it was possible to sample both likely and unlikely classroom occurrences. It was possible to use classroom observations, interviews with participants and researcher's stories to capture a richer interpretation of science education reconstruction in Rwanda .

Results

The results are presented below in four different sections: analysis of descriptive data, analysis of the development aspects of the science curriculum, analysis of statistics from the modified School Level Environment Questionnaire (SLEQ) and analysis of the modified Test of Science Related Attitudes (TOSRA). Quotes from interviews and classroom observations have been interwoven into the results of the analysis from the quantitative data.

Descriptive Data (from part A of questionnaire data):

Analysis of the items dealing with teacher age gave teacher profiles that indicated the majority of the teachers in Rwanda were below 30 years of age. A sizeable proportion of teachers have been killed in the genocide. Immediately after the war the percentage of qualified teachers fell from 60% to 33% (See figure 1)

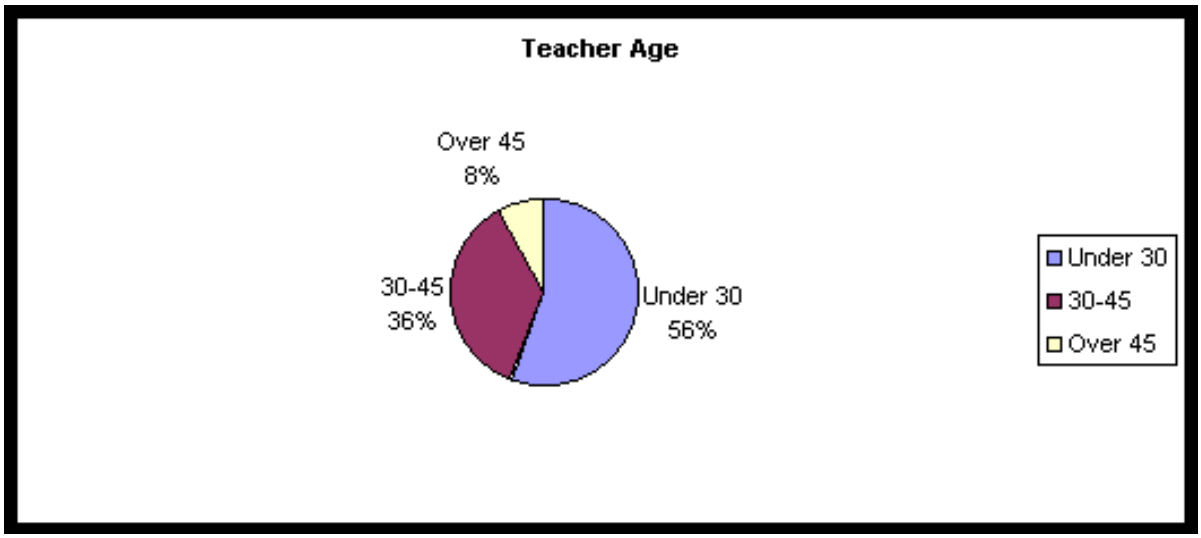

Figure 1: Teacher age

Analysis of items dealing with the qualifications showed (See figure 2) that only 18% of the teachers had a bachelor's degree and 3% a master's degree. A high percentage of teachers are poorly qualified and have limited content knowledge. The first author's personal experience and 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.

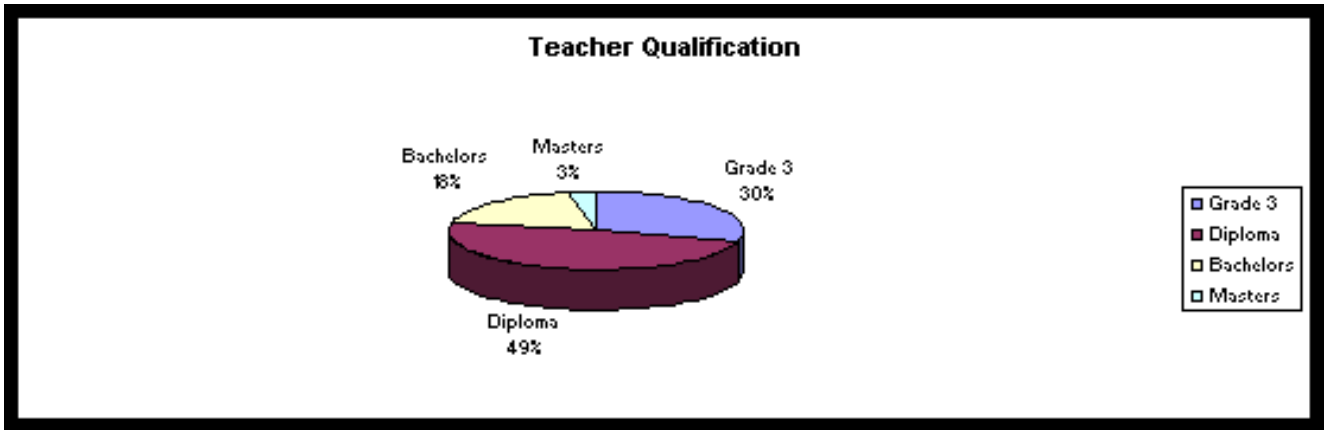

Figure 2 Teacher qualifications in Rwanda.

Another interesting feature was the years of employment of Rwandan teachers used in the sample (see figure 3). 41% of the teachers had only 0 to 5 years of employment, 29% 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%. The genocide of 1994 has had a drastic effect on the number of teachers. Many teachers were killed and many fled the country after the war.

After the genocide the proportion of qualified teachers fell from 60% to 33%. 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 per class and most of the teachers have only completed secondary education .

The relatively new teachers are those who returned; some are very young and have trained in the neighbouring English speaking countries, others are older teachers who have had

many years of teaching experience as classroom or subject teachers and have suddenly found themselves in positions of power.

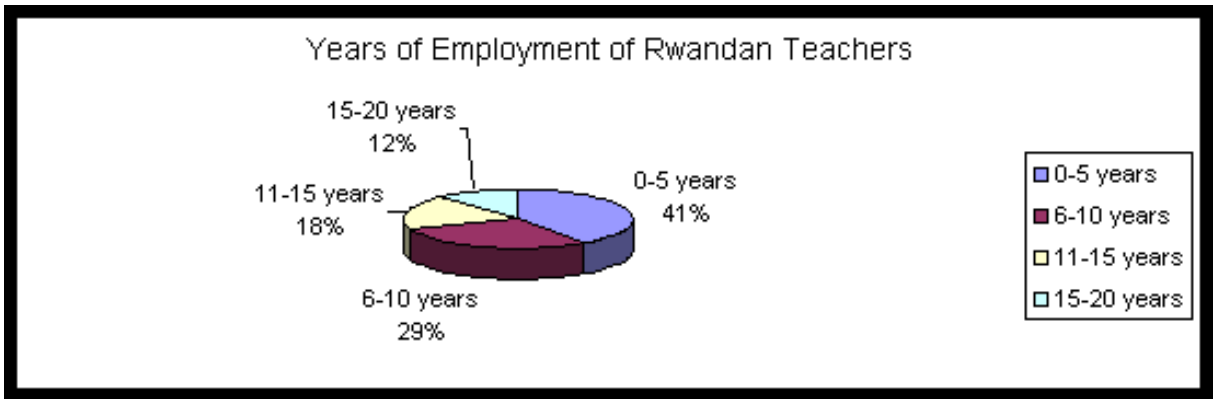

Figure 3: Years of Employment of Rwandan Teachers used in the Study

In-Service Professional Development of Teachers in Rwanda: Of the teachers who answered the survey 43.9% were primary school teachers and 56.1% were specialist secondary teachers. 56% of the teachers had had no in-service professional development in the last 10 years and 44% felt that they had some kind of professional development. Most of the professional development was restricted to professional meetings and some workshops or seminars. Rwanda just did not have the capacity in terms of human, material and financial resources to conduct Professional Development for its in-service teachers. 65.9% of the teachers felt that they get no support for professional development with only 26.8% saying that they have had time off from teaching. A dedicated, returnee teacher supports the inadequacy of the professional development through this interview quote:

> *When the new curriculum was implemented in September 1998, commune inspectors were expected to train teachers. They tried to do so but were themselves limited in skills, qualifications and resources. The professional development exercise was not very effective. We are expected to change teaching methods, this is impossible with large classes and the pressure of exams.*

Developmental Aspects of the Science Curriculum (part B of the questionnaire):

In 1998, a reform questionnaire was administered to teachers and students in Botswana to measure to what extent stated development-related functions of science education had been incorporated into the new curriculum (Vlaardingerbroek, 1998). A revised version of the questionnaire was administered to 125 teachers in Rwanda. Analysis of the data established that science teachers viewed that development-related functions of science education had been incorporated into the new curriculum. 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, and also involving 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).

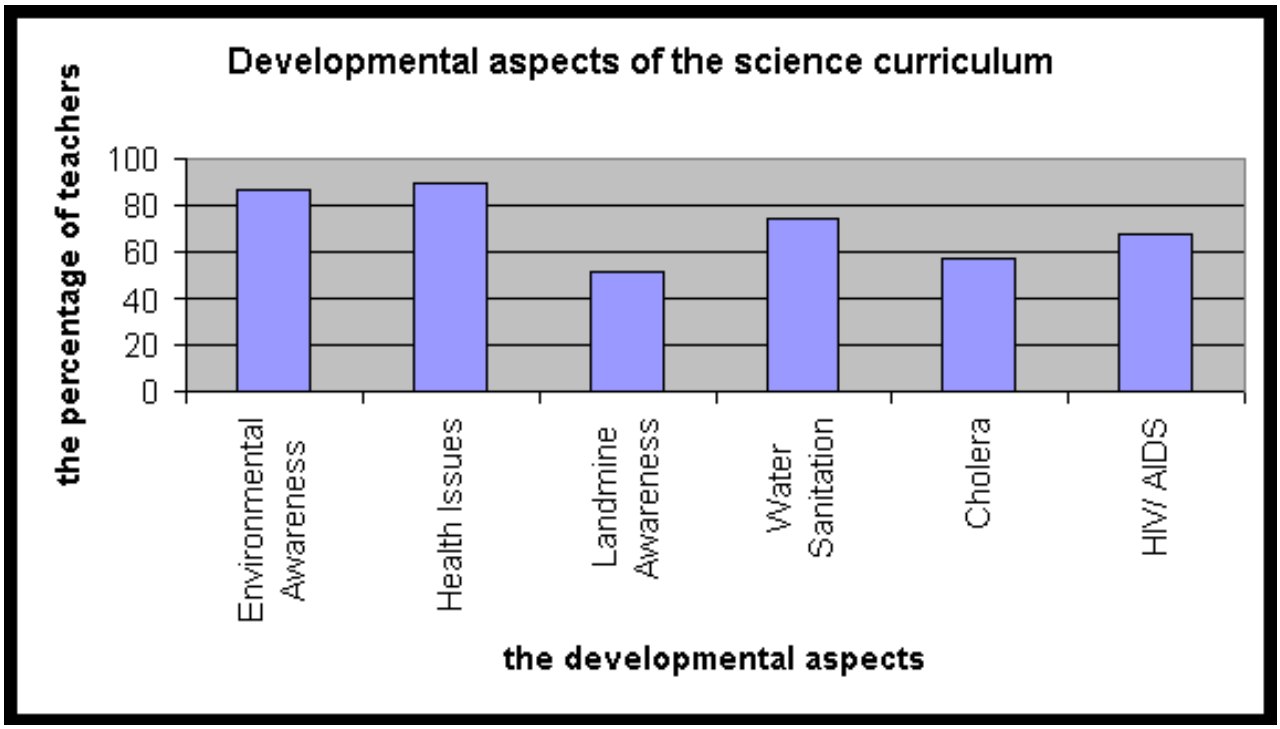

Figure 4 Developmental aspects of the new curriculum and teachers' perceptions of their incorporation into the new curriculum.

An extremely dedicated refugee returnee teacher had this to say about the primary science curriculum implemented in schools:

> *The Ministry of Education should give more importance to the teaching and learning Science. Many primary schools are not interested in giving importance to Science because it is not examined at the Year 6 National Examination. Although Science is a practical subject it is taught in a theoretical manner. Schools do not have the equipment or the means. Science can and must be taught in a manner that is relevant to us as Rwandese.*

An expatriate, highly qualified science teacher in an elitist urban school tries to make sense of the detail in the curriculum:

> *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 what is relevant to the exams.*

Analysis of the data generated statistics, which were used to investigate the reliability and validity, the factor structure, the internal consistency reliability and the discriminant validity.

The School-Level Environment Questionnaire (part C of the questionnaire)

A modified version of the SLEQ (School-Level Environment Questionnaire) 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 showed nearly all items having a factor loading of at least .30 on their *a priori* scale and no other scale (see Table 1). The factor loadings for the four scales- affiliation, staff freedom, resource adequacy and work pressure, indicate that each factor loaded into its scale and no other when correlations below 0.3 were discounted (see Table 1).

Table 1 Factor Loadings for the School Level Environment Questionnaire

		Factor Loadings		
Item No	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 assesses 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 co-relation ranging from .10 to .21 for the four scales affiliation, staff freedom, resource adequacy and work pressure (see Table 2). There was some overlap between the mean correlations but generally each scale measured a unique aspect of the school environment.

Table 2 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 are shown in Table 3. Responses indicate that teachers perceive a limited amount of work pressure, a lack of resources, affiliation between staff members and a great deal of staff freedom. The level of work pressure often varied from type of school and was often high in the private schools where teacher salaries were also higher. The competitive nature of the examination-driven curriculum, places enormous pressure on both the teacher and the student and fosters a teacher-centred classroom. There is constant pressure to maintain high achievement

scores, improve position of schools in national examinations and a constant need to improve student test results.

Two teachers who teach sciences for the national examination class expressed that the entire focus was the national exams and the student performance at the exams:

> *I teach so that my students do well in the exams and it is important that students 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. As the exams draw nearer we are expected to even come on Saturdays, Sundays and even during the holidays and this puts a lot of pressure on me, and the student' as we do not have a break at all.*

Most schools in Rwanda lack resources and in some instances have equipped laboratories donated by aid organisations that are often not used or used ineffectively. Textbooks are in acute shortage in the whole country and are not yet published in Rwanda. The study highlighted the acute need for significant improvement in water and sanitation facilities in most schools. Many schools had no toilets or latrines within the school and many had pit latrines outdoors. This structural damage caused teachers to teach in difficult circumstances and the learning process is difficult for many students especially in rural schools. A school principal in a small, rural Christian boarding school is struggling to improve infrastructure in his school and although not very optimistic, hopes for the best under difficult circumstances,

> *I just have the minimal basics in terms of structure. I need more latrines, water and desks for the school. We desperately need resources of every kind. Resources mean funds and these are slow in coming.*

Table 3: Mean and Standard Deviation with respect to the scales for the 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

Measure of Science-Related Attitudes among School Students

Two Scales of the Test of Science-Related Attitudes were administered in Rwanda to 500 Rwanda students between Year 6 and Year 12. The two attitudes measured were Enjoyment of Science Lessons and Attitude to Scientific Enquiry. Statistical analysis was performed on this data in order to identify certain items, which could be deleted, and to enhance the overall scale characteristics. For each refined scale the mean, standard deviation, reliability, and scale inter correlation for each of the scales was calculated. 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

showed nearly all items having a factor loading of at least .30 on their *a priori* scale and no other scale (see Table 4). The factor loadings for the two scales- Enjoyment of Science Lessons and Attitude to Scientific Enquiry indicated that each factor loaded into its scale and no other when correlations below 0.3 were discounted.

Table 4: Factor Loadings for the Test of Science-Related Attitudes

	Factor	Loadings
Item No	Enjoyment of Science Lessons	Attitude towards Scientific Enquiry
1	.504	
2	.565	
3	.640	
4	.525	
5	.537	
6		.420
7		.500
8		.361
9		.630
10		.532
%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 2 Student Science-Related Attitude Scales. The internal consistency of each of the scales was 0.71 for the Enjoyment towards Science Lessons Scale and 0.63 for the Attitude to Scientific Enquiry scale. The average item mean and the standard deviation for each scale indicated that Rwandan students enjoyed science lessons and had a positive attitude towards scientific enquiry inspite of the limitations and difficulties in the system. But the whole process of learning science is didactic and teacher centred with emphasis on set examinations. Teaching of science is often related to the exams the students are going to appear for and students felt that they were able to approach teachers with questions or difficulties they were experiencing. Laboratory practicals are compulsory according to the Rwandan curriculum but in many schools they are often limited due to lack of time, resources, water and electricity. Students also enjoyed investigations when they had practical lessons inspite of the limitations.

Table 9: Mean and Standard Deviation with respect to the Scales for Science-Related Attitudes.

Scale	Mean	Standard Deviation
Enjoyment of Science Lessons	4.050	0.74
Attitude to Scientific Enquiry	3.376	0.86

N.B.- The average item mean is the mean of each scale divided by the number of items

Class Observations

Observations of sciences classes indicated that the teachers were able to teach science effectively and often did so in the difficult circumstances they worked under. In Rwanda, the teacher is required to keep the students interested and attentive. Students are passive learners. There is no room for manoeuvring or investigating a variety of materials or assimilation of new information by either the teacher or student. Students have respect for the teacher, they were quick to get ready for a lesson and the teacher was rarely interrupted and there was no distraction of fellow students. The teacher's knowledge, the teaching methods or the content knowledge were never questioned. Many a time even if they had difficulty in understanding the content they would rarely ask the teacher. They had respect for the ability of the teacher. Respect was reflected and demonstrated through classroom behaviour and interactions between the students and their teacher.

Teachers are trying to do their best under the existing conditions in Rwanda. They write definitions of concepts and re-draw illustrations from the textbooks on the blackboard. Pupils replicate these in their notebooks. School examinations are organised at commune level in Rwanda and also mainly control and stimulate the development of memorisation skills in pupils. There is constant pressure to maintain high achievement scores, improve position of schools in national examinations and a constant need to improve student test results. Success was identified with goal achievement and performance in school. Students exam results were most important, so that students could go for higher education and hence the competitive nature of the examinations. This encouraged teachers to concentrating on developing the academic ability and allowed limited opportunities for discussions or questions.

Practical Science and Use of Laboratories

Most teachers in schools in Rwanda have never done any laboratory work and have done few demonstration experiments over at least the past 10-12 years. Many of them have never been given any training in practical activities. They recognised openly their lack of skills and didactical knowledge in this area and were eager to learn. From interviews with teachers, it became clear that they were unaware of the didactic and organisational problems related to the use of laboratory equipment. However, after some discussion they recognised that it was not at all clear to them how laboratory work could be done under existing school conditions. It was also seen that the maintenance of existing materials was not always satisfactory. It is obvious that using and maintaining science equipment would have to be developed amongst teachers. In some instances schools had laboratory equipment donated by aid organisation that teachers did not use. Teachers asked for support materials for teaching science. They felt an acute need for all kinds of demonstration equipment: from simple locally available equipment to slide-projectors, OH projectors, maps, test tubes, magnets, etc. Some teachers expressed concern that the provision of laboratory equipment would not change

their style of teaching much because of existing factors: overloaded classes, lesson times, lack of physical space in schools and a lack of in service training.

Discussion and Recommendations

The qualitative and quantitative data findings identified factors, which have influenced the science education process and make meaningful interpretations of the background, culture and the situation in Rwanda. By weaving questionnaire data with observations and interviews with participants it was possible to provide a more complete picture of the reform process from the perspective of science teachers and explain differences and similarities in the questionnaire scores. The quotes from interview and classroom observation data brought to light that, teachers' and students knowledge and experiences had an impact on the science reform process.

This paper highlights the constraints faced by teachers in a transitional society like Rwanda in the implementation of a relevant science education program. The constraints in the successful implementation of the education reform have been identified as young and inexperienced teachers, most of whom do not have university degrees, the content and relevance of the curriculum which is not meeting the needs of the students, acute lack of material resources, finances required to reconstruct and improve educational institutions and work pressures on teachers due to extremely set exams.

It must be acknowledged that teachers, school administrators, educational professionals and students at all levels in Rwanda and are very motivated and enthusiastic. They live and work in harsh conditions, have limited pedagogical training, especially in modern methods of teaching, but try to do their best for Rwandan children. The challenge lies in the education system's ability to respond to these constraints. Three recommendations are with particular reference to students, teachers and the curriculum.

Recommendation 1: Provide increased opportunities for and access to secondary education

Changing economic structure and employment patterns have affected Rwandan society. Unemployment, especially long term, is emerging as a major determinant of poverty and thus the increased demand for further education . Even after the efforts at rehabilitation the dropout rates remain high and the prospects of access to secondary education remain limited. The challenge is meeting the need for secondary and higher education. It is a future catastrophe for any country if only 20% of its primary school leavers are able to continue onwards to secondary education.

Recommendation 2: Provide a contextualized science curriculum

The challenge lies in improving the quality of education in mathematics, sciences, technology and English language so that the curriculum is presented in a relevant context. For example, topics might include training in rural subsistence-based activities, mine awareness, health, water and sanitation, to equipping young people with a skill base applicable to modern and industrial technological contexts and the development of skills conducive to environmental preservation, disease prevention and self-employment namely development-related functions of science education as seen in Figure 4. A developing country like Rwanda needs to have greater confidence in its ability to produce curricular material and not simply emulate what happens in the developing world . Rwanda needs to develop policies that are authentic, contextually relevant and affordable.

Recommendation 3: Provide a framework for sustainable practical science that is locally relevant.

Taking into account existing curricula frameworks, school conditions, physical conditions (electricity, water supply, quality of pupils' and teachers' desks, floor quality, ventilation) and limited financial resources; it is feasible to provide a core set of science education equipment to schools. Teachers will need time and training to familiarise themselves with equipment and to prepare some demonstrations or practical work for students. Decisions about the use and allocation of supplies and equipment should allow a degree of flexibility and adaptation for each particular school's conditions. Many issues concerning the organisation of sustainable practical work in science could be solved locally with assistance from the community and parents. It is also important to find some of the consumable materials for science experiments locally from within the environment and using local teacher knowledge.

Recommendation 4: Provide improved conditions and incentives for teachers

It has been identified that teachers form the backbone of the education system and it is important to train and motivate teachers. There are not enough teachers to meet the needs of early childhood, primary, secondary and higher education in Rwanda. The challenge is re-organising of teacher training structures, redefining science teacher training programmes, development of structures, the creation of a higher pedagogical institutes, increasing content knowledge, improving remuneration and incentive packages. In Rwanda teachers are not motivated enough to stay in the teaching field due to low wages and economic conditions. It is important that the government in Rwanda acknowledges this and improve the conditions of teachers.

References