FACTORS AFFECTING THE CHOICE OF SCIENCE SUBJECTS AMONG GIRLS AT SECONDARY LEVEL IN MAURITIUS

A thesis submitted for the degree of Doctor of Philosophy

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Dedication

I dedicate this work to

My lovely granddaughter Thaj Anahata who I hope will be inspired by my work one day.

Abstract

This research attempts to identify the factors which influence the choice of science subjects in Mauritius among girls at the end of the third year of secondary education, the level up to which science is a compulsory subject. This low uptake of science subjects by girls beyond the compulsory level is a matter of concern. The study was undertaken in four purposely selected schools in Mauritius, two mixed-sex and two girls' schools. Using mainly a qualitative approach, data were collected through: (i) non-participant observations of 60 science and 20 non-science lessons, (ii) 16 semi-structured face-to-face interviews of teachers, and six group interviews with pupils and (iii) 135 questionnaires administered to the parents of the pupils in the classes observed in the four schools. Based on the results of a pilot study, modifications were made for the main study. The data provided insights into teachers' teaching approaches, the behaviour and interest of pupils in the lessons and other factors such as pupils' perceptions of science, their self-identity and role models, and the extent to which parents and peers influence the choice of subjects among girls. The findings show that teaching approaches were mainly traditional and that both girls and boys prefer hands-on activities and contextual examples reflecting real-life situations. The majority of the girls' experiences of science were negative and this deterred them from taking science beyond the compulsory level although they were aware of its importance. Teachers had positive opinions about girls' ability to do science but stated that lack of infrastructure facilities did not allow them to involve the pupils in practical work as much as they would wish. However, brighter girls' decisions to study sciences were not outweighed by these factors. Parents felt that they did not influence their daughters in the choice of subjects or eventual careers though they held science in high esteem.

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ACRONYMNS and ABBREVIATIONS

AAUW: American Association of University Women

APU: Assessment Performance Unit

CPE: Certificate of Primary Education

CSO: Central Statistical Office

EVS: Environmental Studies

GASAT: Gender and Science and Technology

GIST: Girls into Science and Technology

HSC: Higher School Certificate

ICT: Information and Communication Technology

La MAP: La Main a la Patte

MCA: Mauritius College of the Air

MEHRD: Ministry of Education and Human Resources Development

MES: Mauritius Examinations Syndicate

MIE: Mauritius Institute of Education

MISP: Mauritius Integrated Science Project

MOECHR: Ministry of Education, Culture and Human Resources

MRC: Mauritius research Council

MRI: Magnetic Resonance Imaging

MWFWCD: Ministry of Women, Family Welfare Child Development

NCCRD: National Centre for Curriculum Research and Development

NEPAD: National Education Project for African Development

NGO: Non-Governmental Organisation

NRC: National Research Council

OECD: Organisation for Economic Co-operation and Development

Ofsted: Office for Standards in Education

PISA: Programme for International Student Assessment

PSSA: Private Secondary School Authority

RGSC: Rajiv Gandhi Science Centre

ROSE: Relevance of Science Education

SLIPP: Supported Learning in Physics Project

UK: United Kingdom

UNESCO: United Nations Educational, Cultural Cooperation Organisation

UOM: University of Mauritius

USA: United States of America

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Chapter 1

1.1 Introduction

This study aims to understand why girls in Mauritius tend not to continue with their science studies after the age of fourteen, at which point science is no longer compulsory in schools. The main objective of the study is to elucidate the factors that encourage or inhibit girls to study science beyond the compulsory level. In order to find an answer to this problem, observations of lessons are undertaken in four Mauritian schools, interviews and questionnaires are used to study the perceptions of teachers, pupils and parents and relevant documents are analysed.

The present study is conducted in Mauritius; the low enrolment in science subjects at the end of lower secondary level is an issue of concern and this has serious implications for a small island state like Mauritius that depends heavily on the quality of its human resources. There is a growing recognition of the importance of science in all realms of life, at individual as well as the wider socio-economic and political level, both in Mauritius and internationally. With the level of development and changes taking place in Mauritius, young people are being called to take a stance on socio-scientific issues, to become more critical and problem solving so as to meet the challenges confronting them. Scientific literacy has been recognized as a major goal of science education in the world (MRC, 2001; ROSE, 2005; OECD, 2009) and it can be argued that science education is important for acquiring citizenship skills as well as preparing students for the globalised world of work, new technologies and a knowledge-based society. Although girls and boys in Mauritius have equal opportunities to realize their rights and potential, the low participation of girls in all three science subjects, especially the physics after the compulsory level is a cause of concern. There are a variety of ways that could be imagined in which the science curriculum is failing in Mauritius to gain the interest of young women, and these will be explored in this thesis.

Recent statistics available from the Mauritius Examinations Syndicate show that a relatively low number of students, particularly girls, take science subjects up to the School Certificate level (Table 1.1), (MES Statistics, 2005-2006; 2008-2010). In Table 1.1, the figures for science subjects' enrolment at School Certificate level are compared to those for English, which is a compulsory subject, for the period 2000-2005 and 2006-2010. The percentages show the enrolment in each science subject, separately for boys and girls, relative to the number enrolled for English. Previously, the Mauritius Research Council, which is the advisory body for science, expressed concern about the low enrolment of boys and girls in science (MRC Report, 2001) and though there has been a slight improvement in later years (MES Statistics, 2005-2006; 2008-2010), they still indicate that there is a lack of uptake of science subjects. Sex-disaggregated data for science subjects were unavailable for the year 2007.

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Year	**Biology**		**Chemistry**		**Physics**		**English**	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
2000	1214 19.8%	1173 17.8%	2122 34.5%	1675 25.3%	2029 30.7%	900 13.6%	6143	6608
2001	1147 19.4%	1122 16.9%	2016 34.1%	1661 25.1%	2076 35.1%	904 13.7%	5909	6612
2002	1131 16.4%	1234 16.9%	2055 29.9%	1703 23.3%	2191 31.8%	980 13.4%	6883	7306
2003	1795 25.5%	2014 27.2%	2774 39.4%	2206 29.8%	2782 39.5 %	1162 15.7%	7048	7404
2004	1761 25.1%	1966 26.3%	2700 38.5%	2222 29.7%	2723 38.8%	1113 14.9%	7018	7474
2005	1829 25.3%	2017 27.0%	2654 36.7%	2259 30.3%	2776 38.4%	1209 16.2%	7231	7468
2006	2014 25.6%	2387 29.0%	2879 36.5%	2568 31.2%	2915 37%	1419 17.2%	7876	8227
2008	1997 23.2%	2498 26.9%	2878 33.5%	2749 29.6%	3265 38%	1673 18.0%	8589	9272

2009	1948 22.9%	2424 26.2%	2805 33%	2668 28.8%	3203 37.7%	1670 18.0%	8496	9260
2010	1991 23.1%	2376 26.2%	2911 33.8%	2645 29.2%	3250 37.7%	1719 19.0%	8612	9053

Table 1.1: Science enrolment at SC Level for both Boys and Girls (MES Statistics, 2010)

The figures in Table 1.1 show that though there has been a slight increase in the number of boys and girls taking science subjects after the compulsory level since 2002, the overall situation regarding the uptake of science is poor. Statistics for 2010 show that about 19.0% of girls compared to 37.7% of boys take physics, 33.8% of boys and 29.2% of girls take chemistry whereas in biology there are slightly more girls (26.2%) than boys (23.1%), a phenomenon which has been observed worldwide. Overall entries for science were less than 28% for both boys and girls; the figures for preceding years tend to reflect a similar pattern. It must be noted that 52% of the Mauritian population consists of females (Central Statistics Office, 2010), and scientific literacy is of vital importance for both males and females if they are to be sufficiently equipped with the necessary knowledge and skills to face the challenges of a fast changing modern world.

Biology appears to be more popular with girls whereas, for girls, physics is the least popular of the three science examination subjects. There is very little difference between the number of boys and girls who choose to study chemistry. Science and technology are believed to be the engine for economic growth, personal and social development and for the improvement of the quality of life of the people (MRC, 1999, MRC, 2004; Jugessur, 2008). Qualifications in science subjects are necessary for accessing prestigious and highly paid jobs in the field of science and technology. Girls have an important role to play in the scientific, technological, economic and social development of Mauritian society. A low participation in these subjects may impact on the level of scientific literacy of girls and the future workforce of the country as girls will lack important knowledge, conceptual understanding and skills needed for facing the challenges of a fast changing world. Advancement and improvement in agriculture, fisheries, natural resource management and environmental protection and healthy lifestyles can only be possible through the availability and contribution of appropriately qualified science and technology human capital (National Report on Science and Technology, MRC, 1999) and a scientifically literate population.

The gender-related phenomenon in science and the under-representation of females has been widely discussed in the international literature (Keller, 1982; Harding, 1986, 1991; Blickenstaff, 2005; Adamuti-Trache, 2008; Brotman, 2008) and the 'leaking science pipeline' is a global phenomenon. The 'second wave' feminists of the 1970s and early '80s presented a grim picture of the existing gender disparities in the classroom where girls were 'marginalized and belittled' (Francis, 2000). These feminist studies then raised awareness among teachers concerning the low aspirations of girls and achievement in science and mathematics at post compulsory level as there were relatively low numbers of women proceeding to higher education in the sciences (Stanworth, 1981; Spender, 1982). Many other studies seemed to express concern with the role that education seemed to have on the self-confidence and the feelings of self-worth in girls. Girls consequently avoided the 'hard sciences' and their ambitions for further studies in those subjects were lowered because their performance at 'O' level was significantly lower than the boys (Spender, 1982, Miller *et al*., 2006). Concerns about the problems of girls and science have been raised in the developing countries too (Mulemwa, 1997).

Studies carried out at a global level have explained the low participation of girls in science and they reveal that secondary school students perceive some subjects to be difficult and gendered, with girls appearing to favour subjects which involve clearly identifiable personal interactions such as biology (Johnson & Murphy, 1986; Walkerdine, 1989; Harding, 1996; Freeman, 2004; Bystidzienski & Bird, 2006). It has been suggested that the lack of human figures in the physical sciences and mathematics accounts for the different interests shown by boys and girls. Gender boundaries remain as science is perceived as 'masculine' and a difficult subject by girls and as interesting by boys; girls see the 'feminine' subjects as easy and boys find them as 'boring' (Attar, 1990; Archer, 1992). Studies on the factors that determine the choice of science subjects by girls (Cheng *et al*., 1995; Adamson *et al*., 1998; Osborne & Collins, 2001; Baker & Leary, 2003; Cleaves, 2005; Miller *et al.,* 2006) have shown that gender was a most important factor in subject choice. Miller *et al.* (2006), in their recent study in the USA, examined gender differences in high school students' attitudes in their science classes, their perceptions of science and scientists and their views about continuing further studies in science. They reported that females were more interested in people-oriented aspects of science such as biology and those females who chose physical science did so because they needed a science background to enter a health profession, typically medicine or physical therapy. The desire to help people and care for animals, plants and the environment were evident as the favourite topics of girls were about animals and trees; the girls showed a strong preference for hands-on activities and group interaction whereas boys favoured abstract and constructional activities dealing with mechanical devices (Ross, 1991; Baker & Leary, 2003). Christidiou (2006), in a study of 9th grade students in Greece, reported that girls were more interested in topics related to human biology, health and fitness and were more familiar with instruments seeking information about nature, handicrafts and the kitchen. Dalgety & Coll (2004) argued that parents, peers, teachers and relatives have an influence over students' enrolment choices, more particularly for female students. Gender issues and science will be discussed further in Chapter 2.

In Mauritius, gender stereotyping still permeates the school system where science and mathematics are considered masculine and economics, business studies, accounting and home economics are feminine subjects (MRC, 1999). In Mauritius, the issue of girls' participation in science was not considered a problem until the 1990s. My interest in gender and science stems from my personal experience at the conferences I attended in the 1990s which then became formalized in my professional work. My participation in the GASAT 7 International Conference in Ontario, Canada (1993), the GASAT 8 International Conference in Ahmedabad, India (1996) and the Commonwealth Secretariat Regional Workshop (1996) held in Mauritius and GASAT 9th and 10th International Conference (2000) contributed to creating an awareness of the problem in science in the education sector. Since then, the authorities in Mauritius have become more conscious of the low interest of girls in science. UNESCO initiatives such as the meeting of African Girls in Science (1997) and the NGO Forum in Beijing (1995) have all tried to focus on the issue of girls in science. A successful GASAT 11th International Conference held in 2003 in Mauritius further highlighted the issue of girls and women in science. As chair of the conference, I was successful in attracting sufficient support and 'Women in Science' was the theme of the Ministry of Women's Rights at the International Year of Women in 2003. The Mauritius Research Council has made several propositions concerning science education following the Science, Technology and Innovation Audit carried out by Prof. R.T. Parfitt in 2002, and the Mauritius Research Council Recommendations and Action Plan, 2004-2006 (MRC, 2004). There is now a strong move at the Ministry of Education and Human Resource Development to make science compulsory up to Form V level and piloting of a compulsory science programme called Science for the 21^{st} century started in 10 secondary schools in January 2009. Apart from superficial interventions and surveys, though, there has been no in depth research on gender issues and science education in Mauritius.

Gender imbalance in science enrolment beyond the compulsory level may have serious implications both for individuals' autonomy and quality of life and for national development. Besides scientific literacy, Mauritius needs a critical mass of scientists, technologists, engineers and human resources in science-related occupations.

Additionally, research conducted internationally shows that women are still generally under-represented in fields of science engineering and technology (Bebbington, 2002; National Science Board, 2008). In the UK they account for 31%; in the USA for 34%. Exact percentages are hard to come by for developing countries. Nevertheless, gender differences in the take-up of science subjects are still evident in many countries, developing and otherwise (Eccles, 1994). Science is typically considered as 'male', embedding masculine qualities of rationality and technical competence (Kelly, 1985; Brickhouse, 2001; Howes, 2002). Girls studying science are often expected to assume masculine qualities (Walker, 2001). Young female students all too often tend to drop out of science at a crucial time when their decisions are likely to have great repercussions on their future career prospects.

The most recent report (Ministry of Women, Family Welfare and Child Development, (MWFWCD), 2007) shows that women are less economically active in Mauritius; in 2005, 77% men aged 15 years and above against 41% of women of the same age. The majority of these women were in low paid jobs, such as plant and machine operators and in government services (MWFWCD, 2007). The low engagement of girls in science in the early years is reflected in the various hierarchical positions in Mauritius. Available data in Mauritius show that there is an under-representation of women at senior level in the government services (Table 1.2).

	2003		**2004**		**2005**	
Occupation	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Rector & Principal	62	34	63	34	51	32
Headteacher & Deputy headteacher	668	388	673	400	567	550
Education officer	981	1089	1046	1248	1061	1293
Medical doctor	538	158	546	158	572	170
Dentist	42	17	40	18	50	19
Engineer	94	4	93	5	93	5
Scientific officer	31	12	31	10	34	10

Table 1.2: Representation of women at senior positions in the government services (MWFWCD, 2007)

The figures in Table 1.2 show that women are under-represented in most senior positions in government services, though more women than men are employed as education officers. However, in administrative positions, the situation of women has improved considerably in the government services; in 2005, there were 18 men and 12 women as Permanent Secretaries. Given that there are a large number of women as Assistant Secretaries (70 women against 59 men), it is likely that there will be more in senior administrative positions in future (MWFWCD, 2007). Sex-disaggregated data for women in top academic positions in tertiary institutions are unavailable.

Tables 1.3a and 1.3b show the number of science teachers by subject and administration in secondary schools.

	Biology		Chemistry		Physics		Integrated Science	
	Male	Female	Male	Female	Male	Female	Male	Female

State	41	59	72	55	95	34	15	12
Private	68	77	102	54	82	31	54	69

Table 1.3a: Number of science teachers by subject and administration in secondary schools, academic year 2006 (MWFWCD, 2007).

	Biology		Chemistry		Physics		Integrated Science	
	Male	Female	Male	Female	Male	Female	Male	Female
State	49	71	85	65	107	43	13	5
Private	63	88	104	57	82	38	51	68

Table 1.3b: Number of science teachers by subject and administration in secondary schools, academic year 2007 (MWFWCD, 2007).

Tables 1.3a and 1.3b show that though the field of education is favoured by women, they are under-represented in chemistry and physics in both state and private secondary schools; there are more women in biology. Integrated science teachers are predominantly women in private secondary schools; state schools employ fewer integrated science teachers. Whether the popularity of biology among girls could be attributed to women acting as role models as other studies have shown is worth investigating in this study. The figures in Tables 1.3a and 1.3b show that there are more science teachers in the private schools, but gradually with the increase in the number of state schools, teachers from the private schools are being recruited into the state schools.

With a small number of women involved in senior positions and under-represented in science, there are likely to be fewer role models for girls. Indeed, the low participation of girls in science subjects at the upper secondary level is likely to be reflected in their eventual career choices and representation in employment at senior levels in various sectors.

It is not easy to decide to which countries to compare Mauritius, but as it ranks among the newly industrialized countries with a high literacy rate of 85% and as both are products of colonial background, Singapore and Hong Kong may be obvious choices.

However, Mauritius has a longer history of democracy and is culturally different from both Singapore and Hong Kong. India could be another country to which Mauritius could be compared because the majority of Mauritian people originally come from India but it is dissimilar because the former is a huge country with lower life expectancy and a class/caste system with different expectations.

The factors influencing girls' participation in science are diverse and my reasoning is that teaching methods, teacher-pupil interactions, teachers' and pupils' perceptions of science and science education, societal factors and curriculum materials may be responsible for the low participation of girls in science after the compulsory level. In this first chapter there is a brief account of the history, geography, and socio-cultural aspects of Mauritius so as to establish the national context of the thesis. The chapter furnishes a background to the education system in Mauritius and the efforts made to date to improve science education in the country. The chapter also discusses the value of science education and identifies the broad area of research within which the research questions will be located

1.2 Historical background

Mauritius was originally an uninhabited island. It is said to have been visited by the Arabs and the Malays in the twelfth century but the Portuguese were the first people to show some interest in the island in the 16th century, using the islands to stock up food supplies for their ships. As there was no sign of human life, they left the island. The Dutch were the first settlers in the island in 1598 and they named it 'Mauritius' after their ruler Prince Maurice of Nassau. After occupying the island for more than a century they left in 1710. As there was no food available, they hunted the dodos, the famous flightless birds which became extinct just before they left.

In 1715, French sailors arrived and took possession of the island. They renamed it 'Ile de France'. In 1722, they brought slaves from Madagascar and Africa to clear the forests and work on the plantations. The French attempted to grow coffee, indigo, sugar and cloves but they were unsuccessful in their efforts to cultivate these crops because of the weather and concentrated mainly on sugar cane plantations which were able to withstand the cyclones. Thus, sugar established itself as the main crop of

Mauritius. The French built a port and major developments were started under the French regime led by the French Governor Francois Mahe de Labourdonnais (1735-1764). Mauritius became a prosperous French colony under his rule as he encouraged French people to come and settle in the island.

In 1810 the French and the British fought for the possession of the island and by the Treaty of Paris in 1814 'Ile de France' was ceded to Great Britain together with its dependencies Rodrigues and Seychelles and it regained its former name, Mauritius. Seychelles was detached from Mauritius in 1903 and came under direct rule as a British colony. The British administration brought about important social and economic changes, the most notable one being the abolition of slavery in 1835, an event which had important repercussions both socio-economically and demographically. The liberated slaves refused to work in the sugar cane plantation with the result that the French had to bring in Indian indentured labourers as a new cheap labour for the sugar plantations. These labourers brought with them their languages, traditions and cultures. These were mostly of Hindu and Muslim faiths. Later the Chinese traders joined them and the economy of the country improved.

A major breakthrough in constitutional development took place in 1948 with the holding of the first general elections; the right to vote was extended to all adults who could pass a simple literacy test. Further constitutional changes took place from 1955-1957 and for the first time voting took place on an adult universal suffrage basis of one person one vote in 1959. The last constitutional conference held in 1965 and the general elections held in 1967 paved the way for independence on 12 March 1968 and twenty four years later, in 1992, the country achieved the status of Republic.

As the population is of various origins, there is a cosmopolitan culture; this unique melting pot of people, cultures and languages mirrors peaceful coexistence among the Mauritians of Indian, African, European and Chinese ancestry. This is evident in religious festivals where the people of various origins participate collectively, sharing cultures and values. Though English is the official language and medium of instruction in schools, French is more commonly spoken and a French patois Creole is spoken and understood by all. The variety of origins of the population gives rise to a complex language situation; those of Indian origins learn the Asian languages such as

Hindi, Tamil, Urdu, Marathi and Telegu at schools. People of Muslim faith study either Arabic or Urdu and those of Chinese origin learn Hakka or Cantonese.

1.3 Geographical location

Mauritius is made up of a number of small islands scattered within a radius of 800 kilometres. The main island is Mauritius and it covers an area of 1865 km^{2}. The Republic of Mauritius includes Mauritius, the islands of Rodrigues, Agalega and small islands called the Cargados group and have a total area of 200 km^{2}. Mauritius is of volcanic origin, formed around 13 million years ago. It is located 20° South of the equator, latitude 20° South and longitude 57.5° East. It is situated about 800 km from Madagascar and 2500 km from Durban, South Africa, 4000 km from India and 5100 km from Australia (Figure 1.1).

Figure 1.1: Location of Mauritius in the Indian Ocean

(*Source:* [*www.bluemarlin.nl/st_pics/map-mauritius.jpg*](www.bluemarlin.nl/st_pics/map-mauritius.jpg))

1.4 The Mauritian education system

1.4.1 Overview

During the French period, religious bodies were responsible for promoting education and the boys were the ones who mostly attended schools. The French sent their children to schools in France but with the onset of the French Revolution it became unsafe for the French settlers in Mauritius to send their children for secondary education in France. Thus, a secondary school was opened on the island. Some schools were opened by the sisters of Loreto of Dublin in 1845. In 1908 out of 60,000 children of school age only 7000 were attending schools. Many children obtained cultural and religious knowledge in 'baitkas'[1] and 'madrassas'[2] or makeshift places provided by Asian socio-cultural societies conscious of educating their children (Chinnapah, 1983, p.24). Up to 1945, there were few primary schools.

However, it was between the 1930s and the 1940s that the historic movement to mass education took place; there was a slow progress of education for the masses thanks to the efforts of missionaries and religious bodies. Only a privileged group of the population benefited from the education system started by religious bodies and some missionaries (Master Plan of Education, 1991, p.11). As there was a lot of conflict between the French and the British on the issue of granting access to education to children of Indian immigrants because of a problem of what language they should be taught in, the opening of more primary schools was delayed until much later on. The Constitutional reforms in 1948 in its commitment to 'Education for All' militated for greater social, cultural, political and economic equality. There was a handing over of political power from the French sugar magnates to the people and several events of the 1950s led to an increase in demand for education, namely the right to vote, the recognition of Indian languages and the Declaration of Human Rights and social justice. As there was an urgent need to cater for the education of the masses, this brought about an increase in the number of private secondary schools.

[1] Hindu village school
[2] Islamic school where Arabic, Urdu and Religious Education are taught

Since independence in 1968, a considerable number of changes took place in the education system with concomitant input of financial and other resources and infrastructural development. The Grant Aid system was introduced and since then the education system has been under dual control with the government on one hand and the Church and private sector on the other (Ramdoyal, 1977, p.71).

The objectives of full employment and industrialisation led to further important educational reforms as it was felt that education provided the avenue for social, cultural and economic equality. It was a time when many private secondary schools and state secondary schools came into existence as there was a growing demand for secondary education. The post-independence period witnessed diversification of the economy; moving from a mono crop sugar-based one to manufacturing, public services and tourism. This expansion in the economy demanded a high level of training and education to face the new challenges. Furthermore, the 1960s and '70s were marked by the development of tertiary education: the University of Mauritius, the Mauritius Institute of Education, the Mahatma Gandhi Institute and the Mauritius College of the Air.

In the wake of further educational reforms (Ramphul Commission, 1973-74; The Glover Commission of Enquiry, 1977-78; The Richard Commission of Enquiry, 1978-79; The Glover Report, 1982-83), the education system was changed to meet the demands of a fast changing society. The post-independence period was also marked by a strong commitment to social development policies with particular emphasis given to education. In order to increase equity and access, free education, which had only been available at primary level, was extended to secondary level in 1977 and in 1988 to the tertiary level. Increasing the participation of girls and women in the labour force of the country necessitated the expansion of the education sector and considerable efforts were being made on the gender front to provide equality of access to secondary and tertiary education. This resulted in a greater number of pupils, particularly girls, attending schools and more state schools were constructed to allow them to have access to quality education.

There is still a scarcity of places in state-owned schools and the government is increasing the number of state schools so as to accommodate more children. Current statistics show a higher enrolment for girls than for boys in secondary education. In 2005, there were 50.8% boys against 49.2% girls in the primary sector and 48% boys and 52% girls in the secondary sector (Ministry of Women's Rights, Child Development, Family Welfare and Consumer Protection, 2007). There still exist some fee-paying schools in the pre-primary to secondary levels which cater for some high income groups. Granting free education from pre-primary to university level was a very bold and challenging step taken by the government of the time and, owing to it, Mauritius boasts a literacy rate approximating 85% (CSO Statistics, 2008).

1.4.2 The present education system

Table 1.4 shows the structure of the education system which is based on the British system: six years of compulsory primary education, leading to the Certificate of Primary Education (CPE) and five years of compulsory secondary education leading to a School Certificate (SC) or the General Certificate of Education (GCE O Level) and a further two years of secondary education which is not compulsory leading to the Higher School Certificate (HSC) or GCE A Level. With the introduction of eleven year schooling, education is compulsory and free up to age sixteen since January 2005. At tertiary level, full time undergraduate programmes are free at the University of Mauritius and the Mauritius Institute of Education.

Level	**Age (years)**	**Science taught**	**Exam taken**
Pre-primary	3-5	Environmental science	None
Primary	6-8 (years 1-3) 9-11 (years 4-6)	6-8 science as EVS Basic science	 CPE at end of year 6
Secondary	12-16	12-14 (Forms 1-3) science core subject 15-16 (Forms 4 & 5) science optional	School Certificate (Biology, Chemistry,

			Physics)
Secondary	17-18	Science optional	HSC
Tertiary	19 onwards		University degree

Table 1.4: Summary of the Mauritian educational system

To date, the condition for enrolment in the academic stream of secondary education is the CPE. Prior to 2002, CPE examinations served for certification purposes and pupils who achieved high marks were admitted to the 'star' schools, which are the highly rated schools according to the Ministry of Education and Human Resources list. In 1978, the Private Secondary Schools Authority (PSSA) was set up to look after the running and maintenance of standards at the private secondary schools. Children who fail to get admissions in the state secondary schools are admitted in the private secondary schools.

In the year 2002, ranking of pupils was abolished and a grading system was introduced. These reforms were presented in the document 'Ending the Rat Race in Primary Education and Breaking the Admissions Bottleneck at Secondary level - The Way Forward (2001)'. All children obtaining the minimum pass grade E in English and French and an overall 35% are admitted to the secondary mainstream schools. All those who do not pass the CPE after two attempts join the pre-vocational schools, which were launched in 2001, and they follow a three-year course. It is expected that through the adoption of remedial measures all children will be able to join the secondary mainstream (Mauritius Report, 2006).

Primary education has been compulsory since January 1992 and secondary education since January 2003. The number of primary schools in Mauritius in 2005 was 290 with 5578 teachers. The number of secondary schools in that year was 189 with 7761 teachers and a pupil-teacher ratio of 20:1 (Digest of Educational Statistics, 2006). All the 80 state secondary schools are single sex and under the control of the government so far as curriculum and examinations are concerned. 119 private schools, which are mostly mixed sex, are government-aided and have their own specificities and governing bodies but the same curriculum and examinations as do state schools.

There are four education regions in the island of Mauritius; enrolment at primary level is 100% and the zoning policy obliges children to attend schools in their respective geographical regions. Competition is still an issue in the educational system in Mauritius and it has a tremendous effect on the attitudes of students, teachers, and parents alike. Morrison *et al.* (1987, p.172) argued that "there is nothing inherently wrong with competition if it is structured to make equals. Indeed this form of competition can engender motivations to excel. In Mauritius, the structure of competition does not match equals". Morrison *et al.* contend that the education system is like a "200 metre race around a circular tract in where there is no provision for a staggered starting point. In this type of race some runners have a lead before they start the race!" (1987, p.172).

The Master Plan in Education of the Ministry of Education and Science (1991), The Action Plan in Education (1998) and The Education Reforms of the Ministry of Education and Scientific Research (2001) implemented additional changes to do with the restructuring of the education system and the easing up of the bottleneck situation at CPE for the admission of students to secondary schools. Though these measures were well intentioned at that time, they were unable to keep pace with the growing demands of an education system needed to meet the challenges of an increasingly globalised economy. It is interesting to note that recent national educational reforms intend to introduce a gender policy in the education sector. The Education and Human Resources Strategy Plan, 2008-2020 of the Ministry of Education, Culture and Human Resources (MOECHR, 2008) aims to 'develop a sector gender policy consistent with the principles and operational strategies of the National Gender Policy Framework' providing 'equal opportunities to both sexes in learning environments that will ensure gender-sensitivity of curricula and teaching and learning materials' (MOECHR, 2008, p.60).

1.5 Tertiary and other institutions

Tertiary institutions have a crucial role in Mauritian society and the economy; they potentially provide an education which is adaptable and innovative so that the country is equipped with a properly trained workforce that can meet the emerging challenges of a knowledge-based society.

1.5.1 University of Mauritius and the University of Technology, Mauritius

The University of Mauritius (UoM) was created in 1974 and began to offer courses which were in line with the economic development of the country. The UoM, after a difficult period, has now established itself into an institution of international standard offering undergraduate and postgraduate courses (Education Report, 2003). The University of Technology, Mauritius (UTM) which was created in 2000, charges fees to students and run courses which are more in line with public administration and technology.

1.5.2 The Mauritius Institute of Education

There was a great demand for teacher training and the National Development Plan (1971-75) initiated the debate on the creation of the Mauritius Institute of Education (MIE), and in January 1973 the MIE was established. Its aim was to provide pre-service and in-service training to teachers at both primary and secondary levels and to engage in educational research and curriculum development and thereby to promote the achievement of learning and knowledge in the field of education and in particular, to provide a teacher education responsive to the social, linguistic, administrative, scientific, agricultural and technological needs of Mauritius (MIE Act, 1973, p.2).

In the late 1970s, the MIE transformed the out-of-date colonial curriculum into a more relevant contextual one suited to the needs of Mauritian children and in line with the developmental needs of the country. In 1985, the curriculum development activities were taken over by the Curriculum Development Centre under the aegis of the Ministry of Education. The function of curriculum development has now shifted to the National Centre for Curriculum Research and Development (NCCRD) under the aegis of the Ministry of Education and Scientific Research.

Furthermore, at its creation stage, the MIE was responsible for the conduct of examinations at primary level. This role was taken over by a separate institution known as the Mauritius Examination Syndicate (MES) in 1988. The major role of the MIE is now teacher education and research; however, a large number of its academic staff is still involved in curriculum development, assessment and examinations at national level. Being the sole public provider of teacher education in the country it is now being called upon to play a more proactive role in the fast changing educational system with emergent issues that need to be addressed and a dire need to be firmly grounded in classroom reality (MOECHR, 2008).

1.5.3 The Mauritius Examinations Syndicate

Pupils at the end of primary schooling take the Certificate of Primary Education (CPE) examination which is under the responsibility of the Mauritius Examinations Syndicate (MES) which was created in 1984 (in 1980, the Primary School Leaving Certificate and the Junior Scholarship Examinations were abolished and replaced by the CPE). This examination is taken by children aged 11 or 12 years and, up till 2003, the main feature of the examination was ranking which served the dual role of (a) selection to get into the best schools and (b) certification. The highest ranked students got admitted to the best secondary schools of their choice which was either state or government-aided confessional schools and the rest were admitted to lower standard private secondary ones. This is illustrative of the fact that there is a disparity in the quality of education offered in the schools. In the wake of educational reforms introduced in 2001, ranking has been abolished in 2001 to be replaced by grading, still a somewhat milder form of discrimination in the provision of equal access to education. More recently, the government which was elected in 2005 introduced a new grading structure whereby those who score A+ grade in subject areas are admitted to ‘star’ schools termed National state colleges and others to regional state secondary schools and private secondary schools.

Other tertiary institutions such as the Mahatma Gandhi Institute and the Rabindranath Tagore Institute are involved in dispensing post-secondary education and training for creative arts.

1.5.4 Non-formal institutions and the promotion of science

The Mauritius College of the Air, created in 1978, started to provide non-formal education through distance mode. Nowadays, science programmes dealing with specific topics in the school syllabuses and other issues of topical interest which can be viewed during school hours are broadcast on the Knowledge Channel.

The Rajiv Gandhi Science Centre (RGSC) is a non-formal educational institution which aims at promoting science and technology among students and the public. It popularizes science via exhibitions, science demonstrations, lectures, science fairs, science seminars, quiz stations and other outreach programmes for children. A display of permanent galleries of interactive exhibits provides visitors with an enlightening and entertaining experience on the origin of universe, origin of Mauritius, the environment and resources of Mauritius, new technologies and the world of science. Some examples of educational activities at the Rajiv Gandhi Science Centre are:

(i) National Science Challenge. This is an event which was held for the first time in 2007 and has now become an annual feature; it provides students with an opportunity to investigate issues related to Science and Technology using a scientific approach.

(ii) Science Communication Contest 2008. In this activity lower secondary students had to research a topic in science and present it in PowerPoint in front of a panel of judges. This has become an annual feature.

(iii) Young Scientist Workshop, a hands-on activity for lower secondary students. Workshops were held on the Secrets of Plants and the Earth Science. Other activities were: Science Festival (Dec 2007), Science and Innovation (March 2008), Security Week (June 2008), National Science Challenge, 2009 and 2010, Science Competition Challenge, 2010, Science Project Competition, 2010, *Caravanne de la Sante*, 2010, seminars, exhibitions and workshops on science and environmental issues.

1.6 Importance of science as a school subject

Education in science is seen in many countries to be an important element of schooling and is taught from the early years in schools. Scientific literacy is a much contested term. The traditional view is that it enables an individual to use scientific knowledge to ask, find answers about questions and draw evidence-based conclusions in order to take informed decisions about the natural world (PISA, 2003, 2006). A more contemporary view is that a scientifically literate person is able to identify, reflect and argue critically on scientific issues underlying local, national and global decisions and take informed positions about these. Indeed, some authors have argued for new ways of thinking about science and science education in relation to social justice and the relevance of science in their daily lives (e.g. Roth & Calabrese Barton, 2004). The issue of scientific literacy will be discussed further in Chapter 2.

Mauritius places great importance on scientific and technological literacy which, it is hoped, will enable its citizens to contribute to human and national development. It is a vision which is linked both to the relevance of science in the everyday life of its citizens and to the creation of a pool of future scientists. In this context, scientific literacy may be seen to aim to equip a person to take informed personal decisions about issues that involve the attainment of a high quality of life, such as protection of the environment and its resources, proper diet and health care whilst allowing sustainable development to take place.

However, in the midst of various national educational reforms there is still in Mauritius a lack of interest by girls in science and technology as school subjects (MRC 2001; 2004). Moreover, it is still apparent that girls are not attracted to science subjects. Some initiatives have been taken to counteract the observed trends (UNESCO, 2000; Commonwealth Secretariat, 2002; LaMAP, 2003; NEPAD, 2006;) but the present state of science in Mauritius still leaves a lot to be desired. There is a high level of political interest in the issues regarding science and no doubt this study, is likely to shed some light on the issue of science from a gender perspective and suggest policy measures and feasible changes at school level.

1.7 Science education in Mauritius

Science is taught as a core subject to all pupils at the primary level and up to age fourteen at the secondary level.

1.7.1 Primary level

At primary level (years 1-3), science is taught as an integral part of environmental studies; at upper primary level (years 4-5), it is taught as basic science. Science is a compulsory examinable subject at CPE level and aims at providing children with knowledge and understanding of scientific ideas in order to help them to understand their physical, chemical and biological environments, thus laying the foundations for a knowledge and understanding of scientific concepts and facts that will be useful to them as citizens.

1.7.2 Secondary level

Science is compulsory at year 1 to 3 (Forms I to III) at secondary level and appears as the optional subjects of biology, chemistry and physics. Science was introduced in all schools in Mauritius as Integrated Science (MISP) from the early 1980s with the implementation of the Glover Report in 1978. Only a few schools had the facilities to teach science prior to 1980. There was a large World Bank funded curriculum project which brought about major changes in science education in Mauritius. Curricular materials adapted to the local context were developed and with the setting up of the Mauritius Institute of Education in 1973, teachers were trained in large numbers at primary and secondary level to equip them with the necessary pedagogical knowledge and skills to teach the new curriculum.

At secondary level, science teaching aims at providing a general grounding in science for all students in order to familiarize them with scientific methods and a necessary amount of scientific information for pursuing courses in individual science subjects for those students who intend to specialize in science as a preparation for School Certificate examination. The intention of the science programme at secondary level is to promote scientific literacy and produce a specialized manpower for those who want to study the subjects further for mastering present and future scientific and technological areas.

The Master Plan of Education (1991) and the White Paper in Science (1992) sounded the alarm regarding the low number of students (25%) who take up science after the compulsory level (Form III). The majority of students chose Accounts or Economics. Of the 25% who opted for science, the number of girls taking science was much lower than boys. Various initiatives and activities were introduced, for example science action plan, exhibitions and competitions. These led to an increase in the number of pupils taking science up to around 40% of which 60% are boys and 40% are girls (MES Statistics, 2002). As is the case in many countries (ROSE, 2005) science does not seem to be popular with young people, in particular the girls for various reasons which will be elaborated in Chapter 2.

It is generally agreed that that effective science teaching requires an array of teaching strategies on the part of the teacher to make the subject appealing and interesting to the learner (Wellington, 2000). In Mauritius, the teaching of science appears to be mainly teacher-centred and very few activities are conducted as teachers argue that there is a lack of time for activities, a lack of facilities and an over-loaded syllabus (Master Plan of Education, 1991). These factors result in a monotonous atmosphere in the classroom where teachers are more concerned about completing the syllabus than involving pupils in activity-based learning. Though many teachers are now given the opportunity to train themselves in pedagogy, fresh graduates are still being recruited to teach in secondary schools.

1.8 Equity and gender

During the period up to 1945, there was no such thing in Mauritius as the right to secondary education for girls as they were often married at the early age of 15 or even earlier. In 1945, it was rare to find a woman who would have successfully completed primary education (Ujoodha, 2003). Education and educational reforms became a priority policy for the Government in 1969 with equality of the right to education for men and women. This was further reinforced by the Sex Discrimination Act (2002) which aimed at eliminating all forms of gender discrimination and sexual harassment. Thus, boys and girls have equal rights to education and employment. A document published by the Ministry of Women's Rights, Child Development and Family Welfare, *Statistics in Mauritius: A Gender Approach* (2007), reports that at secondary and tertiary levels, enrolment rates in 2005 were higher for females than males: 52.0% for females against 48.0% for males at secondary level and 55.4% for girls against 44.6% males at tertiary level.

By the term 'gender', reference is made to attributes and opportunities associated with being a male or a female and the socio-cultural relationships between men and women. These attributes and opportunities are socially constructed and they are acquired through socialization processes (Rennie, 1998). 'Sex' refers to the biological differences between men and women (Rennie, 1998). Francis (1998a) argues that different individuals and different cultures and societies may construct masculinity and femininity differently; in Western society attributes such as rationality, strength, aggression, competition, mind, science, activity and independence are considered masculine whereas emotion, frailty, care, cooperation, body, nature/arts, passivity and dependence are feminine. Some researchers view gender differences as having little biological differences and as simply being the result of cultural, social and environmental factors (Etzkowitz and Gupta, 2006). Paechter (2006, p124), following Butler (1990), argues that the distinction between gender and sex is problematic:

> We have now to rethink how we understand what it is to be male and female, masculine and feminine and whether the sex/gender distinction and related dualisation are useful to the conceptualization of gender.
> The traditional conception of the difference between sex and gender is that sex pertains to the body and is therefore given, and gender is socially constructed.
>
> Construction of gender in the social system which children are part of needs to be taken more into account (Paechter, 2006, p.124)

Glasser and Smith (2008) argue that certain traits vary significantly among persons of the same sex and that gender is socially constructed rather than being primarily connected to biological differences. Gender as a social construct is manifested at various levels ranging from the household, community and school to the national. At the school level, teachers may give differential treatment to boys and girls by reinforcing stereotyped gender roles, their teaching styles, and the use of texts and curricula that reinforce gender stereotypes.

This study will enable me to explore the factors that influence fewer girls than boys to study science beyond the compulsory level and look into the ways teaching is carried out at the level of Form III as this is the stage when decisions about subject options are made. Many girls do not seem to be aware of the importance of science subjects and they tend to drop them at an age when they are still developing mentally, physically and emotionally. As there is no in-depth study from a gender perspective carried out in Mauritius except for some superficial surveys carried out by the Ministry of Education (2000), the Mauritius Research Council (2001) and an intervention study by some researchers in a few schools (Ramma *et al.,* 2000). My research is original in the sense that it is going to shed light on gender issues and science education by using an integrated methodology that has not been applied by other researchers in this new area in Mauritius.

1.9 My research focus

To find out how science is taught at Form III level, I have observed the teaching methods used by teachers in the schools I have selected for my study. I studied pupil-teacher interactions and the perception of teachers and pupils regarding science and science teaching by interviewing them and the pupils, the infrastructure facilities, the societal factors that influence the choice of subjects, and the role of stakeholders such as the Ministry of Education and other institutions concerned with the promotion of science.

The next chapter provides an account of the literature review which focuses on prior research which has been conducted in areas related to gender and science. It covers in particular the main factors which may influence girls to opt out of science after the compulsory level, which in Mauritius is at age 14. It also examines how parents influence the choice of subjects. An insight into the role of science in the Mauritian education system is given and the role of school science is highlighted. Relevant documents with science and gender issues from both international and local contexts have been analysed to identify gaps in the literature and the research questions relevant to this study are discussed.

Chapter 2

Literature review: factors influencing the choice of science subject seen from a gender perspective

2.1 Introduction

In this chapter I explore the work done by other researchers on gender issues in science education. This chapter is organised into three themes: theme 1 deals with girls and scientific literacy, theme 2 reviews the interventions carried out in developed and developing countries to increase girls' retention in science and, finally, theme 3 deals with the situation of girls in science in Mauritius. I focus on the aims of the study by looking at pedagogy, the science curriculum, students' perceptions of science, students' interest in and attitudes towards science, self identity, social and cultural factors, and the influence of parents on the choice of science subjects. An exploration of work done by researchers in both developed and developing countries provides an insight into gender issues and science education. I have identified those bodies of literature which are from theoretical and interventional perspectives. Despite the fact that in Mauritius there is equality of access to education and choice of science subjects after the compulsory level, there is evidence as shown in Chapter1 that there is a low interest in science subjects, more particularly in physics as girls progress through secondary school. Some recent interventions in science to increase participation of girls in Mauritius are presented so as to provide a Mauritian account of the situation regarding science education and gender issues. The fact that girls are in a minority in science subjects after the compulsory level has serious implications for their successes in science in Mauritius and this eventually blocks their future career prospects. Numerous studies carried out at international level have attempted to explain girls' low participation in science subjects at school level. By examining bodies of literature from the developed and the developing world, I expect to identify gaps and address those relevant to the developing world in my research.

Worldwide, science is frequently viewed as an essential prerequisite for modernisation, economic development and for bringing changes in the quality of life of people. Science is increasingly essential in all realms of life. Students should be able to extract meanings from what is learned at school and apply them to their lives. School science should also be enjoyable and those who wish to access higher institutions for careers in science should be given the opportunity to do so (Naidoo & Savage, 1998). Science as a school subject has attracted researchers' interest due to the particularly high status it enjoys in the school curriculum of many countries both in the developed and the developing world and there is a widespread present day concern about the number of pupils opting out of science at the point of choice. For the last three decades the increasing impact of scientific and technological developments on everyday life has brought science education within the school curriculum to the forefront, especially issues such as scientific literacy and the relevance of science to the everyday life of boys and girls, men and women in a highly competitive world. Indeed, the importance of scientific literacy has been emphasized by Millar and Osborne (1998) who have argued that the science curriculum should provide learners with knowledge and understanding of the world they live in and which will be of use to them as ordinary individuals so as to enable them to become scientifically literate citizens and benefit from and contribute to human and national development. Therefore, a knowledge of science is important and the form in which it is taught is of universal value and it is something that an individual needs later in life not merely as a gateway to a set of career choices but rather to enable him/her to function as responsible citizens (Millar & Osborne, 1998). This view has been further emphasized by recent international studies (Sjoberg & Schreiner, 2005; OECD, 2009)

2.2 Scientific literacy and girls

Despite the fact that it is widely held that that science and technology are increasingly important in a globalised world, many researchers have argued about the socio-historical legacy of traditional science and science education. In the past, science was reproduced as an objective, privileged way of knowing restricted to a selected intellectual elite and it excluded many girls (Eisenhart & Finkel, 1998; Brickhouse, 2001). It has traditionally been equated with Western science over many centuries and conceived in universal terms as transcending cultural boundaries. It fails to consider other cultures which have their own views and theories of the world and the science taught in school is too often remote from the everyday lives of the learners, especially girls and women (Aikenhead & Jegede, 1997).

Scientific literacy is a term used to express the broad and encompassing purpose of science education. A number of authors have attempted to clarify the meaning of scientific literacy and its purpose in science education (e.g.,Bybee, 1977, Koballa *et al.*, 1997, Mayer & Kumeno, 2002, Millar, 2006; Osborne, 2007). The focus has changed from educating primarily for future scientists to educating future citizens. In a recent publication, it is stated that scientific learning is concerned about "'knowing' science (i.e., scientific understanding), 'doing' science (scientific enquiry) and 'talking' science (scientific discourse)" (Lee & Luykx, 2006, p.1). Scientific knowledge is acquired by engaging in science enquiry, carrying out investigations, analysing data, drawing inferences and making conclusions in order to make sense of the world. Talking science involves scientific argumentation through formal and informal discussion and is considered an important aspect of acquiring a "shared understanding of rules of scientific discourse" (Lee & Luykx, 2006, p.2).

Similarly, scientific literacy as defined by PISA 2009 includes an individual's:

- Scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomenon, draw evidence-based conclusions about science-related issues.
- Understanding of characteristic features of science as a form of human knowledge and enquiry.
- Awareness of how science and technology shape our material and cultural environments.
- Willingness to engage in science-related issues, and with ideas of science, as a constructive, concerned and reflective citizen (OECD, 2009).

The Framework for PISA 2009 Science Assessment includes four areas which were: (1) science in a personal, social and global context, (2) science competencies, (3) scientific knowledge and (4) attitudes towards science. It had a variety of goals for science education which address life situations that involve science and technology, identification of scientific issues and responses to those issues.

Despite the rhetoric of scientific literacy for all students, science in schools is all too often virtually the same; students are confronted with basic facts and theories and minority groups are disadvantaged because of the forms of knowing and the nature of scientific practices (Roth & Barton, 2004). Scientific literacy is viewed as a contested field and the stance of these researchers on scientific literacy might well apply to societal issues and women in the developing world. Wolff-Michael Roth and Calabrese Barton (2004) have redefined scientific literacy as how people use scientific knowledge in everyday life; it is inextricably linked to social justice and community participation apart from being an important outcome of schooling:

> For many science educators, efforts to promote greater scientific literacy have been shaped by the image of laboratory science. Science courses are often a means of pushing the students into the world of scientists rather than a way of helping them cope with their own life worlds (Roth & Barton, 2004, p.22).

In Mauritius too, scientific literacy has been emphasised by the Mauritius Research Council, a body responsible for advising the Ministry of Education on scientific matters:

> Scientific literacy is a must in order for one to comprehend the world and be able to contribute positively to its development … The teaching and learning of science becomes a prime consideration for the development of human capital (MRC, 2004, p.2).

The document published by the Mauritius Research Council ‘Teaching and Learning of Science in Schools’ (2004) comments further:

> For a large number of young Mauritians education in science is an end-in-itself, when they complete their Form III (age 14 years). The little education in science does not develop in the youth (a) an ability to make informed decision whether to

choose the formal study of science beyond 14 or not; and (b) the knowledge, understanding, skills and competencies required for a technologically literate citizen (MRC, 2004, p.9).

In addition to the above statement a case is made to make science compulsory up to Form V level (age 16) in line with most developed and developing countries. Therefore, the aims of science education in the secondary school curriculum in Mauritius as stipulated by the Mauritius Research Council are to provide:

> Good knowledge and understanding of science and scientific ways of thinking necessary to function confidently and effectively in a global and technologically evolving society…to interpret and understand what they see and read in the media, messages of scientific nature, which could be conflicting and have social, moral, and ethical implications.
>
> With the rapid pace of technological advancement, individuals come across, and get opportunities, to use new products and services at home, at work, and during their travel abroad. Teaching science would enable them to use and contribute to improvement of such products and services. As responsible citizens in a democratic society, they should be able to evaluate and make judgment about the benefits and risks associated with the developments in science and technology and their applications…be able to participate with interest and engage themselves in the debate on the issues posed by science, environment and technology which have implications both for them individually and society as a whole…to meet the challenges of globalization and to keep Mauritius relevant in the global economy (MRC, 2004, p.10).

The aims stated above acknowledge the fact that school science is important for every individual and spell out the needs of a democratic country in a globalised world economy. However, there is no mention about a science which is socially equitable. The emphasis is on being able to face the challenges of a modern world. Unlike the situation in many countries, science education in

Mauritius is currently only compulsory up to lower secondary level (age 14), though Mauritius appears to attach great importance to scientific know-how and technological skills of its human resources in order to be at the competitive edge (MRC, 2004; Jugessur, 2008, p.30). As stated in the MRC report, the science practised in schools reflects very much the traditional science, a science which focuses on basic facts at lower secondary level. Many pupils, more particularly girls, drop science subjects at an early age during adolescence and the real importance of science in their everyday life has not been clearly understood by many of them. This is particularly so in the case of girls despite the fact that some initiatives in Mauritius are already in progress to encourage their participation in science. These initiatives will be discussed later (Section 2.5). More needs to be done to develop this sector of human capital so that girls and women can participate fully in all Mauritian spheres of life.

As mentioned earlier in Chapter 1, studies in developed countries during the last three decades have indicated that there is a decline in interest in science among girls whereas in the developing countries this is not generally the case; girls in developing countries often appear to be interested in learning science, perhaps because education is considered to be a luxury in those countries (Sjoberg, 2000). Similar findings have been obtained from the ROSE project; the higher the level of development in a country, the lower was the level of interest expressed by students towards science and technology (Schreiner & Sjoberg, 2005). This might reflect post-materialistic values of young people in the developed countries in contrast to the developing ones which view science to be important for development and improving the quality of life. Schreiner (2006) interpreted the low interest of girls and boys in developed countries in science as a sign of late-modern identity; girls generally tend to accentuate their femaleness and boys their maleness (Baram-Tsabari *et al.*, 2009). Mauritius, which is a newly industrialised country, seems to fall in between the developed and the developing ones and it is possible that the low interest of girls in science is the result of the changes taking place at various levels of the Mauritian society.

Some superficial surveys initiated through the Post Graduate Certificate of Education and Master's degree courses and projects at the Mauritius Institute of Education provide a limited view on the issue of gender and science. These will be discussed in Section 2.5. In addition, institutions like the Rajiv Gandhi Science Centre are making some efforts to encourage interest in science but it is still not known how effective they are in achieving their aim of getting more girls interested in science and opting for science subjects beyond the compulsory level.

2.3 Science and gender issues

The terms ‘gender’ and ‘sex’ are often used synonymously although as pointed out in Chapter 1 they can be understood to have different meanings (Rennie, 1998). Gender is most straightforwardly seen as a ‘social construction’ (Howes, 2002; Scantlebury, 2007), as not determined (fixed by biology) and therefore open to change. Gilbert and Calvert (2003) highlighted the fact that femininity does not reside exclusively with females nor masculinity with males. A focus on ‘gender’ as a social construct as opposed to biologically determined sex characteristics emerged during the late 1970s and early 1980s when the scientific community and the ‘second wave’ of feminists (Kelly, 1978; Harding, 1981) expressed concern about the low participation of girls and women in science. Therefore, the starting point for concern about gender and science was discrimination and marginalisation based on sex and there was no distinction between gender and sex. More recent literature (Brotman *et al.*, 2008) indicates that studies in gender for the past 12 years can be organised into four broad themes or approaches though overlaps among the major themes do exist:

(1) A focus on equity and access

(2) A focus on curriculum and pedagogy

(3) A focus on reconstructing the nature and culture of science and

(4) A focus on identity.

Certain major studies carried out on gender issues in science education are highlighted under the appropriate sub-headings below. The issues raised are explored in more details in the relevant sub-sections.

2.3.1 Equity and access

Equity and access focus on eliminating sexism and gender differences in science classrooms and call for equal access for males and females to the study and practice of science. The findings on classroom biases and inequities are quite mixed. For example, studies by Catsambis (1995) on Grade 8 students indicated that girls of all ethnic groups had more negative science experiences than boys but they achieved as well as boys. Bailey, Scantlebury and Johnson (1999) examined whether boys and girls participated equally well or better in hands-on experiences and they found that equitable interactions(i.e. classroom dynamics where gender issues are considered) were observed. Miller, Blessing and Schwartz (2006) investigated high school students' views and perceptions about science classes, science and scientists in USA. Access is not a problematic issue in science education in Mauritius as choice of science subjects at age 14 depends on girls' preference for what they would like to study but equity is an area that requires further research. Gender equity in science education is still not well understood by many educators in Mauritius though it is being debated in other areas for example, in politics recently.

2.3.2 Pedagogy and curriculum

Pedagogy and curriculum that incorporate the experiences, interests, learning styles and preconceptions of boys and girls have been termed 'gender inclusive' (Harding & Parker, 1995; Rennie, 2002). They pay attention to issues such as sexism and gender bias in the teaching strategies and the curriculum and it has been found to have a positive effect on girls (Rennie, 2003). Harding and Parker (1995) reviewed policy and practice around gender inclusive science in five countries (Australia, Denmark, England, Sweden, and Wales) and they concluded that progress towards gender inclusivity in science in those countries fluctuated due to changing political and economic circumstances. Roychoudhury, Tippins and Nichols (1995) explored the application of feminist ideas about women's learning to science teaching and they found that collaborative learning triggered empowerment and confidence among girls. Haussler and Hoffmann (2002) studied the impact of a year-long curricular implementation on girls' interest, self concept and achievement in physics. They found that curricular changes, teacher training and small single-sex classes, increased interest, achievement and feelings of self-confidence in both boys and girls. Zohar and Bronshtein (2005) examined teachers' knowledge and views about gender gaps in physics participation in Israel and their findings showed that teachers did not know about gender inclusive pedagogy.

Studies about pedagogy and the curriculum by several researchers indicate that there is a variety of teaching approaches and active learning strategies available to motivate interest and inspire students to study science and develop a positive attitude towards the subject. These range from the traditional ‘chalk and talk’ to activity-based methods such as experiments, investigative work, group work, discussion, project work, internet searches, role play and excursions. Science is not just about memorisation and discovering of facts; it is rather about the construction of arguments to explain phenomena which are supported with evidence (Osborne *et al*., 2004). Though students find it difficult to engage in scientific argumentation, several researchers have suggested that students working collaboratively with others can benefit (Abell *et al*., 2000, McNeill *et al.*, 2006). Appropriate pedagogy can promote learning in science by clarifying difficult concepts (Reiss, 2000; Osborne & Collins, 2001).

In investigative work, pupils are involved in using different kinds of procedures to plan, measure, observe, analyse data and evaluate methods and make their own decisions individually or in groups (Watson & Wood-Robinson, 1998). Practical work can help to make science enjoyable and by exciting the curiosity of the learner, it develops positive attitudes to it. Practical work is considered to be “one of the distinctive features of science teaching and one of the great expectations of pupil learning” (Wellington, 2000, p.146). Practical work in science is popular with most pupils but the way it is presented is of crucial importance so that pupils show interest in the subject. Learning styles of girls differ; some prefer the traditional approach whilst others enjoy science when they are actively involved rather than being treated as passive recipients of knowledge. Studies carried out in Norway (Angell *et al*., 2004) and in the UK (Hart, 2002; Sharp, 2004) provide evidence for the value of activity-based learning, showing that practical activities enhance the interest of pupils in science, as did a variety of teaching styles using group work and collaboration with peers. However, care needs to be taken that the results of practical work feed into student learning (Wellington, 1998). A recent study by Abrahams and Millar (2008) has questioned the effectiveness of practical work as a teaching and learning strategy. They observed 25 typical science lessons involving practical work in English secondary schools. They noted that teachers focused predominantly on science substantive knowledge rather than on understanding the scientific process of enquiry which would help pupils to reflect critically on the results of the practical activities. Abrahams (2011) has posited that practical work should focus on conceptual understanding rather than merely involving pupils in manipulative activities. It is worth noting that girls typically prefer to carry out hands-on activities by collaborating with others and are willing to accommodate different perspectives whereas boys tend to do the opposite (Frost *et al*., 2005). It is to be noted that in an intervention study by Eisenhart and Finkel (1998), where girls were engaged in different kind of activities, it was found that substantive changes in pedagogy and curriculum show that girls can do science and learn science as well as boys.

Educators responsible for promoting science education have strongly advocated the use of a range of resources, materials and artefacts to explain concepts which are abstract and difficult to understand. The use of hands-on and mind-on approaches has been advocated so that they bring about meaningful understanding of scientific concepts (Ausubel, 1963). The notion of the spiral curriculum, of constructing knowledge by starting with the familiar and moving to the unfamiliar so as to situate learning in a real life context, has been advocated by Bruner (1991). Vygotsky's (1978) social constructivism theory views each learner as a unique individual with distinctive needs and background. Vygotsky believed that children by engaging in joint activities and conversation with other children, adults and the physical world can undergo profound changes in their understanding, implying that social communication and prior knowledge can lead to the construction of meaning. Other researchers have built on the work of Vygotsky and emphasized the importance of group work and cooperative group structures where learning can take place in a collaborative way (Matthews & Sweeney, 1997). Social interactions have been viewed by Lave and Wenger in their theory of situated learning (1991) as a critical component where learners are involved in meaningful activities in a community of social practice. Such involvements promote identities which reflect certain beliefs and values within the community. Cooperative learning strategies have helped to remediate predetermined misconceptions in pupils' understanding of electrochemistry in a study where the traditional and cooperative learning based on constructivist approach was used (Acar & Leman, 2007). The constructivist approach involves taking children's ideas about the natural world and reorganising and reformulating scientific ideas to make sense of the world; it is based on the ideas of Ausubel and Bruner (Driver *et al*., 1994, 1996; Ross, 2000a; Ross *et al*., 2002).

Gender bias has been reported to be reinforced in science textbooks and curriculum materials; for example, depiction of masculine images of science, lack of gender-inclusive language and absence of female models in course content and images (Hoffman-Barthes *et al.*, 2000). Presentation of science concepts in a gender sensitive and cultural way has also been advocated (NSF, 1998; Ladel & Thibault, 1999). Furthermore, an excessive amount of content and the lack of time for science have been stated to be responsible for students' disenchantment with the science syllabus. This was found in a survey carried out by Osborne and Collins (2000) with year 11 pupils across 20 schools in England; students, more particularly girls, could not keep pace with the work and found it hard to assimilate difficult and unfamiliar concepts in science.

Pupils have different learning styles: some learn better when they are actively involved and are described as 'kinaesthetic' learners; others learn visually using pictures and pictorial imaginations whilst others learn through speaking and hearing. If these learning styles are taken into consideration there is some evidence that pupils' achievement can be significantly raised (Dunn & Dunn, 1978; Gurian & Ballew, 2003). Girls tend to do better where writing and linguistic skills are concerned and coursework and project work improve pupils' marks more noticeably in the case of girls. Boys generally do well in multiple choice tasks while girls achieve higher marks in open-ended tasks. Murphy (1991) based her studies on the findings of the Assessment of Performance Unit (APU) and found that boys and girls typically treated tasks in completely different ways: girls tended to see problems in a holistic way while boys approached them in a de-contextual manner. Boys tended to be brief and factual whilst girls preferred style was more extended and reflective. Girls performed better when they talked about the task or the problem. The APU surveys provide strong evidence that girls achieve better in some areas and boys in others depending on the assessment strategies used. Keeves (1992) noted that boys were on average better at questions testing understanding whereas girls were better at recall. These research findings have important implications for assessment and learning styles in science. We must take into account the weight of evidence concluding that girls can do equally well if appropriate teaching and learning styles and assessment strategies are used to suit the learner. Interestingly, a more recent study (Hyde & Linn, 2006, 2009) points out that gender stereotypes are reinforced by popular literature and these researchers conclude more emphasis on gender similarities between boys and girls may encourage girls to opt for scientific and mathematical fields.

2.3.3 Self-identity

Possible links between personality and the study of science have revealed some very interesting results. Head (1980, 1985), Harding and Sutoris (1987) and Head and Ramsden (1990) have explored this aspect and they link subject choice to ego development. They argue that adolescents go through a process of crisis where there is intensive questioning and commitment about their beliefs so as to achieve ego-identity. Boys are typically less person-oriented and more objective, tougher-minded and less emotional; so they are more likely to choose science as science is usually presented in an impersonalised, objective way remote from human emotions. Girls at a similar age of development tend to avoid science as it is not a conventional choice. Adolescence is a period when girls become most concerned with their feminine development, the building up of identity and peer acceptance. Many girls undergo an erosion of self esteem during adolescence.

Within the school environment, gender identities are constructed through informal processes such as peer culture; young people almost inevitably have to respond and conform to the norms of their peer group in order to gain approval and acceptance. Girls are expected to adopt roles, behaviour and identities which allow inclusion and integration with their peers. These impact on their confidence, self-esteem and their engagement in academic subjects (Whitelaw *et al*., 2000; Rose & Smith, 2006). How an individual thinks, feels and behaves is related to his/her self-esteem (Kling *et al.*, 1999). To a certain extent, researchers have found that peers, parents and teachers exert some influence in the enrolment of students in science classes (Reid & Skryabina, 2003; Dalgety & Coll, 2004) though Schibeci (1989) contends that home background is not related to pupils' interest in science. Girls tend to be more influenced by their friends than are boys, particularly in single-sex schools (Johnston & Stelepeng, 2001). It has been suggested by researchers that peer culture tends to be an important factor in determining the behaviour and personality of young people (Breakwell, 1992; Warrington *et al*., 2000)). In certain respects, as the influence of the family on boys and girls decreases in the transition from home to school environment, interaction with peers can be particularly influential in the choice of science subjects. Gradually, peer culture manifests itself in the stereotyped gender-specific behaviours and attitudes of boys and girls. Being like their own sex generally matters more to the girls than having male roles which may be less valued by their peer group. As noted by Solomon (1997), girls are generally more inclined to study biology and less likely to choose physics.

Girls are normally more person-oriented and are often alienated by the way much science is presented. Science appeals to only a limited range of personal characteristics. Girls who do choose science are likely to be emotionally mature and have considerable self knowledge which enables them to sustain themselves in such choices (Harding, 1996). Only a very small group of girls display such less person-oriented characteristics (Lee, 1998). This may imply that science is a straightjacket (i.e. a mould which is expected to apply to all pupils) and appeals only to those exhibiting masculine traits. Harding and Sutoris (1987) have located the roots of girls' avoidance of science in their childhood days linking it to emotional insecurity, delayed autonomy and continuing dependence. The statistics for participation of girls in biology and the physical sciences suggest that there is a tendency for a similar trend in Mauritius (MES Statistics, 2010) and it is worth investigating what orientates girls towards subject choice.

Brickhouse *et al*. **(**2000) examined how female students participated in science and formed scientific identities in and out of school. Case studies involved African American girls in low achieving schools. It was found that they were confident in science if they engaged with it in ways that connected to them and when their teachers were more positive towards them. Gilbert and Calvert (2003) piloted a new methodology for approaching issues of gender that explored women scientists' relationships with science and reasons for pursuing it. Early indications were that women were then not alienated by science and its rational, unemotional analytical aspects. Ford *et al*. (2006) explored multiethnic elementary girls' access to and choices of science subjects; their findings indicated that girls preferred narrative genres, information and books about animals.

On the other hand, boys and girls are exposed to many influences regarding gender roles and tend to adopt gender-stereotyped behaviours and attitudes which are initially passed on from parents to children during the early years in the home. These gender stereotypes are reinforced as the children grow and develop and differences between boys and girls appear during early childhood as part of the social creation and embodiment of the 'self' (Martin *et al*., 1990; Etzkowitz *et al.,* 2000). Initially, the shaping of self-concept is influenced by those who are close (i.e. immediate family) to the child; gradually, during adolescence, other influences such as peers, role models and cultural norms tend to recast gender differences into gender stereotypes. The child thus may fearfully avoid what is considered as socially unacceptable and tries to conform to stereotypical social roles (Eccles *et al*., 1990). However, these researchers argue that the social environment at home, for example, parents, and fathers more particularly, may have an encouraging effect and support their daughters in developing an interest in science and mathematics.

Some educational researchers have argued that there are innate differences between male and female brains but there is little if any solid evidence for the idea that male and female brains are engineered to work differently (Hyde & Linn, 2006). Considerable research on girls' intellectual ability, notably in the area of spatial ability, has been cited as providing sufficient evidence to dismiss the notion of inherent deficiencies in the intellectual ability of girls (Kelly, 1981; Murphy, 1982; Harding, 1983; Whyte, 1986; Kahle & Meece, 1994; Abell & Lederman, 2007). These researchers concluded that there are no inherent biological differences between girls' and boys' intellectual ability. A more recent landmark study by the National Institute of Health using MRI to study normal brain development (Waber *et al*., 2007) found that mental performance differed very little with sex. Steven Rose, the Director of the Brain and Behaviour Research Group at the Open University in Britain, notes that men and women appear to be using different parts of their brain to solve problems but they come to the solution at more or less the same time. It seems clear that cognitive behaviours are more related to individual differences between people than to whether they are females or males. Therefore, differences between male and female brains are almost certainly not a major issue for the creation of the self in girls.

2.3.4 Social and cultural factors

Gender differences seem principally, or even entirely, to be the result of social factors due to the socialization experiences of males and females and the socially determined assumptions and viewpoints of researchers studying the area. Adolescence marks the point of significant transition for both sexes and it is a particularly difficult time for girls as they move from 'young girl' to the 'young woman' stage. The gender specificity of identity development has been further emphasised by Duveen (2000); boys and girls tend to develop different ways of responding to the world and making sense of it. Girls from a very young age take part in activities which are creative such as drawing, reading or talking whereas boys are generally observed to be more constructional and involved in technical tasks (Murphy, 1997, 2002).By taking part in activities which are characteristic of their sex, pupils develop gendered ways of being in the world (Murphy, 2000). Societal factors, childhood socialisation, the learning environment in the science classroom and altruistic reasons for choosing science have also been reported to develop gendered identities in girls (Baker & Leary, 2003).

One way of understanding the importance of these socialising effects is through the concept of 'cultural capital'. The notion of cultural capital was first articulated by Pierre Bourdieu and Jean Claude Passeron in 1973, with two other important forms of capital being economic and social capital. Cultural capital concerns forms of knowledge, skills, education and advantages that a person has acquired and is passed down the generations and gives him/her a status in society. Parents provide their children with cultural capital by transmitting to them the knowledge and attitudes needed to succeed in the education system (Bourdieu & Passeron, 1990). Parents play a crucial role in the creation of sex-differentiated values and self-perceptions. Though these effects may not be intentional, parents, perhaps unconsciously, promote gender-specific beliefs and behaviours which discourage their daughters from studying science, mathematics and other science related subjects. Andre *et al.* (1999), in their study on competency beliefs, positive effect and gender stereotypes of elementary students about science versus other school subjects, showed that parents perceived science as more important for boys than girls and expected boys to do better in science. They suggest that attitudes and beliefs about gender differences in science tend to start by the earliest elementary school years. The role of parents in the choice of subjects is an area that has not been explored in Mauritius and requires further investigation.

Normally girls are treated differently from boys from an early age by their parents; boys are encouraged by parents to be more adventurous and forceful and are more likely to have hobbies and interests dealing with electrical and mechanical devices; they may be asked to help their father doing technical tasks in the house and garden and use tools such as electric drills, saws and hammers. Girls, by contrast, are more likely to be asked to play with soft toys or to help their mother with housework and not to involve themselves in dangerous activities which could hurt them. Such interests, hobbies and behaviour could be linked to boys' preference for the physical sciences (Murphy, 1986; Whyte, 1986; Dawson, 2000). Many experiments in science involve equipment and tools which are unfamiliar to girls. Boys, therefore, get a better chance to process scientific knowledge in schools. Family background, such as having a relative who is in the engineering or scientific field, has been found to be another predictor of whether girls choose science or engineering career (Breakwell, 1992; Gogolina & Swartz, 1992; Dalgety & Coll, 2004). These researchers noted that having a mother or a father who strongly supported science was a predictor for greater involving in scientific activities and development of positive attitudes to science by pupils. Nevertheless, it has been found that parental influence for the study of science tends to decline as boys and girls grow up and relationships with teachers and other role models become more important (Johnston & Spelepeng, 2001; Jarvis & Pell, 2002a). However, in the Mauritian context, it may be that stereotyped beliefs and perceptions about girls and boys are gradually reducing as girls experience change as a result of modernisation of the society. Adolescent girls are continually changing and adopting new roles associated with their sex. Home environment and parental influence may be important factor influencing girls' choice of subjects in Mauritius given the fact that parents provide strong support to their children's education and their future career.

2.3.5 Nature and culture of science: masculine image of science

Researchers have examined ways of engaging girls and other marginalized groups in science by challenging the portrayal and the nature of science in the classroom and the world at large. Much science is often portrayed as difficult, objective and masculine. Earlier studies by feminist thinkers such as Evelyn Fox Keller (1985), Sandra Harding (1986) and Donna Haraway (1998) have argued that scientific knowledge, just like any knowledge, is very often influenced by the people who created that knowledge; historically, men being primarily the ones who worked in science, science is associated with traits which are masculine and lacking emotion. The masculine image given to science has been identified by many researchers (Kelly, 1978; Rosser, 1988, 1990; Archer & Freedman, 1989; Harding, 1991, Jones *et al.*, 2000; Miller *et al.*, 2006).

Such authors have contended that science, especially the physical sciences, is perceived by girls as an unattractive masculine province which excludes females and this perception is believed to be one of the greatest barriers that deters adolescent girls who would like to be seen as 'normally feminine' from showing an interest in pursuing studies in science after the compulsory level (Rosser, 1993). Science has traditionally been portrayed as factual, objective, male, masculine, culture- and value-free and dealing with phenomena rather than people. More males than females tend to choose science and work in science; science is therefore predominantly a male enterprise leading to a creation of an ecological niche which is supportive to males and not females. Perception of science as a masculine subject starts at a very early age and the greatest gender-related differences in her personality appear in the middle school years when a young female adolescent may see her feminine values, societal roles and science as being in opposition (Newton & Newton, 1998). Conformity to social roles is heightened and the study of science typically does not fit with the gender roles of female adolescents (Eccles, 1985; Kelly, 1988). It is very unfortunate that boys and girls often have to make crucial choices about subjects at about the age fourteen, during early adolescence, a period which is marked by physical, emotional and psychological changes and perhaps especially sensitivity to peer judgements about what is acceptable and desirable.

It has been argued that boys are more likely to identify with the physical sciences given their experiences of more physical, science-related activities such as model cars, tools and computers whereas girls show preferences for bread making, knitting and other feminine activities (Jones, Howe & Rua, 2000). In that study, science was presented in a way which related to the world of boys and men in the practice and applications of science and the choice of experimental topics for experimentation; the use of male subjects for experimentation and how data are interpreted and theorized are more characteristic of a masculine approach to the world. Perceptions of science as a masculine subject start at a very early age, the greatest gender differences in these perceptions beginning in the middle school years (Kelly, 1988). In her study regarding subject choice, Kelly found that boys enjoyed physics and technical craft more than girls and received greater support from parents, teachers and friends for continuing with these subjects. In science education, an inappropriate teaching and learning environment is created when science subjects are designed on a paradigm which is seen as male and patriarchal using measuring instruments which are associated with males. Gender bias and stereotyping of roles attract boys rather than girls to science. In a study of male and female participation in secondary school chemistry, Cousins (2007) argued that chemistry was not totally gender inclusive. School science all too often has little to do with the realities of the lives of girls, women and, as argued by Layton *et al*. (1993), even adults have difficulty in integrating it into the grain of everyday life. Furthermore, those girls who take mathematics and the sciences and perform well in them tend to drop the subjects at higher level and are less apt to pursue a scientific or technological career. To date, there is no research in Mauritius on girls' perception of science as a male domain which alienates them from studying science

Science subjects are often presented in a way that is seen as dispassionate, objective and of little or no relevance to the lives of girls and women so that they are put off by science, especially the physical sciences. The frequent depiction of males as associated with the physical sciences, for example the frequent association of advances in the physical sciences with men and the naming of units, laws, constants, hypotheses, equations, effects and experiments after male scientists, gives science a male bias (Harding & Parker, 1995). Though this is to a large extent inevitable, some explanations about the historical imbalance could be given to show such a representation and represent science as it was, is and should be (Powell & Garcia, 1985).

Similarly, Jan Harding (1996) has argued that the gendered perceptions of science alienate females and the constraining effects of stereotyping must be challenged. There should be recognition of the plurality of human beings and the diversity of science from which the world can benefit. Caring values ascribed to females and inclusion of human and environmental issues may increase the attraction for science. Girls generally have a higher personal interpersonal orientation than is the case for many boys and men (Jenkins & Pell, 2006). Studies on school and teacher effects (Crossman, 1987; Jones, 1990) have confirmed stereotypes and shown how girls are all too often discouraged from taking science.

Furthermore, interactions between race, class and gender need to be considered as science tends to exclude ethnic minority groups and girls from crossing the borders into the culture of science (Carlone, 2004). Kleinman (1998) studied feminist perspectives on the masculine ideology of science and found that this ideology perpetuated in society and the media. Some studies carried out by Bianchini *et al*. (2003) and Copobianco (2007) aimed at bringing the enactment of feminist pedagogy in their teaching in the science classrooms by bringing it to the attention of teachers. Bianchini (2003) encountered teachers' resistance whereas Copobianco (2007) in his collaborative action research with enthusiastic science teachers did not encounter this kind of resistance.

Science has been considered a subculture of Western culture with a well defined system of norms, values, beliefs, expectations and conventional actions (Aikenhead, 1996). This Western culture, which could explain why science can be alienating for girls and women in developing countries, symbolises materialistic, reductionist, empirical, masculine, competitive, exploitive and ideological characteristics. In many ways, the main goal of school science is to transmit both the subculture of school science and the dominant culture of the country. There are cases where the student's culture is in harmony with the subculture of science but if the student's culture is at odds with the subculture of science, then the student may abandon his/her indigenous culture and assimilate into the new subculture of science.

Indigenous knowledge systems have been acknowledged by researchers in Africa to link informal science with formal science as indigenous knowledge encompasses all the facets of people's lives (Oguniyi, 1988; Jegede, 1995).This point has also been emphasized by Aikenhead (2003) and Bystydienski (2004); they reported that students benefit from school science if it is integrated with humanistic (context-based) perspectives. There is a need for more reliable data over time to demonstrate whether or not Western science can meet the needs of people of different cultures. However, it has been pointed out that some students, particularly boys, do not respond well to the introduction of such humanistic perspectives in science if there is no proper guidance by the teacher (Aikenhead, 2003). Kelly (1988) noted that girls' choice to study biology rather than physical sciences may be a compromise to societal expectations and values though some girls may possess the ability to do well in the physical sciences. However, research has shown that there is heterogeneity in gender-related effects on science-related beliefs and attitudes across science-content areas, socioeconomic and racial groups (Kahle *et al*., 1993) or situational and cultural contexts (Lin & Hyde, 1989). Findings obtained from the Science and

Scientists project (Sjoberg, 2000) show that stereotypical male and female interests cross country borders and cultures; despite strong cultural differences, there were strong similarities between the lists of Norwegian and Japanese science topics favoured by boys and girls. Similar findings were obtained by Baram-Tsabari *et al.* (2005, 2006) in their comparative study of Israeli and international children's spontaneous responses in science lessons.

2.3.6 Relevance of science

Several researchers have explored the issue of relevance regarding students' interest in science; relevance is interpreted in terms of students' views about their interest in and liking for science and its usefulness either to their life or to their goals. Various studies have shown that gender inclusive science reflecting real world themes is more interesting for girls (Kelly, 1987; Rosser, 1993; Baker & Leary, 2003). These indicate that more girls than boys consider biology to be personally relevant to them in contrast to their views of the physical sciences. Girls seemed to like biology, people-oriented majors and the idea of health professions. Studies by Jones *et al.* (2000) and Miller (2006) addressed the negative image held by girls of much of science; they emphasized that girls were more attracted to biological sciences than physical sciences.

In a similar way, a study exploring the science-related interests and out-of-school experiences of 583 ninth grade students in Greece (Christidou, 2006) found significant gender differences between the interests of boys and girls. Girls were typically more interested in topics related to human biology, health and fitness whereas boys were generally more interested in science, technology and their social dimension and threatening aspects. The study indicated that the Greek science curriculum should be made more appealing and integrates topics and experiences that are interesting and relevant to the students' lives. Other researchers too have argued that students are more likely to find science as less of an alien pursuit if it could include examples and resources which are in their immediate local context and reflecting their local cultures (Brickhouse, 2001). In another study (Christidou, 2006) involving sixteen year olds pupils in Greece biology was regarded as more relevant as it is concerned with the human body, health issues and diseases whereas the abstract concepts in chemistry and physics were felt by the pupils to be of no use to them. Studies in the USA have shown that localization of the context has been found to render science more relevant to the experiences and lives of students from diverse and under-represented groups (Olden, 1993; Gibbons, 1992a). By contrast, Brickhouse *et al*. (2000) found that girls' affinity with science at age fourteen was related to their confidence in their ability to perform in science, and their interest in the operation of mechanical devices.

Students show more interest in science if the topic of enquiry is related to their own cultural knowledge, thus giving them greater pride in their own cultures. Carlone (2004), in an ethnographic study in an upper middle class school, addressed the culturally produced meanings of science and scientists and the ways girls participated within and against 'prototypal meanings' in a reform-based physics curriculum called 'Active Physics' which centred on real-world themes such as home, transportation, medicine and sports. Instead of the usual traditional prototypal science, this was meant to be an inclusive and inviting science for girls. The girls' response to 'Active Physics' was mixed; the girls were most concerned about maintaining their good prototypical student identities and resisted promoted meanings of 'science' and 'scientist' which they perceived as threatening in the project. They did the project because they were more concerned about getting good grades and gaining college admission. This project poses questions about those girls who were marginalised by traditional science; many questions were raised about ways that should be found to engage them in relevant, gender-fair science practices.

2.3.7 Teachers' attitudes towards pupils

School-related parameters such as attitudes of teachers towards boys and girls can be seen to be favourable or unfavourable, that is either positive or negative (Schreiner, 2005; Zohar & Bronshtein, 2005). Researchers have claimed repeatedly that there is differential treatment of boys and girls in science lessons with teachers interacting more with boys than with girls, and that this has a crucial influence on students' attitudes, motivation and continuing participationand achievement in science subjects (Labudde, 2000). In mixed-sex situations, male students have been noted to receive more teacher attention than females (Spender, 1982; Spear (1987), in a classic study, showed that teachers tended to favour boys and awarded higher marks if the piece of work was thought to have been written by a boy. Reiss (2000), in his study about gender effects on the interaction of boys and girls with their teachers in mixed-sex classes, found that the girls' participation in scientifically meaningful pupil-teacher utterances gradually declined over the period of the study with the boys increasing their oral exchanges with the teacher and making a greater impression on the teacher by their assertiveness. In physics, particularly, the nature of the teacher-student relationship is more important for girls than boys (Sharp, 2004; Krogh &Thomsen, 2005). It has been pointed out that although such relationships are important for all pupils, they are particularly useful in developing the positive self-concept of girls in physics (Murphy & Whitelegg, 2006).

Many studies have examined the teacher-student relationship. Kelly (1988), in her meta-analysis of international research on gender differences in teacher-student interactions of the quantifiable data obtained from 81 studies from the UK, Canada, USA, Australia and Sweden, concluded that girls showed willingness to participate in science lessons but did not receive their fair share of teachers' attention in class. Boys had a tendency to call out the answers to questions before being selected by the teacher to answer. Though girls raised their hands, they received less attention and were not able to participate as much as the boys. Other studies focusing on science lessons have obtained similar findings (Spender, 1982; Tobin, 1988; Delamont, 1990). It is very often reported that boys tend to dominate the classroom in physics and chemistry lessons in coeducational settings (Sorensen, 2006). Female students tended to be quieter and less active in class (Fennema *et al*., 1980; Morse & Handley, 1985). Thus, traditional sex-typing of the classroom environments gives science and mathematics a male image.

More recently, a small scale study about school-related factors carried out by Robinson and Gillibrand (2004) with thirteen year old girls confirmed the arguments put forward by Dawes (1996) that higher set girls' performance was better in single-sex grouping than mixed-grouping and their interest in science greater. Boys in the higher set benefited too but their interest and performance in biology were lower than the girls. Previously, Harding (1981) provided evidence that girls do better in science in an all-girls' school and an earlier classic large scale study by Dale (1974) had shown that pupils benefited socially from mixed schools and boys performed better in mixed schools than in an all boys' school, a finding which also has been confirmed by McEwen *et al.* (1987).

2.3.8 Role models

Role models have been suggested to make a difference to girls' interest in science as women role models may help to engage them in science by de-stereotyping the objective and value-free image of science (Kelly, 1987; Pettitt *et al.*,1995). It has been argued that male teachers tend to predominate in the physical sciences and girls could possibly be less attracted to physical sciences due to lack of female teachers acting as role models. However, Eggleston *et al.* (1976) have argued that the teaching style in science is more important than the sex of the teacher. How more women acting as role models could encourage more girls to study the sciences has been explored by Byrne (1993) who argues that a critical mass of women scientists is a significant factor for girls in science and mathematics and one way of achieving this is through affirmative actions such as recruiting more role models at higher levels of science. Interestingly, an initiative in the USA by Buck *et al.* (2002) cautions against this; they contended that pupils retained a persistent stereotypical image of science despite efforts made to change this by making use of role models. Furthermore, it has been argued that maternal interaction and socialisation have a particular influence on girls, indicating that there is a gender similarity of girls with the mothers whereas boys develop autonomy and separation from their mothers (Keller, 1986). Recent studies have pointed out that the gender of the teachers is not important; typically young people simply prefer teachers who can forge a good relationship with them (Skelton, 2002; Newman, 2000).

2.3.9 Attitudes of girls towards science

Young people's interest in choosing science is to a high degree influenced by the topics which influenced them in their preceding years. Interest does not only affect career and course choices but also the ability to learn (Dierking *et al.*, 2009). Research has shown that boys are, on average, more interested in science than girls (Gardner, 1975, 1998; Miller *et al.*, 2006) especially in physics and technology, whereas girls are more interested in biology than boys while chemistry is typically equally interesting to both sexes. These are findings from various countries (Friedler & Tamir, 1990; Kahle *et al.*, 1993; Woodward & Woodward, 1998; Farenga & Joyce, 1999; Jones, Howe & Rua, 2000; Osborne & Collins, 2001; Hoffmann, 2002; ROSE, 2005; Murphy & Whitelegg, 2006). The international studies (Sjoberg & Schreiner, 2005) conducted in Denmark, England, Finland and Norway and indicated that girls' interests were focused on the body, the mind, health and medicine whereas boys were more interested to learn about dramatic aspects of chemistry, physics and technology. It is noteworthy that in the past girls had to adapt themselves to a curriculum where for many years the school was a boys' institution, where subjects and school books did not cater for girls. Furthermore, it has been observed that towards the end of the second year of secondary schooling, there is a significant decline in girls' attitudes towards science relative to boys' attitudes (Reiss, 2000, 2004; Reid & Skryabina, 2003; Osborne *et al.*, 2004). Reid and Skryabina noted that factors such as students' enjoyment and liking for the subject influence course choice by students, particularly for the physical sciences. In Reiss' study (2000), many negative comments were expressed about chemistry as many chemical topics were remote from students' concerns and virtually unintelligible. However, Salta & Tzougraki (2004) contended that sex differences in chemistry were less pronounced than often presumed although boys tended to give the subject a higher ranking than the girls. More girls than boys tended to express negative attitudes regarding the difficulty of the chemistry courses as girls had stereotyped beliefs about the courses.

Negative attitudes about science held by girls deter young people from acquiring an interest in the subject (AAUW, 1992; Osborne *et al*., 2003; Miller *et al.*, 2006). Science is perceived as being too difficult, remote from the experiences of everyday life and more of a male activity. Studies undertaken by Johnson (1987), Woodward and Woodward (1998), Sjoberg (2000) and Reiss (2003) have demonstrated that boys generally prefer physical science topics while girls are attracted to biological/medical topics because of the humanistic elements present. Girls have generally outperformed boys in biology and overall there is a trend for boys to outperform girls in physical sciences (GCSE results in UK; School Certificate results, MES Statistics, 2008). The context in which science is taught is important according to the studies mentioned above.

Gender stereotyping perceptions of selected science courses have also been identified by Farenga and Joyce (1999) who, in their study of course preferences of young students between the ages of 9 to 13 in the USA, reported a strong gender effect where both boys and girls perceived physical science and technology-related courses as appropriate subjects for boys to study and life sciences as appropriate subjects for girls to study. Several studies, particularly Hoffman (1985), have showed that interest in physics progressively decreases among boys and girls with an increase in age; however, this is greater in the case of girls. The diminishing interest of girls in physics has been linked to the growing acceptance of their gender role. For example, there are topics which girls find attractive which Hoffmann and Haussler (2002) identify. They state that girls' interest in physics could be promoted if topics such as weather, rainbows, eclipses of the moon, astronomy, optics and presentation of physics in a biological or medical context were integrated into the physics curriculum. Girls would respond better to the physical sciences if scientific knowledge was more closely linked to their direct personal experiences and societal issues rather than to technical apparatus, engines and war materials. In their intervention study Hoffman and Haussler made use of measures in physics which adapted the curriculum to the interests of girls but which proved advantageous to boys too during a period of a whole year. Other additional measures involved improving the ability of teachers to provide girls with an opportunity to improve their self-concept about physics. The situation in Mauritius is unclear on the issue of girls' attitudes towards science subjects and needs to be addressed.

2.4 Gender-friendly strategies to retain girls in science

Girl-friendly strategies are interventions or actions taken to promote interest and motivate girls to engage in science and technology by making use of examples as scene-setting devices or as illustrations of phenomena (Whitelegg, 2006). Life examples which are often meaningful to both males and females are used emphasizing social issues, human activity, making use of personal experience, context, practical activities and curriculum and resource materials which have relevance to their everyday lives and which are sex-equitable in students' use of language and illustrations and examples (Kahle & Meece, 1994). One example is a US study by Freeman (2002) which showed that active participation involving laboratory and project work increased girls' engagement and achievement in learning science.

Prior to the mid 1980s the term 'girl-friendly' was used as the studies then focused more on girls and the science problem. Many of the intervention strategies were designed to boost girls' confidence and correct their misconceptions about science. Kelly (1987) discussed the terms girl-friendly, feminine and feminist science. Girl-friendly science is about making science more attractive to girls; feminine science demands a change in the classroom environment to place more value on caring and cooperation and feminist science involves valuing science as a personal development, adopting a more subjective and holistic approach to nature without privileging science over other forms of knowledge. Girl-friendly science has been criticised because it considered the girls to be the problem rather than 'science' itself. In the last twenty years the development of a growing body of literature has reflected the need for the reconstruction of women to science and the attributes that women bring to science (Manthorpe, 1982; Kelly, 1985; Bentley & Watts, 1986; Harding, 1991; Kenway and Gough, 1998). Gender-friendly strategies consist of the following, though a number of the approaches seem also to engage boys in their science learning:

- Collaborative/cooperative learning/active participation where through classroom discussion and group dynamics, imaginative and creative abilities can be encouraged (Gardner *et al.*, 1989; Harding & Parker, 1995).
- Hands-on experiences and investigations and any challenging visual and tactile or other experiences which develop practical skills.
- Use of science fairs, exhibitions, lunchtime clubs, visits to museums and interactive science centres.
- Experiences and examples from the personal lives of females to serve as role models and stimulate girls' interest in science and technology.
- Opportunities for boys and girls to explore opinions on science-related issues and to perceive science as a holistic and socially responsible subject that emphasises dependence and connection among humans, other living things and environment.
- Use of curriculum materials and resources which have no gender bias orsex stereotyping and are relevant to everyday life.
- Emphasis on the practical applications of science and technology.
- Use of appropriate language and teacher talk.
- Employment of learning styles and assessment tasks which suit both boys and girls.
- Taking account of variations among boys and among girls.
- Integration of information from the history of science.
- Paying attention to pupils' self awareness of the extent to which their education-related decisions and experiences are socially constructed.

The results when these strategies have been used are far from clear cut because most of the projects, for example Girls into Science and Technology (GIST) that have been implemented then have never been formally evaluated but these strategies have generally been more successful in changing girls' views about science than in changing their actual behaviour. Data gathered by GIST on the effects of such strategies showed that there was an increase in the number of girls who opted for the physical sciences in the eight 'action schools' involved in the project. Significant improvements were observed where teachers showed a strong commitment and showed willingness to change and bring about innovations and where women were in a position of authority and teachers were more encouraging towards the girls. Overall, the strategies had a positive effect on the girls. However, feedback obtained from the teachers showed that there was some reticence on their part to implement the strategies though the project made teachers aware about 'Girls and Science' as an educational issue which they agreed they should feel more concerned about. Some important projects that have had some success in relation to the above issues are: Girls into Science and Technology project in UK (GIST), Whyte (1986), Smail (2000); McClintock Collective Initiative (Victoria, Australia); Kreinberg and Lewis (1996), Rennie *et al.*, (1996); Clinic for Girls in Ghana (a project to remedy girls' interest and performance in science and mathematics, GASAT 9, Ghana, 1999) and the Supported Learning in Physics Project (SLIPP) in the UK (Whitelegg, 1996).

The GIST project was the first intervention programme in the UK aimed at improving girls' attitudes to the physical sciences and was funded by the Equal Opportunities Commission and the ESRC (Education and Social Research Council). The project was implemented in 10 co-educational schools of which eight were action schools. The project explored the processes by which children's attitudes to science, engineering and technology changed during the early years of secondary school; it also investigated, by working with teachers, how the gendered nature of subject choice could be affected by teachers' attitudes and behaviour. The eight 'action schools' in the project worked in collaboration with the researches to develop materials and activities that would get the girls more interested in the sciences. The children in those schools were followed from the point of entry in those schools until they made their option choices three years later. Some key aspects of the project were: girl-friendly curriculum materials, lunchtime science clubs for girls, observation of lessons and feedback to teachers, visits by women scientists, parents' evenings and classroom discussion and careers and subject choices talks by women in science. It succeeded in raising awareness about a girl-friendly science and informed research and action at the international level. It altered the approach to the teaching of science and made the curriculum more appealing by making it more girl-friendly. Smail (2000), after reflecting on the project's outcomes, concluded that it managed to raise the issues of the low participation of women in science. However the project was only relatively short lived due to lack of commitment by the teachers and in the end it turned out to have only a marginal impact on the masculine image of science among pupils.

The SLIPP Project (Whitelegg, 1996) was a context-based UK intervention in physics which introduced physics to girls through real life-situations. Concepts in physics were reinforced as they appeared in more than one unit in the course and this had the effect of making the subject more connected, interesting, understood and valued by the girls. The characteristics of the curriculum such as social contexts were found to be important in engaging girls' interest in science. Boys in traditional single-sex schools, on the other hand, did not welcome the context-based approach.

The McClintock Collective Initiative (Hildebrand & Dick, 1990; Rennie *et al.*, 1996) was started by a group formed in Australia in 1983 and aimed at embedding science learning, especially physics, in a socially relevant context. Gender-inclusive materials were produced and gender-inclusive pedagogic strategies were employed including interactive collaborative activities, the portrayal of science as a creative human activity drawing on personal experiences, the introduction of opinions on science-related social issues. School science was context-and non-content driven building on scientific ideas through activities related to the lives of boys and girls and ending up with theories with applications in industry and environment. The strategies had the effect of improving girls' participation and interest in science, more particularly physics in cases where the teachers' understanding of the project was clear. Most teachers felt that the approach made science, particularly physics, more interesting for their students.

2.5 The Mauritian situation regarding gender and science issues

In Mauritius, as introduced in Chapter 1 (Ministry of Education and Scientific Research, 1998) and as shown by more recent statistics (MES, 2008), there is an imbalance in favour of boys choosing physical science and the girls biology after the compulsory level at age fourteen. There is a gender gap shown by the pattern of girls' relatively higher interest in biology and boys' relatively higher interest in physics (with almost equal interest in chemistry by boys and girls). Though a higher proportion of girls choose biology, the overall enrolment in biology is still low compared to English which is a compulsory subject. This gender imbalance in female enrolment in science subjects beyond the compulsory level is of considerable importance and forecasts future skill shortages in the physical sciences. Mauritius has very limited natural resources but places a high importance on the quality of its human resources; both girls and boys are expected to play a crucial role in the technological, economic and social development of the society. The under representation of girls in science at the lower level of education will presumably affect participation at higher levels and eventually in scientific and technological careers.

As reviewed above, the factors which have been attributed to the under representation of girls in science are diverse. However, the available literature on the issue of gender and science that relates specifically to Mauritius is scarce. It is only lately that the notion of girls' under representation in science has begun to gain momentum; hopefully this project will contribute towards deepening knowledge in that area.

It is noteworthy that in high achieving Mauritian state schools girls achieve a higher percentage of passes in science subjects than boys (Mauritius Examination Syndicate Statistics, 2005; 2008). However, on the whole the boys score the best grades in the science subjects in both the School Certificate and the Higher School Certificate Examinations. It seems that bright girls do not appear to have much problem in doing science while other girls find science a difficult subject.

2.5.1 Teachers and science education

Most science teachers in Mauritius are well qualified, being graduates and having a teaching qualification, and they have an important role to play in preparing young girls and boys to emerge with sufficient knowledge and skills to face the future with confidence and become responsible citizens. As agents of change, they are expected to bring about a progression in pupils' learning through effective science teaching. Pedagogy which takes into account the differences between the sexes is seen to have been successful in many countries, but apart from superficial interventions in Mauritius (Commonwealth Secretariat, 2000-2003; GASAT Conference papers, 1993, 1996, 2000, 2003) science is still being taught to boys and girls in the same way as if one size fits all. In a small intervention study undertaken by Goel *et al.* (2000) in 12 pilot schools in Mauritius, low cost materials and examples reflecting the local culture and relevance to everyday life were used to produce gender-friendly resources for science at lower secondary level with the aim of popularising science mathematics, biology, chemistry and physics. Teachers were trained in their respective subject areas in writing materials at workshop sessions held at the Mauritius Institute of Education. They then tried the materials in the schools where they were teaching. Though the project was not evaluated, feedback received from teachers participating in the project at workshops held at the Mauritius Institute of Education showed that it generated interest of boys and girls in science. Teachers reported that the gender aspect was not very evident in all topics and they needed more time to get familiar with gender-friendly strategies to teach an already overloaded syllabus.

In another small scale intervention study carried out in a girls' school in Mauritius (Naugah & Ramma, 2000), gender-friendly teaching strategies comprising hands-on experiences and a constructivist approach were used to engage the girls in science lessons in a secondary state school. Data obtained from observations of lessons, unstructured interviews and survey questionnaires in the classroom under study showed that the girls found physical science enjoyable and interesting when gender-friendly strategies were used to teach science. The girls complained that not enough experiments were carried out by them during their normal science lessons in order to help them understand difficult concepts in physics and other science subjects and the chalk-and-talk method was mostly used during the lessons. Experiments were performed in a routine way without any understanding of underlying concepts. During the interviews, some of the girls mentioned that though they would like to study science beyond the compulsory level, their parents advised them not to but remarked that they were perfectly aware of the relevance of science to their everyday life. This study suggested that negative perceptions of science could be changed by adopting gender-friendly strategies. This point could be explored further in this research project.

The data logging project (2005-2008), an initiative of some researchers at the Mauritius Institute of Education, is being implemented in 12 pilot schools at Forms III and IV level with the aim of improving girls' and boys' mastery of physics concepts at upper secondary level so that they find physics appealing and enjoyable and eventually opt for a career related to physics. The project so far seems to be successful in most schools (Ramma, 2008).

2.6 The study's research questions

One way of organising the various levels at which the factors that can affect girls' participation in science is presented in Figure 2.1. Figure 2.1 provides a framework for the study. It includes the following:

- Self-identity (self esteem, confidence)
- Pedagogic reinforcement (teaching and learning)
- Social roles (of teachers, parents, peers)
- Philosophical clash (modernity, nature and culture of science) and
- National imperatives (scientific literacy, skills heeded at national level).

It is not intended that this thesis will address every level; only those that are relevant to the school setting will be explored.

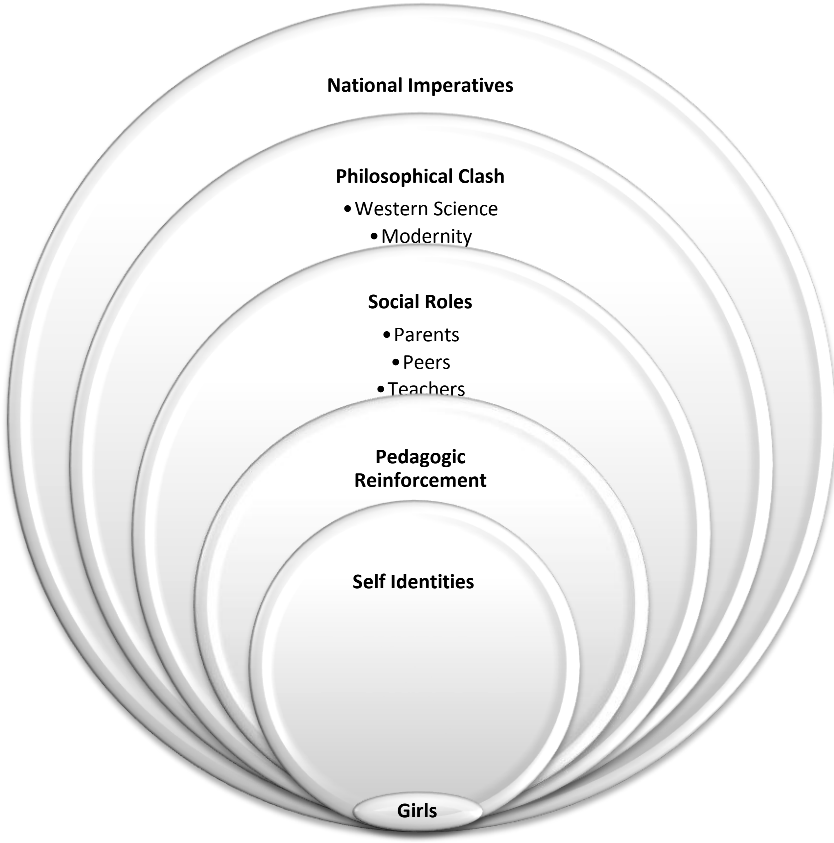


Figure 2.1: Tentative theoretical framework on which this study will be based.

Though some efforts through projects are being initiated to increase the participation of girls in science, concern for girls and the science problem is being expressed in Mauritius and more needs to be done at the policy level to remedy the situation. Given the fact that a module on gender issues has been integrated within the Post Graduate Certificate of Education, the Bachelor of Education degree and Master of Education courses at the Mauritius Institute of Education to raise teachers' awareness on gender issues, it is worth examining whether the gender element is being considered by teachers at school level. Given that science is assuming such importance, it is important to find out what is actually taking place in science lessons in Mauritius and the various factors that encourage or inhibit girls to study science beyond the compulsory level. This study is likely to interest policy-makers, curriculum developers, teachers, parents and others in the field as it is an in-depth original study using a multi-method approach which has not been used so far in Mauritius. The methods used for answering the research questions will be observation of lessons, interviews of pupils and teachers and questionnaires for parents.

In the light of the above literature review and to direct my study three inter-related research questions are therefore raised:

1. How is science taught at Form III level (the last year at which science is compulsory) in the case study schools in Mauritius?
2. Do parents influence the choice of science subjects in Mauritius and if so how?
3. What are the factors that influence girls to study science beyond the compulsory level in Mauritius?

Chapter 3

Research methodology

3.1 Introduction

As outlined in Chapter 1, my research aims at elucidating those factors that influence whether or not girls choose to take science subjects in Mauritius at the end of the third year of secondary education, which is the level up to which science is a compulsory subject. It investigates the context in which science is taught at Form III level (age 14 years) in Mauritius. For the purposes of the research, it was necessary to consider the context, for example schools, the pupils, the teachers, and the parents. The research thus tried to probe into the teaching of science at Form III level from a gender perspective, examining factors such as the self-concept of girls, the roles of teachers, parents and peers and the nature and culture of science. By investigating the teaching of science through lesson observations and interviews of those concerned, light was shed on how science was perceived by the pupils and teachers. In addition, parental questionnaires were used to clarify certain views expressed by both teachers and pupils.

This chapter deals with the research methodology including the pilot study and the effect the latter had on the methods employed in the main study. This research focuses on four Mauritian schools: two mixed-sexed and two single-sexed girls schools. As discussed in Chapter 1, the schools in Mauritius are either state-owned or run on a private basis. In the state-owned schools, the pupils are selected from the top band whereas in most private schools, with the exception of some schools termed 'confessional' which are run by religious bodies, the average and the less able pupils are admitted. The pupils admitted to the private schools typically obtain grades B to E at the Certificate of Primary Education (CPE) examinations whereas those in the state-owned schools obtain grades A+ and A. However, it must be noted that some private schools are highly selective and these are the confessional schools owned by the Catholic, Muslim and Hindu authorities. This study was carried out in three state secondary schools and one private-owned one. The majority of state schools are single-sex and for the purpose of the study I chose a private-owned school because it was a mixed-sex school. A distinctive feature of private schools in Mauritius is that all their teaching personnel are paid by the state and they get grants from the state for the maintenance of their physical infrastructure; the school building is owned by private individuals who manage the school and the staff members are appointed by the school manager. In the case of state-owned schools the staffs are appointed by the Public Service Commission which is the only body responsible for the appointment of officers in the Government service.

In planning my research, I addressed a set of questions regarding orientating decisions, the aims of my proposed research, the research paradigm, methodology, data analysis, presentation of data and the reporting of results derived from Cohen *et al.* (2000) and Robson (2002). The research is exploratory (Robson, 2002) and an interpretive approach within a qualitative paradigm is used mainly but I have also used a numerical approach to crosscheck certain issues which emerged. Qualitative data are the outcome of an interpretation by the researcher. At the same time, the researcher by operating in a detached manner can exercise some control over his/her 'self' and not allow his/her prejudices to affect the investigation to too great an extent (Denscombe, 2001, p.208).

Cohen *et al.* (2000) argue that the interpretive approach is characterised by a concern for the individual and that the observer "makes a difference to the observed and that reality is a human construct" (Wellington, 2000, p.16). On the other hand, quantitative paradigm which is characterised by the positivist stance, is one where the researcher uses objective and replicable claims to develop knowledge yielding numeric data employing pre-determined instruments (Wellington, 2000; Cresswell, 2003). The data are objective in the sense that the researcher does not unduly influence their production and analysis but no research can be free from the influence of the researcher(s) who conducted the study (Denscombe, 2007, p.300). The positivist researcher aims at searching for generalisable knowledge and obtaining 'hard' (and often) quantitative data (Wellington, 2000, p.15).

Such research attempts to mimic the natural sciences, separates facts from values and presumes that human behaviour is rule-governed. On the other hand, in the interpretive paradigm, “the central endeavour is to understand the subjective world of human experience” (Cohen *et al.*, 2000, p.36). It is about discovering and interpreting the subjective meanings which individuals acting singly or together use to make sense of the world. Therefore, the researcher tries to explore perspectives and meanings and develop insights into the situations; the data are generally qualitative and are based on fieldwork, interviews, notes and transcripts of conversations. The interpretive approach enables the researcher to explore perspectives and shared meanings of situations and develop insights and understandings on the human actions in the setting (Cohen *et al.*, 2000; Wellington, 2000). Here, the researcher her/himself is in certain respects the primary instrument involved in the collection and analysis of the data, and the nature of the data collected may be greatly influenced by the researcher’s self (identity, values, beliefs and social background). Since qualitative research aims at understanding the social world, the researcher is able to respond and adapt to the situation and “explore unusual and unanticipated responses” (Merriam, 2002, p.5). Quantitative research on the other hand is concerned with establishing numerical correlations or their relationships between variables but in this study I am not looking for correlations from parents in the parental questionnaire.

3.2 Aims of the study

In order to fulfil the aims of my research, three methods of data collection are used so as to investigate the factors influencing the low enrolment of girls into science beyond the compulsory level and to examine any qualitative relationships that exist between the teachers’ methods of teaching, their perceptions and attitudes and the views held by the pupils and their parents regarding science. The methods used for data collection are: observation of lessons, semi-structured interviews and questionnaires, the first two being the main methods of data collection whilst the last afforded a complementary perspective. By providing an understanding of the factors responsible for the unpopularity of science among girls at lower secondary level, I hoped to shed light on the prevailing attitudes and perceptions of teachers and pupils on the difficulties faced by girls in science lessons in the schools in the study, the influence of parents on their children's choice of science subjects at age fourteen and the children's eventual choice of career. The qualitative part of the study deals with the teaching of science at Form III level and the perceptions and attitudes of teachers and pupils towards science. The numerical quantitative part examines, by the use of a questionnaire, the part played by parents in influencing or not influencing their children in their choice of science subjects.

3.3 Research focus and determination of methods

In order to find out how science is taught at Form III level, I decided to observe the teaching methods used by teachers in the schools I had selected for my study. I observed the pupil-teacher interactions and tried to find out about the perceptions of teachers and pupils regarding science and science teaching by interviewing them, the infrastructure facilities available and other factors such as the influence of parents on the choice of subjects were also looked into. The gender dimension was taken into consideration during the above phases by focusing on equity and access, identity formation of the girls, gender-inclusive pedagogy, learning styles and socio-cultural issues.

After reviewing the literature regarding the methods and methodologies used in educational research to gather data, and guided by my aims of the proposed study, I determined the methods and research design of the project. After consideration of several research designs, I asked myself which methods were best suited to the task that I had at hand given the practical consideration related to time, resources available and access to the sources of data (Denscombe, 2005).

I identified the following resources which would help me with my research project:

- Administrative, namely the Ministry of Education and the schools.
- Human, namely managers and rectors of schools, officials of the Ministry of Education, teachers, pupils from the sample schools and the parents of the pupils in the sample.

- Relevant documents regarding science education in Mauritius and relevant literature on the subject.

I conducted a pilot study in a secondary school in Mauritius from April 2004 to early July 2004. I discussed the results of my pilot study with the supervisors and after considering the various issues emerging from the pilot study, I made some modifications to the semi-structured questionnaire for the interviews and the sample for the main study. The pilot study is discussed later in this chapter.

3.4 Target audience for the findings

I anticipate that the findings of the in-depth analysis of a particular situation regarding the factors affecting the choice of science subjects by girls at Form III level could be of interest to researchers, educators, policy-makers, parents and all those involved in the field of science education in Mauritius and potentially elsewhere. The knowledge gained from that situation can be transferred, with due acknowledgement of relevant differences, to similar situations (Merriam, 2002). In Mauritius I anticipate this research having a tangible effect with regards to the organisation and pedagogy of school science as I discuss in Chapter 7.

3.5 Research design

Design concerns turning research questions into projects (Robson, 2002). The approach in my research is mainly 'naturalistic' as it has the following features: first, it is carried out in a natural setting, which is the school, and the researcher is the primary data gathering instrument with methods that are mostly qualitative. A second point is that purposive sampling is chosen to explore events and situations occurring in the real world (Robson, 2002). My study is intended to bring about an advancement of knowledge in the field of science education in Mauritius regarding the low participation of girls in science at and above the age of fourteen. According to the aims of the research, discussed in Chapter 1 the present study focuses on three research questions:

1. How is science taught at Form III level (the last year at which science is compulsory) in the case study schools in Mauritius?
2. Do parents influence the choice of science subjects in Mauritius and if so how?
3. What are the factors that influence girls to study science beyond the compulsory level in Mauritius?

The first and the third questions deal with individuals' experiences and values and with organisational and cultural factors while the second one addresses the influence of parents. To achieve the aims of my study, I have adopted a multi-method design. I feel that the research questions will best be answered by a flexible design, namely using qualitative research to address the two research questions with some elements of both numerical and qualitative research for the second research question. As a researcher I am interested in insight, discovery and interpretation.

I chose a qualitative approach because the research questions sought to understand the processes that I wanted to study by using groups of people and settings where the research was carried out. One disadvantage is that the findings of the research cannot be generalised to a wider population. Nevertheless, as pointed out by Merriam (2002, p.29), the "rich thick description is a major strategy to ensure the external validity or generalisability in the qualitative sense". The qualitative approach is appropriate for the observation of behaviour in everyday life and the meanings that they convey (Silverman, 2006).

Although quantitative approach can tell researchers about inputs and outputs to some phenomena, it does not describe how the phenomenon is locally constructed (Silverman, 2006). Cohen *et al.* (2000) consider that quantitative approaches lack the explanatory power and fine detail of qualitative approaches. With a quantitative approach such features are lost due to "broad-brush generalizations which are free of the temporal, special or local contexts" (Cohen *et al.,* 2000, p.172).

Research design is governed by 'fitness of purpose' (Cohen *et al.*, 2007, p.78). This concerns the various things which should be considered when carrying out the research, such as the purpose of the research, the theoretical framework that will guide or inform the study, the research questions, the methods and the sampling strategy, the findings and so on (Robson, 2002). There are three major design strategies within educational research to choose from**:** the survey design, the experimental design and the case study design.

The survey design strategy is a form of research where the data are collected on a large scale mainly by questionnaire or by structured interview in order to make generalisations. These data are then examined to determine any patterns of association. It is a method of data collection that operates by asking a set of pre-formulated questions in which the sequence is often predetermined, as in a structured questionnaire, to a sample of individuals who are supposed to represent a defined population (Hulton, 1990). It generally leads to statistically manipulated data.

Experiments involve the "creation of an artificial situation in which events that generally go together are pulled apart" (Blaxter *et al.*, 1999, p.68). The experimental approach attempts to establish relationships between variables under controlled conditions where the researcher can manipulate one variable and observe the effects that it may have on another variable (Dowling & Brown, 2010). The experimental design is widely used in the natural sciences and can yield data which enable causality to be established with some rigour. This design, however, is rarely suitable for social research as the vast majority of independent variables in social research cannot be manipulated under controlled conditions in artificial settings; such a design can also raise ethical issues for participants.

A case study design strategy can be seen to be either the examination of a single instance in action or a study of particular incidents or events over time (Walker, 1986). Case study design entails a detailed and in-depth analysis of one or a small number of cases (cf. Stake, 1995). In this study I have used an interpretive lens to examine as cases four secondary schools. In addition, this approach is ideally suited for small scale research as it focuses on a small number of instances. It has to portray, analyse and interpret the uniqueness of real individuals and situations though accessible accounts. The bounded system, as clarified by Stake (1995, p.2), could be “a child, a classroom of children or a particular mobilization of professionals …”.

Furthermore, the nature of my research questions is important; the ‘How’ and ‘Why’ questions in my research are appropriate for a case study (Yin, 1984, 2003, 2009). The qualitative questions aim at exploring how processes happen, how different people perceive and respond to these and untangling the complexities, complications and contradictions. Case studies can be attention-holding, illustrative, insightful, illuminating and strong on reality but researchers have expressed concerns about issues of generalisability and validity (Bogdan & Biklen, 1992; Woolcott, 1995). These problems can be tackled by taking certain steps such as defining what the case is and what is the unit of analysis – for example, the pupils, the teachers, the parents and the school – and being explicit as to why the researcher has chosen that case – for example, in this study, an interesting feature or a typical instance with regards to the low enrolment of girls in science after the compulsory level. In general, in case study work, the findings, though they are restricted to one or a few cases and are in some respects unique, can be related to similar cases or contrasted with other cases of comparable type by the researcher, thus allaying suspicions about the credibility of any generalisations made. It is possible for people reading case studies to relate to them even though they are not generalisable. As the study of the four cases in this research is generally a multi-method approach, in order to capture the complex reality which is under scrutiny, there can be validation of data through corroboration (Wellington, 2000). Stake (1994, p. 291) identifies three main types of case study:

- Intrinsic case studies (studies that are undertaken to understand a particular case in question);
- Instrumental case studies; (examination of a particular case in order to gain insights into a theory or an issue); and
- Collective case studies (groups of individual studies that are undertaken to gain a fuller picture).

I chose the case study design because it has other special features which can be particularistic, descriptive, heuristic and inductive (Merriam, 1988). The particularistic case study focuses on particular groups of people confronting specific problems and takes a holistic view of the situation whilst in a descriptive study there is a 'rich, thick description' of the phenomenon under study. I believe that the descriptive case study design comprising collective case studies of four schools used in this study will provide a better understanding of social phenomena and thus provide, as best as I can, a compelling interpretation of the situation regarding science education from a gender perspective in Mauritius.

The use of a multi-method approach is another potential strength of this study: the observation of events and the data obtained through interviews of teachers and pupils are combined with the collection of documents from the setting while the questionnaires used to get the views of parents help to provide a particular point which is of value to the study being undertaken (cf. Denscombe, 2005, p.31).

3.6 Sampling

The sample size in this study is four schools. The style of my research in part determined the sample size, and the theoretical basis of the sampling method I decided upon was 'purposive sampling' (Silverman, 2000). As a non-probabilistic procedure, purposive sampling has the disadvantage that the findings cannot be generalised to a wider population because of its non-representativeness. In purposive sampling researchers hand pick the cases to be included in the sample on the basis of their judgement and the cases' typicality and thus build up a sample that suits their specific needs satisfactorily (Cohen *et al.*, 2000, p.103). As stated by Denzin & Lincoln (2000), Silverman (2000) and Robson (2002), purposive sampling allows the researcher to choose a case in which s/he is interested. Furthermore, I chose purposive sampling because of the time and resource limitations. I was trying to research an area in Mauritius which still needed exploring; I expected to obtain meaningful data that would underpin further research in future. As stated by Denzin & Lincoln (2000, p.370) "Many qualitative researchers employ purposive, and not random, sampling methods. They seek out groups, settings and individuals where … the purposes being studied are most likely to occur".

The data were consistently obtained and I used data from four cases and three different methods as, so far as possible, to enhance validity, reliability and trustworthiness. As participation in the study was voluntary and purposive sampling helps to enhance the qualitative data collected, the label of convenience sampling applies to the type of purposive sampling used (Wellington, 2000, p.61). As my research focused on the choice of science subjects from a gender (principally female) perspective, I had to decide on the choice of schools and plan my work in such a way that I could obtain data that would answer my research questions. Other reasons for the choice of the schools in my main study were that they were easily accessible, it was easy to contact the participants in them and some of the teachers and rectors were known to me. I anticipated that they would agree to cooperate in the study and would provide me with the data that I needed to collect.

3.6.1 Schools selected for data collection in the main study

Most secondary schools in Mauritius are single-sex; there are only a small number of co-educational secondary schools. The four secondary schools in the case study were purposively selected so as to include two co-educational schools and two single-sex girls schools since, as the problem of choice of science subjects is more of an issue with girls, this sample meant that I was likely to come across the situations which I was trying to research in the schools sampled while also being able to see whether the presence of boys was important. Mauritius, being a small country where, theoretically, facilities exist equally in the schools located in towns and villages, the issue of rural and urban schools did not really apply. It is to be noted that the facilities inside the schools are not the same (Table 3.1). Furthermore, regionalisation of schools by the Ministry of Education has made it possible for pupils from both rural and urban areas to have access to the schools in the region or zone; for example, School A in the main study has a catchment area which includes both rural and urban areas. At each of the selected schools, I had meetings with the rectors and obtained useful information on the schools concerned as shown in Table 3.1.

Schools	A	B	C	D
School charact-eristics	• Single sex. • Girls; 700 pupils. • State school. • Good infrastructure: staff room, furniture, computer room, photocopying facility and library. • Six science laboratories.	• Mixed sex. • Selective boys and girls; 900 pupils. • Private school. • Good infrastructure: new school building for pupils of Form 1-3; staffroom, laboratories under construction. • Three science laboratories in upper school.	• Single sex. • Girls; 700 pupils. • Highly selective. • State school. • Good infrastructure: new building. • Staffroom, three science laboratories still in process of being equipped; computer room and photocopying facility.	• Mixed sex. • Boys and girls; 900 pupils of mixed ability mostly from middle to bottom range. • Private school. • Good infrastructure but renovation in progress. • Laboratories for biology and chemistry; physics laboratory under renovation; physics practical is carried out in chemistry laboratory.
Location	• Rural residential area.	• Quiet semi-urban area.	• Urban area.	• Very busy semi-urban area.
Social characteristics	• Catchment area both rural and urban. • Mixed ethnicity (Hindu, Muslims and Creoles). • Mixed social background.	• Catchment area both urban and rural. • Mixed ethnicity. • Middle affluent class background.	• Catchment area mostly urban. • Mixed ethnicity. • Middle class background.	• Catchment area is semi-urban and rural. • Mixed ethnicity. • Mostly from working class background.
Human resources	• Teaching staff = 70. • Six science teachers: two for each science subject; one laboratory	• Teaching staff = 80. • Three science teachers in lower school: one for each subject; one	• Teaching staff = 35. • Three full-time science teachers for each subject and one part-time physics	• Teaching staff = 80. • Nine science teachers: three for each science subject; one laboratory

	attendant for each laboratory.	laboratory attendant for each laboratory.	teacher; one laboratory attendant in each laboratory.	attendant for each laboratory.

Table 3.1: Comparative summary of case study schools.

3.7 Methods of data collection

In order to fulfil the aims of the research, four concurrent methods of data collection were employed: classroom observation of lessons, semi-structured interviews with teachers and pupils, questionnaires for parents and documentary analysis. Each method of data collection can look at the situation from a different angle that is, each from its own distinctive perspective so that comparisons and contrasts can be made. The use of multiple methods allows the researcher "to understand the topic in a more rounded and complete fashion than would be the case had the data been drawn from just one method" (Denscombe, 2005, p.132). Each method will be thoroughly discussed in Chapters 4 to 6. The numerical data will be analysed and presented in the form of simple graphical displays in Chapter 6.

3.8 Triangulation

The proposed methodological structure had the aim of obtaining a complementary perspective on the problem rather than a competing one. In triangulation, two or more methods of data collection are used to study the observed phenomena from more than one standpoint. Triangulation is a powerful way of demonstrating concurrent and respondent validity, particularly in qualitative research. Multiple sources of data aim at corroborating the same fact or phenomenon (Yin, 2003, p. 99) and case studies using multiple sources of evidence tend to be viewed to be of high quality. The system of triangulation at the source of data, collection level and interpretation of each research question can enhance the credibility, transferability, dependability and confirmability aspects of a piece of resource (Denzin & Lincoln, 2000) though it can lead to replication of biases and errors in interpretation. I used the multi-method approach for the following reasons:

- In situations where human beings interact, a single method may only provide a limited view of human behaviour and of situations. Multiple methods can be used to triangulate; certain aspects provided by one method may complement data obtained by other methods.
- Research methods act as filters through which we can selectively experience the environment; therefore, they can never be entirely authentic or neutral in representing the world of experience (Smith, 1975). So, the researcher's picture of the particular portion of reality s/he is investigating may be distorted by the exclusive use of one method. I have chosen to use methodological triangulation as it enables the researcher to assess the validity and reliability of the data. I used multiple sources of evidence to corroborate my findings and develop converging lines of inquiry (Yin, 2009, pp.98-99).

3.9 Biases, errors and quality of data

In qualitative research, at the very outset, the researcher should clarify personal values, experiences, assumptions and biases. I tried to ensure objectivity and remove biases and errors that might shape the way I view, collect and interpret the data. The questions were worded clearly and unambiguously during the interviews and in the parents' questionnaire. The observation of lessons was gathered in as clear and faithful way as far as possible. I made rich, detailed descriptions of events, the settings and other relevant information relating to the research questions (Robson, 2002). In any research, the elimination of all bias is impossible but as the data are gathered from multiple sources, that is, from children, teachers and parents, useful insights are provided, hence minimising bias and maintaining the quality of the data (Cresswell, 2003). The 'observer effect' is a possibility as case study research tends to involve the researcher being on site over a period of time and the researched may be conscious of being 'under the microscope' (Wellington, 2000; Denscombe, 2005). Before starting the actual data collection, I spent some time in the setting so that the participants became accustomed to my presence and I became, at least to a certain extent, a 'part of the furniture' in the setting and had minimal interaction with the participants (Denscombe, 2005). I would arrive in the class five minutes before the start of the lessons and sit right at the back of the laboratory or classroom with my head down, thus avoiding eye contact with the pupils. As I was focusing my attention on selective sets of phenomena, sitting at the back was a vantage position which allowed me to see what was happening during the lessons. After each observation of lessons, I met the teachers and discussed any pertinent issues which I felt required further clarification. Moreover, I observed 20 lessons in each school and was engaged in the setting for a sufficient length of time to obtain reliable data. The pilot study I carried out provided a good introduction to researching lesson observations. I was approaching the situation to be observed with as open a mind as I possibly could, trying to find out what was going on and discovering some meaning out of what was being observed. I will discuss the issue of the advantages and disadvantages of acting as a non-participant observer in Chapter 4 when dealing with the observations of lessons in the main study.

3.10 Ethical issues

Ethics is a vital part of any research project and it enshrines such principles as informed consent and the avoidance of harm. When studying people, ethical considerations need to be considered in the planning, conduct and presentation of the research so as to protect the rights of the participants better in the research study (Spradley, 1980; Merriam, 1988). According to Bassey (1995), the three major ethical issues around which social research revolves are: respect for persons, respect for truth and respect for democratic values. Conscious of the fact that I might to some extent be invading the private world of the participants and seeking to ensure that no harm or injury should be caused to them in the research, I took the necessary care to get the participants' informed consent in each school. At first, I could sense that they were a bit wary of my presence in the school, but I soon gained their trust and confidence after assuring them that anonymity of the participants and the location would be preserved by making use of pseudonyms. The pseudonyms chosen for individuals would protect against identification but they were names which would portray gender and ethnicity as far as possible. The schools would be identified as A, B, C and D. First and foremost, I ensured that the rights, needs, desires and values of all those involved in the research were respected as the validity and worth of a study are to a large extent dependent on the ethics of the researcher. I wrote down in my letter to the Ministry of Education and the rectors the details of the research project, how it was going to be conducted and the benefits that were likely to emerge from the investigation. Other gate keepers approached were the manager in the private secondary school concerned and the directors of zones and the senior chief executive of the Ministry of Education and Scientific Research. In all cases I made sure that honesty and openness prevailed (Wellington, 2000). The four rectors and all the teachers who were likely to be involved in the research in the four case study schools were made fully aware of the nature and purpose of the research at meetings which I held in the respective schools so that they could decide whether or not they wanted to participate in the research. I gave them an indication of the time that the observation of lessons and interviews would take so as not to disrupt the schools' normal timetabling arrangements and other activities. They understood that the research was in no way intended to cause any harm to them or their institution and that their rights and interests would be guaranteed. It has been argued that absolute anonymity and confidentiality are complex issues in qualitative research and that informed consent can be difficult to obtain. This was not the case in my research project because the participants, both teachers and pupils, were aware of my identity as a member of staff of a responsible institution in Mauritius and believed that I would follow all the necessary procedures regarding research ethics (Dowling and Brown, 2010).

I thus obtained the informed consent of the teachers and rectors in the form of oral assent. I had to ensure that no harm would be caused to the participants by their involvement in the research. I gave the participants an assurance that their responses would be anonymous and confidential as their identities would not be disclosed, including at the stage of publication of the findings. The participants were made aware that that they were free to withdraw consent and discontinue their participation in the project at any time. By participating in the study, the participants might feel that I was portraying their lives in a way that would risk exposure, embarrassment, loss of self-esteem or standing, employment and reprisal.

The issue of psychological harm does not really arise as the investigation was unlikely to be potentially stressful or traumatic for the participants. I told the rectors and all other participants that a copy of the final report will be sent to the school and the Ministry as an incentive for taking part in the research. I followed the British Educational Research Association (BERA, 2004, p.5) ethical guidelines ensuring, for instance, that I sought permission from the right people through the right channels. Though some researchers argue that such guidelines have some gaps and say very little about children, I was particularly conscious of the fact that special care needed to be taken when interviewing children up to school leaving age. Some interesting ethical questions have been raised by some authors regarding the design, implementation, dissemination and evaluation of research involving young children (Alderson & Morrow, 2004; Alderson, 2005). They argue that thoughtful communication, information sharing, support and respect for children, parents, guardians and other players in the project are important. There should be a balance between potential harms and benefits that the children taking part in the research project will get. In the study reported in this thesis, children's rights were respected and their views were valued and kept confidential whilst keeping anonymity in mind. It has also been pointed out that when dealing with children, consent may raise hard unresolved problems, for example, when observing a whole class, there might be a possibility that one or two children could object (Alderson, 2005). There was no objection from anyone involved in the project because prior to the design and implementation of the project I had discussed the research fully with all participants both young and adults. Their participation was voluntary, at least to a certain extent, and there was no coercion for any of the participants to join the project.

When observing lessons and interviewing teachers and pupils below school leaving age, it was necessary to obtain the permission from the school rector in each of the case study schools. With the permission of the rector, I had a briefing session with the pupils whose lessons I was to observe and explained the project to them, pointing out how results of the research project would benefit society and asked them for their participation. The children felt they were important as they were participating in research which might prove worthwhile for the advancement of learning (Spradley, 1980; Cresswell, 2003). I informed them that I hoped to be interviewing some of them at a later stage. I did not force them to do anything. According to the rectors, there was no need to obtain the permission of parents as they (the rectors) were acting in *loco parentis*; they told me that they would inform the parents about the project. Additionally, as I was to administer a questionnaire at a later stage in the data collection, the parents of the children were made aware by me about the purpose of the research and the procedures to be used. None of the parents expressed any objection at any time while the research was being carried out.

Since the Ministry of Education would be interested to receive a copy of the research report for strategic reasons, ensuring confidentiality by the researcher for the participants in the research and issues such as responsibilities of participants, stakeholders and organisations were also made clear. The reporting of my results would be as true as possible and would not cause damage, stress or humiliation to the participants as the identity of the participants would be kept confidential. It is a policy in Mauritian state schools for teachers to get transferred to other schools in different regions in the country after a period of four years; this would make it difficult for the teachers to be identified at the time of the writing up of the research report.

The researcher plays a key role in data interpretation and may influence, disturb or affect what is being researched. Covert access for observation studies was out of question in this case. My identity as researcher would be bound to be discovered by the participants as I was intending to spend an extended time in the schools. I could not pretend to be a member of the staff as a non-participant observer: for one thing, I am fairly well known by most staff of the schools concerned. As an overt non-participant observer, I tried to show complete detachment and thus minimise the reactivity effects of the observer (Hammersley & Atkinson, 1983). Humans have self-awareness and when they become the focus of attention for research, there is a possibility that they will alter their behaviour and act differently. As stated earlier, the fact that I would be spending some time in each setting and have very little interaction with the participants would help to minimise the 'observer effect' and thus make it more likely that I would become 'part of the furniture' (Denscombe, 2008, p.53).

3.11 Data collection and gaining access

The pilot data were collected during the period January to April 2004 and the main data collection took place from September 2004 to October 2005. As stated by Wellington (2000), access can be a problem in any research if not arranged well before a research project is designed, planned and the sampling decided upon. Before embarking on the fieldwork both in the pilot study and the main study, at a very early stage I planned with the school rectors the dates when I was going to collect the data in each school involved. In the case of the pupil interviews, the rectors were very cooperative and they took the responsibility of informing the pupils and through them the parents. The parental questionnaires were politely addressed to the parents with a covering letter. The contents of the questionnaires were explained to the pupils; they were expected to provide their parents with any help they might need in the completion of the questionnaire.

3.12 Observation

Observation is a method used by researchers to acquire a deeper understanding of social phenomena not obtained by other methods. Observations are powerful tools for obtaining insights into classroom situations (Cohen *et al.*, 2000). Unlike the interviews, the observation of lessons gave me the opportunity to see things as they happen in real life situations. As Cohen *et al*. (2000) note:

> Observational data are attractive as they afford the researcher the opportunity to gather 'live' data from 'live' situations. The researcher is given the opportunity to look at what is taking place *in situ* rather than at second hand (p.305).

The observational data afforded me the opportunity to see closely how events took place in the schools I was studying. Though I have worked for many years in school settings, I had never thought of analysing the actions and behaviours of people through the lens of a researcher. As an observer I could describe what I saw and watching people in their natural settings was a wonderful experience for me. I have been in the business of observing pupils and teachers in my profession but observing for research purposes helped me to understand better what people do rather than what they say they do. Observation, apart from being an empirical method for first hand data collection involving fieldwork, allows the researcher to observe things as they normally take place so long as the naturalness of the setting is not affected by the presence of the observer. This point will be discussed in Section 3.12.2.

3.12.1 Selection of the appropriate type of observational method

Essentially, there are three approaches to observation: the first is a systematic one where the researcher uses a pre-coded observation schedule with a checklist of items and makes a record of events as they occur. As a consequence, the data lend themselves to statistical analysis. In this type of observation, different observers can look at the same item or event and record, for example, for how long and how many times an event occurs, and they record the data thoroughly and systematically thus producing data which are consistent between the observers, thereby producing data with high inter-observer reliability. However, data obtained from such an observation schedule would, on balance, have had too great a risk of not being appropriate for issues that I was investigating. I did not use an observational schedule as I wanted to remain open to recording any relevant data, even if rare or unanticipated that helped me to address my research questions. An observation schedule tends to operate within the agenda of the researcher and certain aspects of the four settings in my research could possibly be neglected if they do not appear in the schedule. Furthermore, systematic observation with a pre-coded observation schedule would have fixed hypotheses, and observational data would have to confirm or refute those hypotheses (Cohen *et al.*, 2000). In this research, I tried to approach the situation with an open mind and not to bring pre-conceived ideas to it, so a pre-conceived schedule would not fit with this approach. Though I was looking at the engagement of girls in science I did not know in advance what key issues would emerge from my observations of lessons.

The second type of observation is participant observation. Participant observation operates in a way in which the "observer participates in the daily life of the people under study, either openly in the role of the researcher or covertly in some disguised role, observing things that happen, listening to what is said and questioning people, over some length of time" (Becker & Geer, 1957, p.28). Participant observation would have meant staying in the setting for a longer time on a regular basis, in a covert fashion taking the role of researcher in an undetected way and engaging fully in the activities of the schools under investigation. This was not really possible for me as I had only a limited length of time to carry out the fieldwork. In addition, such an approach would require the researcher to place greater emphasis on depth than breadth; it would have meant restricting my work to just one school or perhaps two, something that I was reluctant to do for the reasons discussed above.

Robson (2002) has made a clear distinction among the different types of observation and I find myself in the category of the third type which is unobtrusive non-participant observation which is non-reactive, where the observer does not get involved in the setting but keeps aloof from the events and the setting and the participants become habituated to the repeated presence of the observer in the setting. I never intervened in any of the lessons I observed, however much, as a teacher, I felt like it at times! This non-participant type of observation was appropriate in this study because it was impossible for me to act in a covert fashion, in part because my role was known to the teachers and the rectors, and to some extent by the pupils too. Good non-participant observation demands that considerable fieldwork should be carried out in the setting, and that the researcher establish a certain rapport and trust with participants so that data generation can occur with minimum disruption in the setting and be recorded in the form of rich description. As a researcher, after spending some time in the setting, I managed to gain the trust of the participants and become accepted as a member of the group in the setting but I was careful at the same time to retain a certain detachment by not getting too involved or engulfed by circumstances. There was therefore no question of my going 'native' in a school setting (Delamont, 1992, p.34).

Initially, I spent a week in each school carrying out unstructured observations of the setting and some lessons and the subsequent observations became more structured as categories could be specified. I simply took 'field notes' in the setting and evolved a set of categorisations for events and interactions as the study proceeded (Blaxter *et al.,* 1996; 2002).

3.12.2 Advantages and disadvantages of observation

Advantages

The classroom observations had the following advantageous characteristics:

- They were direct as I had immediate contact with the setting and the participants and there was a certain freshness to the data.
- My data were collected *in situ* in real life situations. This allowed me to obtain first hand empirical data. I maintained field notes; I wrote up rough notes promptly and regularly. I would re-read those notes, interpret them and write analytic memos before next going to the site. This helped me to focus, plan my time and look for anything that needed special attention such as some unusual incidents.
- The data were collected in a natural way as I observed events in a classroom setting and recorded the events as they happened. I tried my best not to cause any disruption to the naturalness of the setting by my presence. As an observer it did happen that my views on certain issues were sought at times and I tried my best not to commit myself and avoided taking any active part in participants' activities and experiences. However, other researchers, such as Adler and Adler (1994), have pointed out that some involvement in situations is likely to happen during observations. I tried to be detached from the setting to the best of my ability by avoiding any social interaction with the participants.
- The data obtained from observations were further enriched by other data-gathering techniques such as interviews and questionnaires.

Through the observational data, I hoped to have some explanations of the phenomena that were being observed (Cohen *et al.*, 2000), such as what is happening in the setting, how do the participants interact, are the participants actually doing what they say they are doing, what teaching strategies do the teachers use, how do the pupils respond and what makes certain events happen. In observing the classroom life, as a non-participant observer, as in the pilot study, I observed the setting, the layout of the room, the seating plan, the materials used for the lessons, the lessons' contents and the quality of the teacher-pupil interactions, the extent to which they were girl-engaging or not. I watched the teacher's physical movements, recording verbatim what they said as far as I could and noted the pupils' activities and their interactions with the teacher and each other. Observation notes were taken at regular intervals of five minutes. Critical girl-related incidents were noted too whenever they occurred.

Disadvantages

However, observation as a technique for data-gathering has certain weaknesses:

- According to Kerlinger (1986), the observer may make some erroneous inferences from observations. Some events may be mistakenly reported or interpreted as they might be susceptible to observer bias. Besides, an observer may select some events to observe and ignore others that are equally important.
- The observer's presence may have an effect on the behaviour of the observed and create an artificial situation.
- It makes high demand on time, resources and effort and it may happen that though a lot of time was spent in observation, the research may not yield much significant data.

I will discuss this method further in Chapter 4.

3.13 Interviews

Interviews were the other main method of data collection besides the observations of classroom lessons. Whilst observations allowed me to study people's behaviour in 'strange' situations such as classrooms (Wellington, 2000), interviews yield rich insights into people's experiences, thoughts, views, opinions, values, aspirations, feelings, prejudices, attitudes and life stories (May, 2001). Interviews allow the researcher "to interact with people, to talk to them, to listen to them and gain access to their accounts and articulation" (Mason, 1996, p.40).

I felt that the use of interviews of both pupils and teachers would help to elicit views and perspectives so as to provide a deeper insight into the topic under investigation. In a research study, interviewing people of any age can prove to be an interesting and even enjoyable activity (Wellington, 2000). Whilst observation allows me to study the behaviour of people in a particular situation, interviews can yield data by reaching parts which other methods cannot and to understand how participants see the world (Patton, 1990).

3.13.1 Advantages and disadvantages of the interview method

I considered adopting this method of data collection after having weighed its advantages and disadvantages.

Advantages

The short summary given below highlights advantages to conducting the interviews:

- I made prior arrangements with the participants for a convenient time and location thus ensuring a relatively high response rate.
- Depth of information was obtained through the way the questions were structured and the trust that developed by assuring the participants that their responses would be anonymous and confidential.
- Participants were given the opportunity to talk and express their thoughts, opinions, ideas and feelings freely to someone who showed a certain keenness to listen and note their opinions and ideas without being critical about them. This gave a more personal element to the interview method.
- The use of simple equipment such as a tape recorder, pen and a notebook were all that was needed. During the pilot study I improved my interviewing, recording and note-taking skills.

- There was flexibility in the way interviews were conducted and I tried to make some adjustments during individual interviews.
- It allowed for validity checks as my direct contact with the interviewees enabled me to check the accuracy and relevance of the data as they were being collected.
- The fact that I noted and audio-tape-recorded what interviewees were saying during the interviews made them feel important as they felt they were taking part in research which might prove beneficial and worthwhile for the advancement of science education in Mauritius. Both teachers and pupils participating in the research project were eager to participate and contribute as much as possible.

Disadvantages

- Interviews are time-consuming and care had to be taken so that the interview did not last too long and make unreasonable demands on busy interviewees. An agreed length of time was suggested and I kept to my undertakings in all cases; on average, the interviews each lasted 35 minutes. I planned the interviews carefully, making the necessary arrangements, confirming them and rescheduling them where the time was not appropriate as teachers had to cover absences or attend to some other duties. The transcription and coding of the interview data becomes a major task for the researcher once the interviews are completed.
- The interviewer effect might be difficult to eliminate as interviewees are self-conscious during interviews especially when tape-recording equipment is being used. This could seem to be obtrusive at first but after negotiating with the pupils and the teachers on the issues of confidentiality and anonymity, they welcomed the idea of being audio-tape-recorded. As some researchers have commented, being an interviewee is a flattering event for some people; it is an opportunity to tell the interviewer how they see their world. I ensured that the participants were agreeable to be audio-taped and as the interviews progressed they seemed to be comfortable with its presence and showed no inhibitions during the interview process. Interviewing young children (though the youngest of my subjects was 13 years) could be a difficult task because of the power relations but the fact that I

approached the topic carefully and the use of warming up helped to make them more at ease and overcome any shyness on their part.

- I avoided asking questions which might be embarrassing or leading (Denscombe, 2003) and which might make the interviewees feel awkward or defensive. My personal identity could have had some initial impact on the interviewees but I made efforts to be receptive to what they had to say and kept a neutral stance and created as conducive a climate as far as possible for interviewing by being respectful so that the interviewees felt sufficiently comfortable as to answer my questions in a honest manner.
- Reliability could be an issue as objectivity and consistency would be hard to achieve due to the impact of the interviewer and the context. Some researchers argue that in flexible qualitative research credibility, transferability, dependability and confirmability are more appropriate terms than reliability and validity (Lincoln & Guba, 1985, pp.294-301). I intended to overcome this problem by making use of multi-methods in a complementary fashion to support or clarify issues pertaining to my research (Robson, 2002).

3.13.2 Type of interview selected

Interviews can be of different types: structured, semi-structured or unstructured. In the first case, the interview seems a little more than a face-to-face questionnaire, as it is in survey method (Parsons, 1984). One cannot deviate from the way it is worded or the questions are listed as it is inflexible. I chose the semi-structured interview type as it allows participants to express themselves freely while an interview schedule is provided. The main questions are specified but the interviewer is free to probe beyond the answers in a manner that s/he enters into a dialogue with the interviewee. There is also some flexibility over the range and order of the questions within a loosely defined framework and open questions offer a wide range of choice. However, the context and the content of the interview are important aspects for both the structured and the semi-structured methods. The unstructured type is open-ended in character and it allows for considerable flexibility but the direction of the interview is unpredictable and analysis may prove to be a problem. It is also less necessary when the main focus of the study is known in advance, as was the case here. I constructed an interview schedule which was revised as a result of the pilot study; I made two sets of interview schedules: one for the pupils, another for the teachers. I obtained the rectors' views in a more informal manner during the meetings I had with them. I used one-to-one interviews with teachers and group interviews with pupils. These are discussed in subsequent sections.

3.14 Planning for the interviews and arrangements for the interviews

The teachers' questions were worded with regard to their relevance to the research questions relating to the underpinning theoretical conceptions which would promote conversation and human interactions (Kvale, 1996, pp.129-130). The types of questions ranged from introductory, descriptive ones to interpreting ones for clarifying meanings where answers were not very clear; they were brief, simple and non-threatening.

I started the interviews with easy questions where the interviewees could formulate their views on familiar territory and at the same time give valuable background information about themselves. To motivate them further I gave encouraging and appropriate oral and non-verbal feedback, reflecting on the remarks made by the interviewee and introducing new topics and questions that would elicit the areas of data I was seeking. I used tactics such as silence, repeating or rewording the questions as prompts and probes to clarify any information that was not clear and sometimes summarised their thoughts to check on certain views expressed by the interviewees. The semi-structured schedule enabled me to go back to any point that might otherwise have been missed. I kept a discrete eye on the time and brought the interviews to a close in an orderly fashion whilst ensuring that I had managed to cover the required points in my schedule. At the end of the interview, I gave the interviewees the opportunity to raise any point that they felt should be taken on board and had not been covered so far. I listened attentively to what they were saying and gave the pupils, in particular, sufficient time to answer the questions asked. I always courteously thanked them and wished them well in whatever they were doing at the close of the interview.

The questions related to the topics to be discussed were included in a semi-structured schedule and this was piloted and an amended version was used in the main phase interviews. I approached all the interviews with an agenda having some flexibility to use probes and prompts to achieve my objectives. Potential interviewees had already consented to be interviewed at the very outset of the field work and all the teachers whose lessons I observed in biology, chemistry, physics and accounts, economics or commerce and groups of pupils identified during the observations of lessons in the four selected schools were interviewed as soon as I had completed the observation of lessons in each case study school. In each school, I made prior arrangements for a mutually convenient time for interviewing the teachers whose lessons I observed in the different subject areas. So as not to disrupt the lessons, I scheduled the teachers' interviews during lunch time or their free periods according to their own convenience. Pupils were interviewed during lunch time.

All the interviews were carried out in a quiet room bearing in mind privacy and acoustics. The arrangements for the venue were made by the teachers in each school. As was the case in the pilot study, there was not a single objection from the parents about my intention to interview the pupils as the rector in all the four schools had already informed the parents about the research and how beneficial it was going to be for the school. I tried not to let others in the school interfere or influence the interview structure. The seating arrangements in the pupils' interviews were decided upon by the pupils themselves and they chose to position themselves in a group directly opposite me. In the face-to-face individual interviews of teachers, we sat opposite each other. All parties concerned were made aware about the duration of the interviews. The teachers and the pupils agreed to meet me again if there was any need for further information.

3.14.1 Audio tape-recording and field notes

Note taking and guiding the interview at the same time is a difficult task; the human memory can be unreliable at times and it is simply impossible to remember and accurately record matters such as pauses, overlaps and so forth. To overcome this problem, all the interviews were tape-recorded, with the prior permission of the interviewees, for subsequent transcription. Audio tape-recording helped to provide a permanent record of the speech though it missed the capture of non-verbal communication and other contextual details. Audio taping could be threatening to the informants initially but after some time, people tended to ease up and feel comfortable with it. I had to ensure that the equipment was of a good quality and in good functioning condition before the interviews. I used tapes that were long enough to last the planned duration of the interview (Denscombe, 2005). On two occasions I used a more sophisticated audio tape recorder which enabled the interview data to be transferred to a computer disk straightaway.

I also took quick field notes during the interviews to back up the audio tape recording and supplement any relevant information that the audio taping might have missed such as non-verbal communication, the context of the location, start time, duration of the interview, fictitious names for interviewees and other issues. Notes which were jotted down too quickly to be legible were re-written immediately afterwards and typed up within 24 hours of the interviews. These notes acted as permanent records of what the interviewees said during the interviews and proved very valuable at the transcription stage. The notes and the audio tape recording together helped to improve the accuracy and quality of the data and enriched the 'texture of reality' (Stenhouse, 1978).

3.14.2 Interviewer/interviewee effects

It is a common belief that the personal identity and self-presentation of the researcher, in particular their sex, age, race and ethnicity, can influence the data being collected (Denscombe, 2005) and as an interviewer I had to give due consideration to these issues before embarking on the interview process. My former position as an academic member of the Mauritius Institute of Education could certainly have an effect on the proceedings and the data generated during the interviews. My age, identity, physical appearance and gender could influence the conduct of the interviews but the fact that I was on the scene for some time and attributes such as respect, politeness and punctuality helped to counteract any adverse effect that I might have had during the interviews. I always approached the topic in a friendly manner and asked questions that would make the interviewees comfortable. The nature of the topic being discussed was not likely to cause any embarrassment to the interviewees but, should such a situation arise, I made every effort to create the right climate and thus minimise the interviewer effect on those being interviewed. I adopted a passive and neutral stance on the statements made during the interviews by the interviewees. After all, I was there to listen and learn. I showed sensitivity on issues which the interviewee was keen to talk about but was careful not to ask embarrassing or leading questions. The questions were meant to get the interviewee to open up without upsetting or antagonizing them.

3.14.3 The pupil interviews

When interviewing children of young age the power relationship is an issue; therefore I took care to be polite and relaxed and approached the conversation in a friendly manner giving the pupils enough time to feel at ease and comfortable. The ethical dimension had to be borne in mind, for example I again reassured them about confidentiality, anonymity and that their participation in the interview was voluntary (Alderson & Morrow, 2004). I did not start the conversation in English initially. I spoke to them in French and once they got warmed up, I switched to English and occasionally spoke in French or Creole to suit them. At times I felt that the pupils were able to express their opinions, thoughts and feelings more easily in French or Creole especially when it came to expressing matters which they were not very happy about.

Using the semi-structured interview schedule as a guide, I obtained a cross-section of opinions from the pupils; sometimes they agreed on certain issues and at times they held opposing views. Furthermore, the fact that I had been observing lessons regularly for eight weeks helped them to get used to me and counteract any possible adverse effects that my presence might have had. At the beginning and end of each interview, I made a point of thanking the pupils for having kindly agreed to be interviewed and sacrificing their valuable time. The list of questions given in Appendix 1 indicates the types of questions that were included in the semi-structured schedule. The questions were of the open type which would involve the young interviewees in spontaneous conversation about their experience of school science. I avoided long questions as the pupils might only remember part of the questions and therefore answer part of them. As in the case of the teachers' interview, the questions were 'brief and simple' as suggested by Kvale

(1996, p.132). Leading questions, technical and unfamiliar words were avoided (Robson, 2002).

I approached each interview with a welcoming and friendly disposition and began the conversation by introducing myself, and giving the pupils a brief idea about what the interview would be about so that they could have a grasp of the topics we were going to talk about. I started the actual interview with initial questions which addressed general issues about the study of science to allow them to warm up and minimise the unequal power relationship that might exist, especially as I am a grown up person holding an important position in the educational field in Mauritius. I found that I was not threatening to them because the pupils have been accustomed to my presence whilst I was carrying out the observations of lessons. The follow-up questions were on the teaching of science and their views, interests, problems, resources, gender aspects, choice of subjects and any other issues they felt like talking about. As a researcher, I was aware that whilst keeping in mind the research questions of the investigation, I should also listen actively to what the pupils had to say (Kvale, 1996). Gradually I moved on to questions where emotions and feelings were involved. I took a non-judgmental stance when in some cases criticisms were made regarding teachers' methods of teaching and the pupils' attitudes in science lessons. I tried to establish trust and in this way the pupils disclosed information which they were initially apprehensive to talk about because they felt vulnerable. During the interview, when some of the pupils rambled off the point, I politely steered them to issues which were being discussed (Cohen *et al*., 2007). I avoided creating situations where the pupils might be tempted to give responses just for the sake of pleasing me.

Group interviews are a useful way of collecting data in educational research where pupils are involved (Denscombe, 2007). By the term 'group' the researcher expects those participating in the interview to interact with one another and all discussion takes place at the level of the group. A wide range of responses can be obtained during group interviews and it gives an opportunity for discussions to develop through the challenging of each others' ideas and the introduction of new ideas and there can be a synergy emerging out of the social interactions (Denscombe, 2007, p.176). It also gave me an insight into what could be taken up in subsequent interviews and was an efficient way of getting opinions from a variety of pupils. I did not use focus group interviews because focus groups are a form of interview where the group discusses a specific topic supplied by the researcher, yielding a collective rather than an individual view (Morgan, 1988, p.9; Robson, 2002, p.285; Cohen *et al.,* 2007, p.376). Hence, the participants in a focus group are given a fairly tightly defined topic or theme to discuss and they interact with each other than with the interviewer; the data emerge from the interaction of the group. The participants have a free rein in the discussion and their agenda rather than the researcher's may predominate in a focus group interview if it is not managed skillfully. The participants are interviewed in an unstructured way about their experience and viewpoints (Bryman, 2004). I chose group interviews because I used a semi-structured schedule and I had to ask the same questions in all the interviews and though the semi-structured interview is a rather flexible type, it was important that I asked the same questions in all the four schools in the same order. One problem is that in a group discussion it might happen that some members of the group dominate the talk and the views of the quieter ones get drowned (Cohen *et al*., 2007). I tried to avoid this by asking questions to those who were silent as well as to the more vocal members. Each group consisted of five pupils in each school. In mixed schools, there might be a gender issue if I conducted the interviews in a mixed group of boys and girls; in single sex groups, opportunity is presented to allow interviewees to say things that they might not say in the presence of the opposite sex. Another point is that the boys might dominate by taking the centre stage in the discussion. To avoid this, I interviewed a group of five girls and a group of five boys separately in each of the two co-educational schools.

3.14.4 Face to-face interviews for teachers

I chose the one-to-one type of interview with the teachers, an interview structure in which the researcher meets one informant. Such an interview is easy to arrange as only two persons' time needs to coincide and the views expressed throughout the interview is from a single source, that of the interviewee. A one-to-one face interview is more easily controlled as the researcher has just one person's views and ideas to grasp and questions only one person during the interview. I could have made use of focus group interviews

(Somekh and Lewin , 2011, p.63), and have the teachers largely agreeing and arriving at some shared viewpoint on a specific topic in a relatively short span of time compared to the sixteen face-to-face interviews, but this was not possible for practical reasons. It would have meant grouping 16 teachers from four schools with different specificities and experiences. Furthermore, it would have been difficult to set up a focus group of the science and non-science teachers on a common topic at a place and time which would be convenient for all the teachers whose lessons I observed in the four different schools. I wanted interviews of teachers in which I could talk to individual teachers just as I watched the lessons of individual teachers. This allowed me to explore issues specific to individual teachers.

3.15 Transcribing the interviews

Transcription is a laborious and time-consuming task but it brought me closer to the data by bringing the interview to life again. I listened to each tape several times, transcribed them into a text file and compared them with my field notes. Since an interview is a social interaction, the social encounters, such as visual aspects of the situation, the setting, bodily and facial expressions of the interviewees, should not be neglected. Indeed, as pointed out by Cohen *et al.* (2000), non-verbal communication sometimes gives more information than verbal communication. Therefore, where appropriate, I wrote down the main aspects of the interview such as intonation, inflection of voice of interviewees, pauses, silences, emphasis, interruptions, mood of speaker(s), speed of talk, indecipherable and inaudible speech, bodily gestures, number of speakers talking simultaneously and any other events that were taking place at the same time.

3.16 Reliability and validity in interviews

Validity and reliability for transcripts can be a problem as transcription from one context to another involves a series of decisions and judgments. I checked for plausibility of the data by interviewing people who would be in a position to provide me with credible information about which they had some relevant knowledge. I also looked for recurrent themes that emerged across a number of interviews and so were shared by more than one person. Data collected during the observations of lessons provided some back-up for the interview data. I summarized the interview data at the end of the interview session to check with the interviewees that the statements made by them were adequately understood by me (Denscombe, 2005, pp.186-187).

3.16.1 Reliability

I tried as far as possible to make a verbatim rendering of the taped interviews by listening to the tapes several times to ensure that important details were not missed out. I also checked my reliability by having a second person listen to the tapes and transform them into text and compare both versions.

3.16.2 Validity

Rich verbatim descriptions, the inclusion of pauses, repetitions and tone of voice and triangulation with other methods of data collection helped to achieve validity and reduced biases resulting from distinctive characteristics of the interviewees, the interviewer and the content of the questions (Cohen *et al.*, 2000).

Issues of validity and reliability will be discussed further in Section 3.20.

3.17 Parental questionnaire

During the pilot study and subsequent field work it emerged from the interviews with the teachers and pupils that at least some parents had substantial influence over their children in the choice of subjects after the compulsory level. Indeed, Solomon (2003) in her UK study with children of elementary age had noted that the culture of the homes affected children’s learning of science. Therefore, I felt that it was worth investigating the issue of parents’ perceptions of science and their influence on their children. So, I developed a questionnaire through a process of discussion with my supervisors and other researchers and piloted the questionnaires with the parents of pupils in a class in a mixed school that was not in the main study.

The following details were included in the questionnaire: characteristics of parents (mother, father, guardian and other), details of children, ethnicity, and science background of parents, the parents' perception of science, whether they or somebody else influenced their children on the choice of subject and their eventual career choice. The first three items in the questionnaire were 'closed answers' and the remaining ones were 'open answers' types where the parents were free to formulate a reply as they wished. A polite letter together with the questionnaire was sent to the parents explaining the purpose of the questionnaire and requesting them to complete it and return it to the teacher through their children. I could not contact the parents personally as I did not have their addresses and it is school policy in Mauritius not to disclose the addresses of pupils or their parents or other person responsible for the children. The questionnaires were sent in a sealed envelope. The justification for using the questionnaire with the parents will be discussed more fully in Chapter 6.

3.18 The pilot study

Before embarking on the main study I carried out a pilot study in a school which was not one of the case study schools selected for the main study. The aim of the pilot study was to provide a method of training and experiences in qualitative data collection in observational and interview techniques using semi-structured schedules, note taking, devising observational schedules, determining pre-coded categories, interview recording using audiotapes and transcribing them. It also provided me the opportunity to devise and test a quantitative mini-survey questionnaire. Pilot studies help the investigators to refine their data collection plans with respect to the content of the data and the procedures to be followed (Yin, 1994). The pilot study would help to improve the quality of the data that I intended to collect in the four selected schools. Robson (2002, p.185) regards pilot studies "as case studies in their own right with an exploratory function". The pilot study was carried out to improve the quality of the data that were to be collected during the case study of the four selected schools and clarify the methodology for the data collection. I expected to refine my interview and observation techniques and anticipated that the pilot study would help me by demonstrating any shortcoming in my methods and ensure that the results of my main study would be as effective as possible. Piloting enabled me to ascertain whether the questions in the schedules for the interviews and the parental questionnaires were understood by the pupils, the teachers and the parents.

3.18.1 Selection of the school for the pilot study

I chose a girls' state secondary school in an urban area for the pilot study; the rector was known to me and this facilitated my access to the school. I also chose the school because it was easily accessible, and not in the same educational zone as the ones in the main study. As a former staff member of the Mauritius Institute of Education, I expected the teachers who had followed courses in that institution to know me and I anticipated that there would be no problem with them cooperating with me in the study. However, the pilot study in the selected school could not start early in January 2004 as planned because the beginning of the school term was a very unsettled period with transfers of teachers and timetabling arrangements, appointment of new teachers and other administrative activities. I had to wait till the third week of January 2004 to make contact with the school rector. Around the third week of January, I had an informal chat with him about my research project, outlining all the implications and details and requested him to let me use his school (pseudonym: Justin School) for a pilot study. We discussed the purpose of the research, the methods and techniques for data collection, ethical issues about confidentiality, anonymity and protection of the rights of participants in the observations lessons, inspection of documents and the interviews of teachers and pupils. I then arranged for an appointment to meet him in the last week of January 2004. At that meeting, he called into his office the deputy rector and three science teachers who were involved in teaching a Form III class; there was no need to introduce myself as I was already known to all of them and we had a friendly conversation about general matters before discussing the actual study. The meeting lasted 30 minutes.

During the meeting with the teachers and the rector, I was careful not to get too involved in conversations where I might have to answer questions asked by the respondents or give personal opinions on matters which might bias my research. I explained to them the purpose of my visit and the research I was doing and asked for their consent to participate

in the project to which they agreed. At that time the school was still waiting for a new physics teacher to be assigned by the Ministry of Education and Scientific Research and that particular class was being taught physics by the chemistry teacher. It was during the second week of my observations that a new physics teacher was appointed to the school.
I was told by the rector that it was not necessary for me to write any letter to get their consent. I was then given a copy of their timetables and we arranged for an informal observation of their lessons during my first visit so that I could become familiar with the setting and they and the pupils would become used to my presence. The issue of access with all those involved in the study was thus successfully negotiated.

3.18.2 Observations in the pilot study

After the meeting with the rector, I went into the Form III class identified by him for the purpose of my study; he introduced me to the pupils and told them that I would be coming to their class to observe their science lessons for my pilot study but they should not worry about my presence in their lessons and that they should behave normally as if I was not there. The observation of the lessons was to enable me to see how they were being taught, their interactions with their teacher and their peers and to gather some information on how they behaved in the lessons. I told the rector, the deputy rector and the teachers that I would try not to disturb the normal routine of the school and that my interviewing and other research activities would be carried out during the break time and free periods after having made prior arrangements with the rector and the teachers concerned to observe the lessons according to the timetable given to me by them. I assured them about confidentiality and anonymity again.

Five lessons in each of the three science subjects were observed in the pilot study. Observation of a single lesson normally lasted forty minutes**.** In all, I observed fifteen lessons, bringing the duration of lessons observed to a total of ten hours. Observation as a data gathering technique helped me to focus on the actions and behaviour of people. As a non-participant observer, I observed unobtrusively, without being reactive, by refraining from engaging in any conversation with those whom I was observing. I must admit that this was rather difficult because, at times, I felt like intervening when I thought the teacher should have been doing things differently, but I restrained myself. I followed the flow of events, behaviour and interactions uninterrupted by any intrusion on my part. It was important to stay alert all the time and focus for a period of time on particular pupils, the teacher, the setting and whatever events were relevant for my study.

It is not possible to observe everything that is going on for any length of time and so attention had to be concentrated on those phenomena which would be relevant to my research. In the pilot study my observation was of the broad sweep type: I focused on the setting, the physical infrastructure facilities in the laboratories, furniture, the materials used for the lessons, seating plans and layout of the rooms and the human behaviour and interactions. Initially, I tried to use an observation schedule that I had adapted from Flanders (1970) but that proved too restrictive; instead, I recorded field notes as this gave me a wider view of events. While note-taking, I tried to make my notepad and pen not too visible so as not to distract the pupils from the lessons. I recorded the field notes quickly, sometimes jotting half a word but I tried my best to capture the relevant details pertaining to the purposes of my research. I had to write very fast and within 24 hours, I re-read my notes and typed all my classroom observations and I ended up with a detailed set of field notes which on average were 650 words per lesson. The notes included the title of the topic, the dates, time of lessons, location, type of activities, teaching methods, seating plan, content of lessons, pupil-pupil and pupil-teacher interactions and any other events or occurrences worth noting during the lesson. At the end of the lessons, I would talk informally to the teachers to supplement my observation notes and get their perceptions of events I watched in their lessons. The findings of the pilot study regarding the girls engagement in science lessons is given in Sections 3.18.4 and 3.18.5.

Conventions used in the presentation of data in the study

The presentation of the data uses a notation system which preserves the anonymity of the schools and the participants. The school in the pilot school was given a pseudonym and those in the main study are identified by letters A, B, C and D. In citations of excerpts of observations, female teachers in the main study are assigned the letter F followed by a number while male teachers are assigned the letter M followed by a number. The number is assigned randomly. Pupils are given fictitious names. By using such a convention, it is difficult for the schools, the teachers and the pupils to be identified. However, it may also happen that in a small country like Mauritius, the use of fictitious names (or letters for schools) may not offer complete protection against identification. Excerpts of pupil and teacher talk will be quoted verbatim as far as possible but some elements of subjectivity are inevitable. Some of the events might be considered by another observer who had seen what I had seen to have been inaccurately reported or interpreted by me. What I have reported is from my own particular perspective; therefore I acknowledge that what is cited here is my own interpretation of events, albeit events were recorded as faithfully as I was able to.

Some French words were used in the lessons; so the researcher's brief comments will be included to clarify verbatim quotations. These and other researcher comments are in brackets and italics (*e.g. Teacher introduces topic of lesson*). The researcher's comments are in italics without brackets. Small pauses in the text will be represented by dots without brackets …; where only part of a participant's quotation is being used, the quotation will include dots in square brackets […] to show where material has been omitted.

3.18.3 Interviews in the pilot study

Interviews of Form III pupils

The objectives of the pupil interviews were to explore pupil perceptions of how science was being taught at Form III level, their perceptions of science and their interest in it and what they felt were teachers' attitudes in science lessons. Therefore a semi-structured interview schedule which reflected my research questions was prepared prior to the interview (Appendix 1). The selection of the participants for the interviews was made by the teacher. I could have observed some pupils more closely and selected the ones I wanted to interview, but as the teacher knew the pupils better and knew the aim of my research, he or she was in a better position to decide who should participate in the group interviews of pupils. Prior to the interviews, the rector and the deputy rector spoke to the pupils and asked for their consent to be interviewed by me. They then brought them to a quiet and private room on different days in the following order:

1) Group of Form III pupils
2) Group of Form IV pupils taking science
3) Group of Form IV pupils not taking science.

Each group consisted of five pupils. The group interviews served to elucidate certain points that I observed in the observation of lessons. It was an experience for me to speak to pupils of this age and obtain first hand information about their views on the teaching of science, their perceptions of science and attitude towards science. Careful chairing, advanced preparations and giving attention to the physical layout were important for deriving maximum benefit from this type of interview.

The rector and the deputy rector left the pupils with me and went back to their office to carry on with their normal duties. I greeted the pupils, did my best to make them feel comfortable and explained to them why I was interviewing them. They agreed to my request to interview them after I assured them that whatever I was going to record would be kept confidential and that their views would be anonymously recorded by using pseudonyms. I talked to them in a conversational manner asking them which class they were in, the subjects they studied and so forth so that they could feel at ease and relaxed. They were interviewed in English and at times a few French words were used. When I asked them if I could tape the conversation, they hesitated and were reluctant to be audio-taped as they would feel inhibited by the technology and too conscious that their conversation was being recorded. They also felt that a permanent record of the interview would jeopardise them as they had never been audio-taped before. As they felt rather threatened by the audio tape recorder I took field notes of the interview, jotting down very quickly what they said. Their reluctance to be audio-taped may be due to the fact that I did not sufficiently prepare them for audio-taping the interviews. I could have made the interview last longer, giving the pupils enough time to ease up and make them understand that in no way was the content of the audio tape going to be disclosed to other people. It was my first interview and I needed to familiarise myself with the skills of a good interviewer.

Teacher interviews

The teachers were interviewed individually; a person-to-person encounter is better at eliciting individual views and responses. Before carrying out the interviews, I met the science teachers at a meeting convened by the rector in his office and after discussing the content of my semi-structured interview schedule I arranged an appointment with each of them to interview them during their free periods. After thanking them for having agreed to be interviewed, I assured them again about confidentiality and anonymity. I had met the teachers several times in the past during my observations of lessons; there was no problem in starting an informal conversation on an individual basis. We talked about the school, the background and the pupils; for example, pupils from one good feeder school were much better and more motivated and usually worked very hard.

The interview in each case lasted about thirty minutes. After a brief warming up introduction the interview went smoothly. Mrs B (biology) likes teaching as this gives her some satisfaction. She has followed a professional course at the local teacher training institution in the early ‘80s. She found the course very helpful. The chemistry teacher, Miss C, who is a female, had to teach physics to the class I observed until the appointment of a physics teacher, Mr D. The female chemistry teacher has been teaching for the past seven years and apart from a degree in chemistry, she has never had the opportunity to follow a course in pedagogy.

The questions began with straightforward ones and moved to more elaborate ones (Appendix 1). I audio-taped the interviews as the teachers had no particular objection to their conversations being recorded. They gave me their telephone numbers should there be anything that was left out during the interview. The audio-taped interviews were then transcribed and later re-read to search for meanings and patterns. I also made quick notes during the interviews to complement the audio-recorded data. At the end of the interview with each of them, I read my notes with them, invited further questions or comments and thanked them again for having spared their valuable time to participate in the interview which I enjoyed.

3.18.4 Findings from the observations of the lessons in the pilot study

Teaching of science

The lessons in all three science subjects were held in the laboratory. Teachers used questionings a lot to solicit factual information from the pupils in most instances. Only on three occasions did I notice any higher order questions which were presumably meant to tap conceptual reasoning or understanding. Pupils tended to answer in chorus most of the time.

The questions asked by Teacher B were all of the low level factual type. There was no evidence of questions which were meant to check understanding and critical thinking. After the teacher had explained about the function of the red blood cells, white blood cells and platelets, the pupils were asked to copy the notes which they were expected to memorise. I tried to find out more about rote learning later in the interviews. I noticed that the girls were passive learners and barely asked any question during the lessons, a feature which I observed in all the three science subject lessons of all three teachers. The pupils always had their textbook in front of them and while the teacher was explaining, they tended to check the information in their textbook. There was no evidence of cooperative learning, group work or hands-on practical work, strategies which have been recognised, as discussed in Chapter 2 by researchers to promote learning among girls (and boys). Only in three instances did the teachers carry out demonstrations. These were in biology and physics. The chemistry lessons were on valency and balancing equations and a similar method of teaching to the ones described above were used. I noticed that teachers did not give any praise or encouragement to acknowledge the answers of the pupils but they tried to help the pupils with difficult words.

3.18.5 Findings from interviews in the pilot study

Interview of pupils

Pupils were asked about their perceptions of school science. They perceived science subjects as difficult, with complicated terms and drawings. They said that the drawings in the textbooks seem to be different from the models found in the laboratory. However, the girls were aware of the relevance of science to their daily lives.

When the interviewer tried to probe the issue of practical work and investigations in science lessons, the pupils said that practical activities were carried out very rarely. The pupils preferred to be taught by a female teacher for biology and physics.

The pupils said that their parents guide them in their choice of subjects. They would like to study subjects in which they can pass examinations easily by learning by heart. The pupils found the presentation and the contents of the science textbooks used in their lessons unappealing and they preferred topics like the environment, human body and health.

Other comments which they made about not taking science included the fact that the school results in science are not so good at School Certificate examinations, particularly in biology compared to economics, commerce and accounts. These are subjects in which the pupils reckon it is easier to obtain high grades. They added that they would like to take part in extra-curricular activities but they have no time because too much homework is set in different subjects.

Interviews of Form IV girls

The Form IV girls said that the traditional method of ‘chalk and talk’, where the teacher did most of the talking and explaining, was predominantly used when they were in Form III. They memorised notes given by their teacher. They did not try to make their own notes because they felt less confident about them. They performed some investigative work at times. This helped them to understand the concepts better; the practical work was done in pairs on the few occasions they did practical work but there was not enough equipment for a whole class of 34 pupils. Teachers used questioning techniques during the lessons but pupils usually answered in chorus, some only moving their lips pretending to answer; a few just kept quiet. In their Form III class, I found out that only fifteen out of thirty four chose science at Form IV level; others decided to study accounts and business studies, two subjects which they said are very popular with the girls in that school.

The girls liked the biology textbook but not the chemistry and physics ones. They would like to see these better presented with more colourful illustrations to make them more appealing. They took part in activities such as the Environment Club and Human Values but would welcome visits to places of educational interest and talks by experts in the area of science.

In this interview, I tried to make all five of them speak; some tried to be more vociferous than others. I tried to address my questions to each of them by having eye contact with each of them in turn and elicit some response. The group dynamics helped to bring forth information that I would not have obtained in a one-to-one interview. The interview lasted roughly one hour but the first fifteen minutes was largely taken up with making them feel at ease and getting them to talk freely.

The Form IV girls who did not choose science are aware that science is important and relevant to them but they think that science should be taught in an interesting way so that there is fun in studying it. However, they enjoyed topics like the digestive system and reproduction in biology. They had a strong dislike for chemistry, especially topics such as valency and balancing of equations. The girls in the Form IV non science group started disliking science at the beginning of Form III level. They learned science by memorising notes given by their teachers; they like rote learning in economics, enjoy studying accounts where there is reasoning and working with figures. The textbooks used were not so appealing in chemistry and physics but the biology one was “good”. Their parents influenced them in their choice of subjects; some have relatives who are accountants and they get help from them in their studies; their parents are not knowledgeable about science.

Interview of teachers

Teaching methods and learning style

Mrs B, the Biology teacher, commented:

> I used a mixture of teaching method. However, generally it is teacher centred normally, the students then copy notes – students like to take notes and memorise them. I make them read the information in the book and then ask them questions to find out if they have understood. When asked to make their own notes, they hesitate. Children in the school come from different background. Therefore many have facilities such as computers at home. They look for information on the Internet sometimes when they have to do a project.

She felt that girls seem to lack confidence and are not so keen at asking or answering questions. She teaches boys and girls in the same way because pupils of both sexes like to be copy notes and memorise them. The chemistry teacher, Miss C, said that she tried to use a variety of methods but was not aware about gender issues. Class work is done from the textbooks. In chemistry and the other science subjects, pupils memorise notes which teachers dictate or write on the board:

> Miss C: They learn by heart … Difficult words like effervescence they do not understand … So I refer to Pepsi Cola and fizzy drinks.

Demonstrations and practical work

Miss C, when asked about other methods of teaching used during the lessons, commented that there was very little opportunity to carry out demonstrations and practical work.

The teaching method described above was common in the physics lessons too.

Pupils' attitudes towards science

The biology teacher, Mrs B, suggested that the problems the pupils had in science were due to the fact that they had been taught a content-laden syllabus in a traditional way and because teachers in primary schools lacked content knowledge in science. The chemistry teacher said that she tried to show to the pupils how the study of chemistry could be relevant to their everyday life by giving the familiar examples.

All three teachers said that they encourage the pupils to watch science programmes on television at home. When asked how she tried to bring a change in their interest for science Mrs. B pointed out that she made them participate in activities such as Open Days and watch science programmes which are broadcast by the Mauritius College of the Air. They sometimes go on outings, e.g. to a National Park, but they are not keen to go to botanical gardens. She also made use of video films available from the Mauritius College of the Air, involved them in an environment club, for example keeping their classrooms clean. The biology teacher added that that the pupils are influenced by their peers regarding their attitude towards science:

> They do not have proper guidance about career. By the end of Form III they have already made their decision. Many take wrong subject combination after Form III level.

The different methods used in this pilot study reveal some interesting results. Though the lessons took place in the laboratory, the teachers used demonstration or traditional direct instruction method to deliver the lessons. Whole class teaching prevailed in all the lessons that I observed. There was continuous questioning and the questions were of the factual types which aimed at recall of facts and as the answers were in chorus the teachers predominantly would accept the answers and then move to further expository talk. They stated in the interviews that there was a tension between completing the syllabus and using investigative work in their teaching. Investigative work was not possible because of lack of equipment and the large sizes of the classes. According to both the teachers and the pupils, parents have the final say in the choice of science subjects. The girls who did not study science at Form IV preferred economics and account because they could get better results in those subjects than in science which they found difficult. This point was confirmed in an interview I had with the rector. Interestingly, the biology teacher in her comparison of boys' way of learning and that of girls stated that the girls did not like to engage in thinking activities.

3.18.6 The parental questionnaire

The small amount of quantitative data obtained from the parental questionnaires was suited for descriptive statistical analysis. Each questionnaire was given an identifier, for example P1, P2 and so on. The raw quantitative data did not require any sophisticated software package and were processed using Excel software (Pelosi *et al.,* 1998). The qualitative data which were of the free-response type were categorised and extracts were produced to confirm any point which corroborated that of the pupils and teachers.

Importance of science

Parents value science irrespective of their socioeconomic or educational background. It is worth noting that this is a school with pupils of high ability and most of the parents are economically well off; 96% of the 35 parents stated that the study of science is important. 93% of the parents would like their sons and daughters to study the subject after Form III. Many of them stated that they would like to decide on the choice of science subjects because of a wide choice of career that is available in that field. In my pilot questionnaire, I included other information such as ethnicity and occupation which is outside the scope of this study. They were included because I was not quite sure at that time whether a thorough analysis of these factors would be required.

3.18.7 Importance of the pilot study – how it affected the methodology in the main study

The pilot study was of fundamental importance in terms of research training; it improved my note-taking techniques and indicated the importance of the use of the tape recorder during the interviews. The use of a tape recorder meant I could concentrate more during the interview on such things as body movements and maintaining eye contact with the interviewees and I would be spared of the task of writing very fast and (inevitably) incompletely. I developed my researcher's role in the setting and my observation techniques and interview skills improved substantially during the period of pilot study.

My role as non-participant observer became clearer to me. Though in the initial stage of the observation I tended to be non-selective and record events in a holistic manner so as to get an overall feel for the situation, I later shifted to more focused observations in the classroom, recording only particular events at intervals which were revealing and fitted the purposes of my study. I also improved my skills at data analysis and became more critical about the issues arising during the study. The pilot study showed that science teaching on the whole did not allow much for pupils' participation in Justin School with only a handful of pupils participating actively in the lessons. This was probably connected with the low participation of the girls in science.

3.18.8 Changes I made or intended to make for the main field work

After reflection on the findings of the pilot study, I changed the sample I originally planned to carry out for the main study, which was two girls' schools and two boys' schools and decided upon two girls' schools and two mixed schools, as one of the intentions was to find out whether single-sex or co-educational schools advantaged the girls. I was interested in studying the events, the pupils' and teachers' attitudes, any gender issues that might be taking place and how the people in the situations saw their world, and in collecting data that would answer my research questions regarding the factors which influence the choice of science subjects at Form III. As the study dealt with the low enrolment of girls in science it would be valuable to find out if similar events were taking place in both types of schools (single-sex and mixed) which girls attended.

In addition to 60 science lessons, I decided to observe 20 non-science lessons and interview the non-science teachers teaching the class under study; this might help me to find out why girls are more attracted to subjects like commerce, accounts and economics. A refining of my instruments, such as observing more carefully the lessons and noting down the main points regarding gender issues more clearly, and asking more probing questions during the interviews, would allow me to have a more in-depth study of the situation. I decided it would be more helpful if I observed some pupils more closely during the lessons, and interviewed them afterwards, thus checking with them events and interactions I had observed during the lessons.

The semi-structured type of interview was retained but I modified the wording of some questions in the interview schedule to make them clearer and care was taken to avoid leading questions. I added more probing questions like 'Can you say more?', 'Can you explain further?', 'What exactly did you mean?' and 'Could you give me an example?' to get more in-depth information. I decided to try to audio-tape all the interviews so that I would have a permanent verbatim record. I realised that I should prepare the pupils before the interviews so that they would not get frightened by the thought of audio-taping. I decided that I needed to pay more attention to the fact that children of this age may feel hesitant to express their views openly at times, particularly when it concerns giving their views on teachers and their teaching. I decided that there was no need to interview the Form IV pupils in my main study as these data were not different from those obtained from Form III pupils in my pilot study. I should rather concentrate on collecting in depth data from the Form III pupils.

Since it emerged during the pilot study at Justin School that parents are reported to influence their children greatly in the choice of subjects, I decided to probe further. I prepared a parental questionnaire after discussion with my supervisors and, as outlined above, piloted it with the parents of pupils in a co-educational school that was not in the main study. I decided to look at parents' science backgrounds and their perceptions of science and to find out if these were a determining factor in their children's choices and attitudes towards science.

The results of the piloting of the parental questionnaire were important in bringing about certain modification for the one I intended to use in the main study. Some parents may not be able to write in English as it is not the first language in Mauritius and because of their educational background (some parents in the pilot sample were labourers or in other unskilled jobs), so I determined to ask the parents to feel free to answer in French or Creole. Question 2 was amended to include 'responsible party/guardian' because it might be the case that some children might be living with guardians or other carers aside from their parents. Question 2b was added so as to identify whether the child was a 'son, daughter or other'. I took care to reduce the number of unnecessary questions: Questions 9 and 10 were removed as they tended to ask for information which the parents had already provided earlier. I improved the presentation of the questionnaire by spacing out the questions.

I found that proper indexing of the data and preliminary analysis during the data collection phase, writing analytic memos after reading the field notes and the interview transcripts over and over again are vital for generating emerging themes and categories. The piloting was on the whole very enriching and helped me to reflect on the research topic, the complexities and complications regarding the research. After discussing the results of the pilot study, I changed the title of my research project from 'The teaching of science at lower secondary level in Mauritius: a gender perspective' to 'The factors affecting the choice of science subjects among girls in Mauritius at secondary level'.

3.19 The main study

Table 3.2 gives a summary of the sample and principal data collection methods used in the main study. In addition, individual interviews with the rectors were held to obtain information on the schools and the administrative procedures, the facilities available in the schools and other relevant details, and some document analysis was undertaken too. As the schools and the teachers place a great deal of emphasis on tests and examinations, I was particularly careful not to disrupt the schools' normal timetable.

School	Number of of lessons observed[a]	Number of pupil group interviews	Number of individual teachers interviews[c]	Number of parental questionnaires distributed[d]
A (Girls)	20	1	4	32
B (Mixed)	20	2[b]	4	32
C (Mixed)	20	2[b]	4	33
D (Girls)	20	1	4	33

Table 3.2: Summary of sample, data collected and methods used for data collection in the main study

[a]science: 15; non-science: 5
[b]one group of boys and one group of girls interviewed separately
[c]three science and one non-science teachers
[d]questionnaires administered to parents of the pupils in the classes observed

3.20 Validity, reliability and trustworthiness

In both quantitative and qualitative research, validity rests on the foundation that a method, a test or a research tool is actually measuring what it is supposed to measure. In quantitative research, the researcher can often lay some sort of claim that the test or method is valid by showing that the tool, test or method accurately gauged what it was supposed to measure. In this research, which is mainly qualitative, validity can be shown through the richness of the data, the depth and their scope. According to Miles and Huberman (1994), there are different kinds of validity:

- content validity; here the researcher must show that there is a fair and comprehensive coverage of the items under investigation

- internal validity; so that the findings must describe the phenomena being researched in a way that is both credible and plausible
- external validity; this refers to the issue of the generalisabity of the results, which in qualitative research is problematic.

In flexible research design, some element of subjectivity is unavoidable (Strauss & Corbin, 1998). However, I made every effort to reduce the element of bias in the tools used in the study. Different kinds of data collection techniques used allowed me to improve the overall quality of the data. Things were seen from different perspectives and there was opportunity to corroborate the findings, thus enhancing the validity of the data (Denscombe, 1998; Denzin & Lincoln, 2000). Data obtained from different sources were triangulated on a continuous basis to confirm or refute emerging findings. The pre-testing of the instruments established ‘face validity’ (Cresswell, 1994). The types of data obtained from different sources were compared so as to determine their veracity. Throughout the data collection phase, I followed the same procedures with all the participants in the conduction of the interviews, the observation of lessons and the administration of questionnaires. The same questions were used in the four schools and thus the data were obtained in the same manner, thereby ensuring, so far as possible, consistency throughout the project.

Internal validity concerns the credibility of the findings: triangulation, regular repeated observations of similar phenomena and settings over a period of time and participation of the researched in most phases of the research. The results of the qualitative research could only be credible from the perspectives of the participants. I discussed with the teachers informally at the end of the lessons or the next day what I had observed or noted in my encounter with them during the interviews and what meanings these conveyed to the researcher, thereby confirming or developing a consensus between the teachers and the researcher about the credibility of the data collected. It also gave me an opportunity to probe into what the teachers thought about their actions and behaviours. The interviews with the pupils were another way of ensuring that there was no undue partiality in the responses of the teachers. After having re-written my notes, I met the teachers and the pupils in turn in each of the schools and read the notes to them to check the accuracy of whatever I had recorded during the observations of lessons and the interviews.

External validity refers to what extent the conclusions of the study can be transferred to other contexts. The provision of clear, rich and detailed descriptions (Lincoln & Guba, 1985; Merriam, 1988) makes comparisons with other samples and settings appropriate for potential transferability. These writers suggest that through comparability of groups, settings and participants and the provision of rich data, others can determine whether transferability is possible.

Reliability in quantitative research is a measure of the consistency and replicability over time, over instruments and over groups of respondents and it deals with precision and accuracy (Cohen *et al.,* 2000). Similar results should be obtained if the research is carried out on a similar group of respondents in a similar context using the same method. However, reliability in qualitative research is harder to establish and may be unworkable as qualitative research is concerned with naturalistic studies which include the "uniqueness and idiosyncrasy of situations such that the study cannot be replicated" (Cohen *et al.,* 2000, p.119). This uniqueness seems to give qualitative research strength rather than weakness. However, reliability in qualitative research is problematic because human behaviour is almost never the same for different individuals; what one person experiences is rarely the same as another. Qualitative research therefore does not always yield the same results each time it is replicated but the data collected should be 'consistent' with the results and 'dependable' (Lincoln & Guba, 1985, p.288). The researcher is the primary instrument of the data collection and analysis; s/he can become more reliable through training and practice. Furthermore, I kept a research journal and analytic memos which captured my thoughts and reflections about various issues arising during the research. Triangulation is another strategy which enhanced the reliability of the data.

Trustworthiness is about making the study believable and ensuring that the findings are really what they appear to be. Certain researchers such as Lincoln & Guba (1985) have argued that reliability and validity in qualitative research can be replaced by trustworthiness and authenticity (see also Denzin and Lincoln, 2000). The issues of validity, reliability and trustworthiness will be taken up further in the relevant chapters regarding each instrument of data collection.

3.21 Data analysis procedures in the main study

Data analysis is an integral part of the research cycle and, we are told, not to be considered as a discrete phase near the end of a research plan (Corbin & Strauss, 2008; Dowling & Brown, 2010). It has to begin early in the research in order to influence emerging issues or even aspects of the design. It is, therefore, a formative rather than merely a summative process. Qualitative research tends to produce a large amount of data which can be verbose and lengthy, and analysis of the data can be a lengthy process. According to Blaxter *et al.* (2003, p.206), analysis is about searching for explanations and understandings of phenomena "in the course of which concepts and theories will probably be advanced, considered and develop". The researcher plays an important role in the interpretation of qualitative data. My identity, values and beliefs as a researcher may at times be difficult to eliminate entirely from the research process. I tried to distance myself as much as I possibly could from normal everyday beliefs, operate in a detached manner and avoid making any judgment on social issues for the duration of the research. As reported by other researchers, complete objectivity is impossible and one is bound to make some value judgments at times.

During the observations of lessons and the interviews, I made reasonably detailed descriptions of the situation in field notes and transcripts. Categories and codes were used to organise the data in discrete sectors according to their characteristics. A thorough reading of the observational data and interview transcripts over and over again helped me to get immersed in the data and identify the key categories, sub-categories and concepts which would help to make some sense of the particular situation. During the data collection process I regularly went through my data, reviewed my field notes, transcribed interviews and tried to identify and describe patterns and themes by coding them and rearranging the categories and reviewing them regularly. The parental questionnaire for the pilot study was analysed statistically using Excel. This elementary analysis of numerical data was found to be sufficient for analysis of the parental questionnaire in Chapter 6. The data analysis procedures are discussed more thoroughly in Chapters 4, 5 and 6 as each chapter on the instruments used has the data analysis integrated into them.

Table 3.3 sets out the research questions, the methods used for data collection to answer them and the main outcomes of the analysis of data.

Research questions	**Methods used for data collection**	**Main outcomes of the data collection**
1. How is science taught in Form III (the last year at which science is compulsory) in the case study schools in Mauritius?	Observation of lessons Pupils' interviews Teachers' interviews	Teaching approaches; pupil and teacher behaviour in class; pupil and teacher views about schooling, science and related matters
2. Do parents influence the choice of science subjects in Mauritius and if so how?	Parents' questionnaire	Parents' experiences, perceptions of science and stated influence on the choice of subjects and careers.
3.What are the factors that influence girls to study science beyond the compulsory level in Mauritius?	Observation of lessons Pupils' interviews Teachers' interviews Parents' questionnaire	Pedagogy, image of science, relevance of science topics, behaviour of teachers and pupils, role models, self-identity and socio-cultural factors, parental aspirations.

Table 3.3 Summary of research outcomes from the research questions and the data collected.

Chapter 4

Observations

4.1 Introduction

Observation was one of the two primary methods of data collection in my study. Through the observation of lessons, my aim was to answer research question one: 'How is science taught in Form III (the last year at which science is compulsory) in the case study schools in Mauritius?' and research question three: 'What are the factors that influence girls to study science beyond the compulsory level in Mauritius?' by finding out how science was being taught, about the interactions in the setting noted sequentially at interval of five minutes, factors influencing the choice of science such as the interactions of the pupils during the lessons, the behaviour of teachers, the relevance of the content, objects and artifacts in the setting used as resources for teaching and gender issues. I observed 80 lessons in my main study of which 60 were science lessons while the remaining 20 non-science lessons were in economics, accounts and commerce. I elected to observe the lessons in accounts, economics and commerce because statistics available from the Mauritius Examinations Syndicate (MES) showed that more girls opted to study these subjects than science at School Certificate level (MES Statistics, 2004-2005; 2006, 2008-2010). I decided to observe the non-science lessons because I wanted to have an insight into these lessons to enable me to get a clearer understanding of the complex set of human interactions and experiences so as to help me to elucidate the factors which influence girls to opt out of science after Form III.

During the observations in the main study, I tried to gather impressions and to see events from different perspectives and 'make the familiar strange' (Simpson & Tuson, 1995). In contrast to other methods such as interviews and questionnaires, direct observation allowed me, the researcher, to see events, phenomena and the situation in a natural way as they normally occurred (Burns, 2000). There was no need to rely only on the views, feelings and attitudes of people; by watching what they did and said, I had a view into the actual school life in the real world of the participants in my study. Additionally, as observation is an empirical method for data collection in real life stuations which involves field work, I had to go into the school setting to obtain the necessary information and notice the physical setting, the human setting, the types of interaction taking place between the individuals that were in the setting and the school programme. Another feature of direct observation was that it was an efficient way of collecting a substantial amount of 'rich' data in the timespan I was in the setting.

However, my perceptions of the situation might be influenced by personal factors and affect the reliability of the data. Denscombe (2007, pp.213-214) mentions three points which researchers should pay attention to in order to retain the naturalness of the setting and minimize the likelihood of disruption during observations, namely:

(1) unobtrusive positioning (but being in a vantage point so as to be able to see events and situations);
(2) as far as possible avoiding any social interaction with the participants. This is important in any fieldwork observation in order to minimise the observer effect and thus not alter the situation that is being researched.
(3) Furthermore, being 'on site' for a sufficient length of time minimizes disruption; the presence of the researcher is increasingly taken for granted and s/he becomes part of the setting and has little, ideally , no significant effect on the events taking place.

It is to be noted that a limitation of observation is that it is descriptive and the researcher cannot explain and draw conclusions based on cause–and-effect relationships as in experiments carried out under controlled laboratory conditions. Additionally, naturalistic observation takes a considerable amount of time and researchers may have to wait for some time to observe the phenomenon of interest; after the experience I gained from the pilot study, my observations became more selective and focused on specific areas of interest. Prolonged observation in the settings and other methods of data collection helped to reduce observer and researcher bias. Descriptive field notes were made on a prompt and regular basis, coding and categorizing the data for analysis, which was difficult initially,was undertaken (Denscombe, 2007).

4.2 Planning and conducting the fieldwork

4.2.1 Access and getting ready for observations

After taking into account the input from the pilot study, the schools were contacted again by phone in July 2004 to confirm their participation in the research project. As soon as I received a positive reply from the rectors, I wrote a letter to the Chief Executive of the Ministry of Education to obtain formal consent from the Ministry in writing. The reply from the Ministry of Education was positive but I was told to make the arrangements with the respective Directors of the educational zones of the schools concerned and inform them about my research so that they in turn could officially give the permission to the rectors of those schools to allow me access to carry out the study. As I had already unofficially approached the rectors of all four schools, access was not a problem.

The school year in Mauritius is divided into three terms and the fact that I took over a year to collect my data from mid August 2004 to mid October 2005, means that the data were collected at different stages in each case study school. I could not carry out any classroom observations during November, December, the first two weeks of January, the last two weeks in April and July and the first two weeks of August 2005 because these were vacation periods in the school calendar. Observation of lessons in school A took place in the last term of 2004 (that is, from the beginning of August to mid October 2004); in school B in the first term of 2005 (beginning of February to first week of April 2005); in school C in the second term of 2005 (beginning of May to first week of July 2005) and in school D in the third term of 2005 (from the second week of August to the second week of October 2005). The field work lasted for a total 32 weeks, averaging eight weeks in each school. However, the period January to March in the academic year is marked by many interuptions in the school calendar, such as cyclonic weather, public holidays for the celebration of Independence Day, the Hindu and Chinese New Year and Muslim and Christian festivals. Overall, for the 60 science lessons and 20 non-science lessons observed, I undertook 40 hours of observation of science lessons and about 13 hours of non-science lessons across the four case study schools.

As my study involved young children I had to clarify my position with the participants (teachers and pupils) in each school so that there was no problem with access during the actual study. It could have happened that the participants might withdraw their consent and be unwilling to proceed with the study. Fortunately this did not happen in any of the schools where I carried out the field work, perhaps in part because I had carefully explained the purpose of my study to all the participants. According to the rectors and teachers of the schools concerned in my study, there was no need for any written consent from the teachers or the parents of the children; oral consent from them was sufficient. Although I was aware that a written consent form is the usual procedure in educational research, I was told by the rectors and the teachers that it was not necessary because of the fact that I had explained in broad terms the aims, methods and anticipated outcomes of the research to all those concerned in it. I had managed to gain their trust and, additionally, I had the full support of the rectors and the Chief Executive in the Ministry of Education. The children participating in the study felt important as they were going to be involved in a study which might have important implications for science education in Mauritius. The rectors assured me that they would inform the parents about the research during the parent-teacher' association meetings and also request their consent to participate in the parental questionnaire that I intended to administer after the observations and the interviews were completed.

4.2.2 Classroom observations in the main study

In each school, I observed mostly double periods of science lessons with each lesson (period) lasting 40 minutes. The experience I acquired from the pilot study was valuable in the main study in the sense that I gave sufficient time for each of the schools to settle down at the beginning of each term before starting the actual data collection. After access was granted, I had to spend a week getting used to the setting, the teachers, rectors and pupils, obtaining information on the school and deciding which science class and science lessons to observe and carrying out some initial unstructured observations to get an overall feel for the situation before the actual collection of data. Once the pupils and the teachers became accustomed to my presence in their lessons, I did not expect the participants to change their behaviour during the lessons I observed (Dowling & Brown, 2010, p.54). In each of the four schools, the rector arranged a meeting with the deputy rector and the teachers concerned to provide me with all the help and support I needed for my study. I had discussion with the rector and teachers about the classes I would like to observe and after receiving information on the class I could observe in the school, the teachers gave me a copy of their timetables for that particular class. The teachers in each of the four schools I went to were very cooperative. I normally rang the school before going there to observe the lessons or I would inform the teacher in advance if for some reasons I was not able to come to the lessons. As a matter of courtesy, I always made my presence on the school premises known to the rector or deputy rector before going to the lessons.

4.2.3 Retaining the naturalness of the setting

As discussed in Chapter 3, with classroom observation as a non-participant observer, it is important to minimise the likelihood of disrupting the lessons as people are likely to alter their behaviour when they become aware that they are being observed. They can be embarassed,and react in a way that is not normal (Denscombe, 2001, p.47). During the observation of the lessons, as in the pilot study, I made it a point to arrive early and sit quietly at the back of the room, trying to be as unobtrusive as possible. I discussed my seating position with the teachers at the very outset. Sitting at the back for the duration of the lessons afforded me the opportunity to see what was happening during the lessons without distracting the attention of the pupils and the teacher but it was a disadvantage during practical activity, individual and group work as I had some problems seeing and hearing all the pupils. Any slight movement on my part might divert the attention of the pupils from their lessons and disturb the naturalness of the setting. I tried to concentrate on those near me to find out what they were doing, writing and saying.

4.2.4 Recording events, behaviour and use of field notes

I did not need any equipment in the form of gadgets or software for the observation; apart from my pen which was used for note-taking, my own 'self' was the key instrument. Videotaping the lessons was ruled out even though it had the possibility of yielding rich data. I have videotaped lessons of teachers during microteaching sessions in my professional life and inevitably the teachers and the pupils tended to behave as actors acting self-consciously. It was difficult to rule out the problem of reactivity and selectivity in such a situation. I recorded the detailed field notes quickly, as in the pilot study, within 24 hours of each lesson, I typed all my classroom observations, obtaining rich descriptions in my field notes which on average were 300 words for each lesson observed though this increased to 400-450 words on average after subsequent write up. The notes included the title of the topic(s), the date and time of the lesson, the location, the layout of the setting (arrangement of desks and seating plan), the type of activities and teaching methods, content of the lessons, behaviour in lessons through pupil-pupil, pupil-teacher and teacher-pupil interactions, gender issues and any other events or occurences worth noting during the lessons which would help me to answer my research questions (Moyles, 2002). Behaviour and interest in lessons, dealt with how the pupils responded to the teaching methods used, the types of questions asked and the responses given.

Teacher-pupil interactions concerned oral exchanges between the teacher and pupils and how teachers related to the pupils in the science lessons. During teacher-pupil interactions, teachers often asked questions that would prompt pupils' thinking. I concentrated my attention on the types of questions asked and the instructions and explanations given to the pupils. During pupil-teacher interactions, I tried to concentrate on how pupils articulated their ideas by the responses they made to teachers' questions. Sometimes it happened that pupils who were confident were able to interact and participate in the lessons whereas those who were hesitant gave tentative answers and others remained silent. Pupil-pupil interactions dealt with the social exchanges that took place during group work which engaged pupils in sorting out ideas, expressing their views, carrying out practical activities, interpreting results and understanding concepts and issues in science lessons. Gender issues were noted by looking at how teachers used gender-friendly strategies such as collaborative learning, cooperative group work and practical work, took account of different learning styles, used familiar examples relevant to pupils' lives, encouraged positive attitudes and employed humanistic approaches to promote the participation of boys and/or girls in the lessons. This included praise and encouragement to instil confidence in the pupils.

During the conversations I had with the teachers after the lessons, I tried to clarify certain things which were not clear to me and thus I verified and expanded on what I had written. After one week of observations, the teachers and the pupils became accustomed to my presence and I believe they acted in a way that showed that I had little effect on what took place during the lessons. The fact that I observed so many lessons helped to reduce the observer effect. Moreover, in science experiments one can hardly deny the fact that what is observed is devoid of subjectivity. I may not have been as completely ‘invisible’ as I would have liked to be; observing lessons can have the effect of the observer affecting what went on during the lessons (Reiss, 2000, p.7; Dowling & Brown, 2010, p.53).

4.2.5 Some critical incidents

While observing some of the lessons it did happen that there were some occasions when the teacher or the pupils behaved unusually; I noted such occurences and events as I felt that this gave me some insight into the teacher’s teaching style and the comments made by one pupil in that class typified a particular feature of the child’s behaviour. One example was when the teacher told the pupils not to interrupt him in the lessons if they happened not to understand his explanations of some concepts; he asked them to write on a sheet of paper what they found difficult or to tell the class captain.

A second example of a critical incident was when one boy asked a question on magnetism where the teacher’s response was:

> Teacher M3: For the time being my priority is to complete the syllabus. I’ll deal with your difficulties later.

Another example is:

> Teacher M3: You have to adapt to my way of teaching and I have to adapt to your ways.

This remark gave rise to some comments among the boys whilst the girls kept quiet. Though such events might be non-routine and singular, they are ‘critical’ in what they are revealing (Cohen *et al.,* 2000). Such incidents primarily show that the teacher’s response to each pupil’s remark is failing to create a conducive learning environment.

Another possibility is that the teacher was aware of my presence and might be under the impression that his classroom management was being threatened by such events.

4.3 Validity and reliability

Issues of validity and reliability have been discussed in Chapter 3. It might be argued that the account which I am giving here is from my own particular perspective so that others might see and interpret the events differently. After each lesson I observed, I met the teachers and double-checked with them the accuracy of what I had written. In what follows I make extensive use of verbatim quotations though I acknowledge that the selection of these is inevitably somewhat subjective (Blaxter *et al.,* 1996; Reiss, 2000; Denscombe, 2007). I selected the scenarios according to the research questions. It is not possible to make a judgment that is entirely objective even when several observers are used since different observers may view events differently while their presence may alter the behaviour of the participants (Harlen & Qualter, 1991).

As discussed in Chapter 3, reliability in this research is an inherent property of the data collected and it depends on the trustworthiness, consistency and exactness of the measurements made by the researcher who is the research instrument. Having been in the field of teacher education, I was, at least to a considerable extent, aware of my own self, interests, values and biases and their influence on the research; I tried to be careful in ensuring that the information gained during observations were as valid and reliable as possible and not purposely selected to prove a point. Consistency in the observations was important and this was achieved by focusing on similar events on different occasions in all the four schools in the sample. It would be almost impossible for another person to repeat the study and obtain the same results. However, the follow up interviews with the teachers and the pupils contributed to my understanding of what I observed during the lessons and the process of triangulation using a variety of data sources and methods of data collection helped to address the issues of confirmability or objectivity of the data. Additionally, though one could argue that the research only involves a small sample and cannot be generalised to a wider population, I collected detailed descriptive data of the context so that one can make comparison with other similar contexts and see whether they fit with them (Lincoln & Guba, 1981).

4.4 Qualitative analysis of observational data

After having looked at the conditions in which my data were found, I painstakingly reviewed my field notes and read them again and again. During the data collection process I had quickly jotted down some analytic memos so as to remind me of certain issues that interested me. From the vast array of words, I selected the data which I considered to be relevant to my study searching for concepts, patterns, meanings, explanations and understanding about the phenomena and issues under considerations. Analyses of qualitative data began with the identification of key themes in each school (Miles & Huberman, 1994, Coffey & Atkinson, 1996, Silverman, 2006, Denscombe, 2007). Data were organised and managed and meaningful bits were retrieved by assigning codes (i.e. tags, labels attached to the raw data) based on concepts; they were then categorised by grouping the codes together, making relationships between the codes, looking for patterns and themes, making interpretations and drawing conclusions after reflections made about the information obtained. I also tried to be vigilant about spotting inconsistencies and contradictions compared to what other studies have found or elucidated; I used my research questions as a guiding force in the collection and analysis of data. I categorised the data in the light of the research questions mindful of the fundamental issues that this research was intended to address.

I followed the analytic process described by Miles and Huberman (1994) by breaking down the data analysis into three stages:

1. data reduction
2. data display
3. conclusion drawing and verification.

Data reduction involves the selection, simplification, transformation and condensation of data that appear as field notes; the data are collated, summarised, coded and arranged according to categories, thus reducing the data to manageable proportions. Data display consists of organising and assembling the data and then displaying the data in some form which would allow the researcher to interpret the data and draw conclusions. Conclusion drawing involves searching for themes, patterns and regularities, comparing and contrasting units of data until I found a meaning to the data and drew conclusions from them. It involved stepping back to consider what the analysed data meant and thus assessed their implications for the research questions. The conclusions are verified for their validity by going back to the field notes and other sources of data and checking them against these. Data analysis is therefore a cyclical process rather than a linear activity.

The analysis of the observational data was therefore conducted by hand as follows in three stages. First, preliminary analysis to point out the key issues and themes arising from the data was undertaken. I read through all the notes carefully and thus got a sense of the whole. I set out to discover patterns, processes, commonalities, and differences. I got familiar with them, discerned interesting patterns, asked myself what they were conveying, looking for the underlying meaning and wrote some thoughts and analytic memos in the margins alongside the raw data. Themes and key issues were pulled out from the observation data and given a code/category and sub-categories as shown in Table 4.1. Coding the data involved breaking the data into units for analysis and then categorising those units by being on the lookout for particular events and ideas. These codes and categories are not fixed as new insights and meanings emerge during the analytic process. Coding and categories were used not only to simplify or reduce the data but to open them up so as to interrogate them further and formulate new questions and levels on interpretations. Sub-categories were sub-types used to expand the categories.

Code	**Category**	**Sub-category**
T1.0	Teaching methods	
T 1.1 T1.2 T 1.3 T1.4 T1.5		• Chalk and talk, whole class teaching • Practical work and investigations • Project work • Inquiry method • Other
B2.0	Behaviour and interest	
B2.1 B2.2 B2.3 B2.4 B2.5		• Teacher-pupil interaction • Pupil-teacher interaction • Pupil-pupil interaction • Interest in science • Other

R3.0	Resource materials	
R3.1 R3.2 R3.3 R3.4 R3.5 R3.5		• Textbook • Chart • Video film • Internet • Laboratory equipment • Other
G4.0	Gender issues	
G4.1 G4.2 G4.3 G4.4 G4.4 G4.5 G4.6 G4.7		• Praise/encouragement/attention • Participatory/group activity • Image of science • Familiar examples relevance to everyday life • Learning style • Role model • Other
O5.0	Other	
O5.1 O5.2 O5.3 O5.4		• Homework • Out of school activity • Choice of subjects/career • Other.

Table 4.1: Codes, categories and sub-categories in analysis of observations.

The first category was teaching methods and the sub-categories consisted of an array of different teaching methods that could be used to interest and engage pupils in meaningful learning. The second category was assigned to denote behaviour in lessons, for example teacher-pupil, pupil-teacher and pupil-pupil interactions; a third category addressed resource materials, a fourth one was on gender aspects and a final one, 'Other', was where any data which failed to be included in the previous four categories were placed.

Secondly, a short summary was written for each of the case study schools. A list of categories was made (teaching methods, behaviour in lessons, resource materials, gender issues and other). This second stage involved a systematic analysis of the key themes and patterns as advocated by Miles and Huberman (1994); this involved noting and tabulating and the use of participation responses, key descriptive words and phrases. Themes that were identified to answer my research questions focused on the teaching of science and gender.

The third stage of analysis was through cross-sectional cutting by themes. Teachers' and pupils' responses were coded, sorted and re-analysed several times when emphasis was given to certain themes through the process of 'reduction' (Cresswell, 1994, p.154). In this way, I managed to reduce a large amount of data and categories and then reconstructed them to present a final consolidated account. Throughout the whole process of analysis, I repeatedly reviewed the coding and categorisation by consulting my notes, re-reading them to ensure that any overlap and coding errors were reduced to a minimum.

4.5 Observation field notes

4.5.1 Conventions used in the recording of the presentation of the data

I decided to present the data school by school as each school had its own specificity and this allowed for the richest interpretation of the school-specific findings before I drew more general findings across the four schools. Every effort is made to report data as fully as possible but without causing any harm to the school or the participants by breaking confidentiality and anonymity (as in Chapter 3). The presentation of school data provides some authenticity to the account given of each school and allows the researcher to describe how science was taught in each school, the behaviour of the participants in those schools, the different settings and the gender aspects observed in the four locations. Finally, the analysis procedure adopted gives a rich description of the events taking place in the science lessons at that time.

4.5.2 Observation field notes – a summary

After sorting all the coded categories, I entered the data into a matrix as shown in Tables 4.2a-d. The display identifies schoolwise the topics taught, the teaching methods used, behaviour of teachers and pupils, use of resources and gender effects in the different lessons and other issues observed in each subject.

Subject: Biology	**School A**	**School B**	**School C**	**School D**
Topics (content areas)	• Reproduction, birth control methods. • Sex determination. • Sexually transmitted diseases.	• Cell structure and function. • Diffusion. • Osmosis. • Active transport in organisms.	• Biotechnology. • Project on preparation of various products in biotechnology.	• Digestion of carbohydrates, proteins and fats. • Enzymes. • Osmosis. • Diffusion.
Teaching methods	• Whole class teaching. • Questioning technique mostly. • Individual work during class work. • Copying notes.	• Whole class teaching. • Pupils involved to some extent. • Skills emphasised orally (no practical work). • Homework.	• Demonstrations. • Questioning, explanation. • Project work involving group practicals. • Group presentations. • Copying notes. • Homework.	• Class practical. • Questioning techniques. • Explanations. • Group work. • Class work from textbook. • Copying notes.
Behaviour	• Teacher-pupil interactions. • Pupil-teacher interactions. • Pupil-pupil interactions. • Girls mostly quiet during lessons.	• Teacher-pupil interactions. • Pupil-teacher interactions. • Boys dominate.	• Teacher-pupil interactions. • Pupil-teacher interactions. • Pupil-pupil interactions. • Cooperative learning/group work.	• Teacher-pupil interactions. • Pupil-teacher interactions. • Equal participation of both sexes. • Pupil-pupil interactions.
Resources	• Charts. • Textbook. • Board.	• Textbook. • Board.	• OHP. • Laboratory equipment. • Textbook.	• Textbook. • Board. • Laboratory equipment.
Setting	• Classes in laboratory.	• Classes in classroom.	• Classes in laboratory.	• Classes in laboratory and classroom.
Gender issues	• Female teacher. • Helps. • Examples relevant to life.	• Male teacher. • Traditional approach. • Topic relevance to everyday life not clear.	• Male teacher. • Encourages. • Participatory group work. • Relevance to everyday life.	• Male teacher. • Helps. • Equal participation. • Examples relevant to life.

Table 4.2a: Observation notes on biology lessons – summary.

Subject: Chemistry	**School A**	**School B**	**School C**	**School D**
Topics (content areas)	• Reactivity series. • Balancing equations. • Preparation of a soluble salt by titration method.	• Elements, metals and non-metals. • Valency, formulae and equations. • Radicals, molecules. • Balancing equations.	• Soluble and insoluble salts. • Separation of soluble and insoluble salts.	• Reactivity series. • Experimental techniques.
Teaching methods	• Demonstration of experimental skills. • Practical work in pairs. • Questioning and explaining. • Class work. • Homework.	• Whole class teaching. • Questioning and explaining. • Copying notes. • Class work. • Homework.	• Demonstration of experimental skills. • Practical work in groups. • Questioning and explaining. • Whole class discussions.	• Demonstration of experimental skills using dataloggers. • Practical work in pairs. • Questioning and explaining. • Whole class discussions.
Behaviour	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.
Resources	• Laboratory equipment • Textbook. • Worksheets. • Board.	• Textbook. • Board.	• Textbook. • Board.	• Worksheets. • Computers. • Dataloggers. • Laboratory equipment and materials.
Setting	• Laboratory.	• Classroom.	• Laboratory and classroom.	• Laboratory.
Gender issues	• Female teacher. • Praises, helps, encourages. • Examples familiar to everyday life. • Participatory. • Cooperative learning.	• Female teacher. • Praises, helps, encourages, challenges girls to compete with boys. • Boys more dominating than girls during interactions. • Girls interact with girls mostly.	• Female teacher. Praises, helps, encourages. • Examples familiar to everyday life. • Cooperative learning.	• Male teacher. • Helps, encourages. • Cooperative learning and participatory. • Girls and boys interact.

Table 4.2b: Observation notes on chemistry lessons – summary.

Subject: Physics	**School A**	**School B**	**School C**	**School C**
Topics (content areas)	• Pressure. • Mass. • Density. • Volume. • Weight.	• Velocity. • Distance and displacement. • Acceleration. • Graphs and gradient.	• Light. • Heat and temperature. • Expansion and contraction.	• Energy. • Power. • Solid, liquid and gas.
Teaching methods	• Whole class teaching traditional approach. • Questioning and explaining. • Demonstrations. • Class work. • Note-taking. • Homework.	• Whole class teaching traditional approach. • Questioning and explaining. • Class work. • Reading from textbook. • Homework.	• Whole class discussion. • Questioning and explaining. • Class work. • Reading and copying notes. • Demonstrations. • Homework.	• Whole class teaching. • Questioning and explaining. • Demonstrations. • Class work. • Copying notes. • Homework.
Behaviour	• Teacher-pupil interactions.	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.	• Teacher-pupil interactions.
Resources	• Textbook. • Board.	• Textbook. • Board.	• Textbook. • Board.	• Textbook. • Board.
Setting	• Laboratory.	• Classroom.	• Classroom.	• Classroom.
Gender issues	• Male teacher. • Helps and encourages. • Examples familiar to everyday life.	• Male teacher. • Interacts more with boys; looks in the direction of boys when explaining. • Formal approach. Examples unfamiliar.	• Male teacher. • Helps and encourages. • Relaxed. • Examples familiar to everyday life.	• Male teacher. • Interacts equally with boys and girls.

Table 4.2c: Observation notes on physics lessons – summary.

Subject: Accounts, Commerce & Economics	**School A**	**School B**	**School C**	**School D**
Topics (content areas)	• Different types of goods. • Market, planned and mixed economies.	• Cargo handling. • Services. • Communication.	• Bank transactions. • Ledger, credit and debit.	• Bank transactions. • Ledger, credit and debit. • Entries in book.
Teaching methods	• Whole class teaching. • Questioning and explaining.	• Whole class teaching. • Questioning and explaining. • Reads information in book, then explains. • Homework.	• Whole class teaching. • Questioning and explaining. • Class work.	• Whole class teaching. • Questioning and explaining.
Behaviour	• Teacher-pupil interactions.	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.	• Teacher-pupil, pupil-teacher and pupil-pupil interactions.
Resources	• Textbook. • Board.	• Textbook. • Board.	• Textbook. • Board. • Notes dictated by teacher. • Charts.	• Textbook. • Board. • Notes copied.
Setting	• Classroom.	• Classroom.	• Classroom.	• Classroom.
Gender issues	• Female teacher. • Examples relevant to everyday life.	• Female teacher. • Examples relevant to everyday life. • Girls less involved.	• Male teacher. • Examples relevant to everyday life.	• Male teacher. • Examples relevant to everyday life.

Table 4.2d: Observation notes on accounts, commerce and economics lessons – summary.

4.5.3 Presentation and analysis of data from observation field notes

Tables 4.2a-d summarise the observation notes in the four case study schools and Figures 4.1, 4.2, 4.3, 4.4 and 4.5 illustrate the general plans of the laboratories and classrooms. The laboratories were of similar designs in schools A and C which were state-owned schools. The lessons were held in classrooms in school B whereas the laboratories in school D, which was a private secondary school, were slightly different from those in the state-owned schools (Figures 4.4 and 4.5). I have analysed the results by categorizing by schools as this allows me to note patterns and themes in the data obtained in the four case study schools. The codes assigned to the thematic content in the schools reflect the research questions. All the points summarised in Tables 4.2a-d were considered in what follows.

Teaching methods

<u>School A</u>

In school A, there were 35 pupils in the class and all science lessons were held in laboratories which were well equipped. The non-science lessons were held in classrooms. From the observations of the lessons, it is evident that there was a heavy reliance on whole class teaching in biology and physics, commerce and to some extent in chemistry; both the science lessons and the non-science lessons were dominated by teacher questioning and explaining. Most of the questions were initiated by the teachers in all four subject areas and the pupils either raised their hands or gave some chorus answers. The questions varied from closed ones, based on recall of facts, to open-ended ones which required higher level of thinking. Overall, 70% of the questions were closed. For example, in Accounts, Teacher F7 used questioning techniques to develop the lessons:

> Teacher F7: Pupils remember the basic questions: what? who? where? when? and why? What are the types of economic system?
>
> *(One pupil in the front row answers and at the request of the teacher she writes on the board: market economy, planned and mixed economy.)*
>
> Teacher F7: What is barter system?
>
> Pupil Rani: Exchange of goods for goods.
>
> Teacher F7: Yes, it is about subsistence economy … when money was invented, people had to buy to get goods.
>
> *(Teacher F7 refers to the information in their textbook and told them that there is a long history about the topic of money.)*
>
> Teacher F7: Just in a single sentence who can differentiate between three types of economic system?
>
> Pupils *(several)*: Market economy is owned and controlled privately by individuals. Planned economy is owned by government and is state controlled. Mixed economy is controlled both by government and private individuals.
>
> Teacher F7: Which ones do you prefer and why?
>
> (*No answer from pupils. Teacher then explains and pupils copy notes in their exercise books.)*

Copying notes from the board was a feature in science teaching and even, to some extent, in the non-science classes.

In physics, after explaining the concept of mass, weight, volume and pressure, teacher M1 tried to check understanding of the concepts by setting some quantitative problems for the pupils to answer. The girls had difficulty in coping with the mathematical calculations. The teacher therefore worked out the examples on the board for the pupils to copy. Pupils were then asked to work out similar problems in class from their textbooks. The teacher went round to check the classwork.When dealing with the topic of pressure, teacher M1 used a higher level question to check pupils' understanding and critical thinking:

> Teacher M1: Why can we cut easily with the sharp edge of a knife but cannot do so with the blunt edge?
>
> *(There was no response from the pupils at first. Then, some of them tried to explain.)*
>
> Pupil Rubina: There is more force in the sharp knife.
>
> Teacher M1: Can you explain why?
>
> *(No response from pupil. Teacher M1 asks the whole class. Still no response.)*
>
> Teacher M1: Pressure due to a solid = force divided by area; there is more force distributed over a small area … Examples of application of pressure due to a solid are, a knife, a nail or thumbtack and the wheels of a tractor.
>
> *(Teacher M1 gave pupils classwork and homework to consolidate on the concepts taught during the lessons.)*

In another example, the pupils were given homework on balancing equations and chemistry teacher F2 checked whether pupils had done their homework. She then asked one pupil to write the following equation on the board, write the products obtained and balance it:

> Teacher F2: Sodium hydroxide + sulphuric acid … look at the salt obtained and balance it.
>
> (S*he then explains*:) Do the cross method.

(Pupils have problems with valency.)

Teacher F2: You don't have to remember the formula of the equation by heart … just work them out.

(Pupil has problem working equation out; teacher explains how to balance equation by using the cross method she has done earlier. She then asks another pupil, Anusha, to work out another equation: sodium hydroxide + hydrochloric acid.)

After Anusha has written the equation on the board, she looks at the teacher in a hesitant and unsure way.

Anusha: It's … balanced.

Teacher F2 *(reassures her)*: Yes, that's correct.

(She then asks another pupil, Nasreen, to go to the board and work out the reaction between sodium hydroxide and nitric acid; the pupil experiences some problems writing out the equation.)

Teacher F2: Sodium nitrate is $NaNO_3$. Now write down the equation and balance it.

Nasreen (*writes*): $NaOH+HNO_3=NaNO_3+H_2O$.

Teacher F2 (*asks whole class*): Is it balanced?

Pupils (*chorus*): Yes.

The lesson on balancing equation was carried out using questioning techniques to involve the pupils in problem-solving activities. Teacher F2 used interactions between the pupils and herself to engage them in the lesson and involved some of the pupils individually to ensure that they grasped the concepts of balancing equations in chemistry.

Science Lab – School A

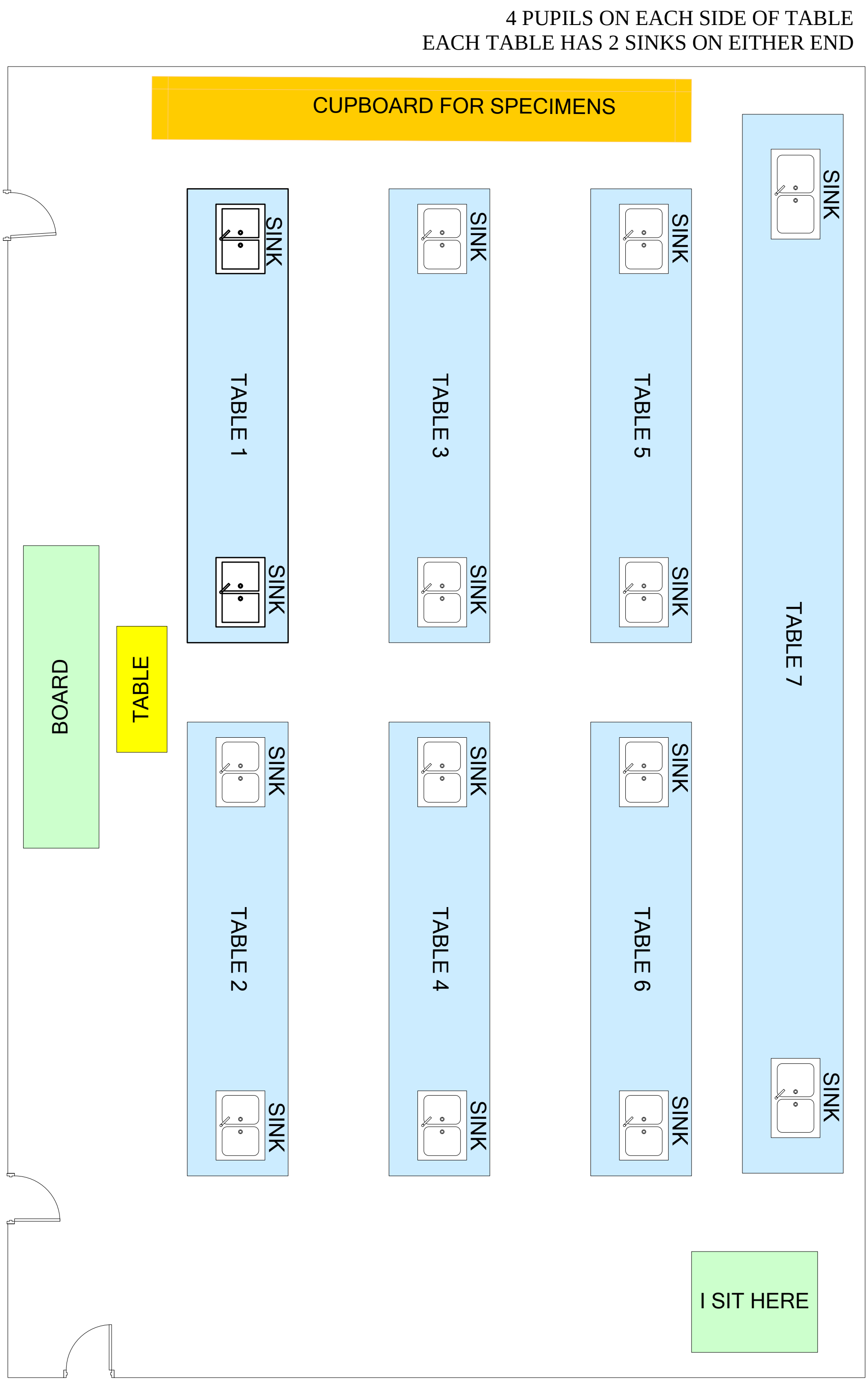


Figure 4.1: Plan of science laboratory in school A.

In biology lessons, teacher F1 used questioning techniques to check prior knowledge which ranged from low order factual questions to higher order ones. Pupils answered in chorus most of the time, for example:

> Teacher F1: Birth control methods … what does it mean?
> Pupils *(several)*: Not to get pregnant.
> Teacher: Who gets pregnant?
> Pupils (*several)*: The woman.
> Teacher F1: If a condom is used, what will happen?
> Pupils *(several)*: Sperms will not penetrate the vagina.

Questions from the teacher and responses from the pupils were recurrent throughout the lesson.

Teacher F1 wrote notes on reproduction on the board and the pupils copied them into their exercise books. The topics in biology were to do with the human body and life. The girls were very interested and this was evident from questions and responses by the pupils; there were more interactions in the lessons and some open-ended type questions were asked by the teacher.

> Teacher F1: Why does a woman take pills?
> (*Pupils try to find answer in their textbooks.)*
> Pupils *(several)*: To prevent ovulation.
> *(Teacher F1 explained about ovulation and then asked the following question)*: What are the problems associated with the pill method?
> *(Pupil Anusha sitting in front row was not sure about the answer and asked a question to the teacher.)*
> Pupil Anusha: Does she become sterile?
> Teacher F1: They do not get children if they take pills for a long time … but they do not become fertile immediately.
> What happens to ovum after fertilisation?
> (*Teacher points at girl in front of her.)*
> Pupil Fawzia: It becomes an embryo.

Other lessons observed showed the same mode of teaching in biology in school A. The teacher always positioned herself in front of the class near the board. However, in chemistry in that same school, pupils had the opportunity to carry out practical work in groups. The practical activity on titration generated a great deal of interest and enthusiasm and it was evident that they were finding the lesson enjoyable as it involved them in hands-on activities and work in groups cooperatively. Cooperative learning in practical work in science has been found to be beneficial in science lessons (Reiss, 2000; Angell, 2004; Sharpe 2004; Abrahams, 2009). During a demonstration lesson on titration and salts, questioning by the teacher was used to a great extent to develop knowledge and skills. Copying notes from the board was a feature in science teaching and even, to some extent in the non-science classes.

<u>School B</u>

In school B, the science lessons were held in normal (i.e. non-laboratory) classrooms containing 34 pupils of whom 16 were girls and 18 boys. I drew a plan of the physical layout of the classroom, noting the seating plan; the desks were in four horizontal and five vertical rows. The boys tended to sit more towards the left (shown in blue in Figure 4.2); the class captain (a boy) sat near the teacher's desk in the front row on the left whilst the girls occupied the rows on the right. There was no visible interaction between the boys and the girls. The boys interacted with each other and the teacher whereas the girls were quiet most of the time and followed the lessons in a passive way. Figure 4.2 illustrates the layout of the classroom in school B where all the lessons were observed.

The class captain was responsible for discipline in the class while the teacher wrote on the board. I noted the details of the setting in my field notebook so that I could refer to these points in the interviews at a later stage. The biology and the physics teachers, M2 and M3 respectively, were both males, still in their late twenties or early thirties and I found out later, after the lessons, that the biology teacher was in his second year of teaching after completing his degree course at the university whereas as the physics teacher was in his first year of teaching.

Physics teacher M3 was a newly recruited teacher who had some problems controlling the class. The lessons on velocity, displacement and distance were explained using the traditional chalk and talk method but he asked many questions during the lessons to check pupils' understanding of the topics he was teaching. I tried to ignore the behaviours of some of the boys during the lessons but the teacher's inability to control the class in some way affected the proper conduct of the lessons and I could sense the tensions which were developing during the physics lessons.

What follows is an extract from my field notes on one of the physics lessons:

> Teacher M3: Do you know what is meant by distance? What is distance?
> Raise your hands if you know.
> *(Seven pupils (boys) raise their hands, girls do not; one boy answers.)*
> Pupil Kumar: Distance is a physical quantity between two points.
> Teacher M3: Is it scalar or vector?
> Pupil Kumar: It is scalar.
> Teacher M3: Yes, it is scalar as it does not involve direction.
> *(He draws a line A to B on the board to explain the concept. He then asks further questions.)*
> Teacher M3: What is displacement?
> *(As there is no answer, he draws a triangle and then explains that displacement is a vector quantity because it has both magnitude and direction. He then gives some examples of vector quantities. He then asks the pupils to refer to their textbook and then explains the example given in the book.)*
> Teacher M3: What is the total distance in the example given?
> Isabelle: 7 km.
> *(Teacher accepts this answer and then asks several questions on other examples in the book.)*

The extract from the physics lesson illustrates the way in which the teacher used the board and the textbook to a great extent to develop the lessons and bring about conceptual change.

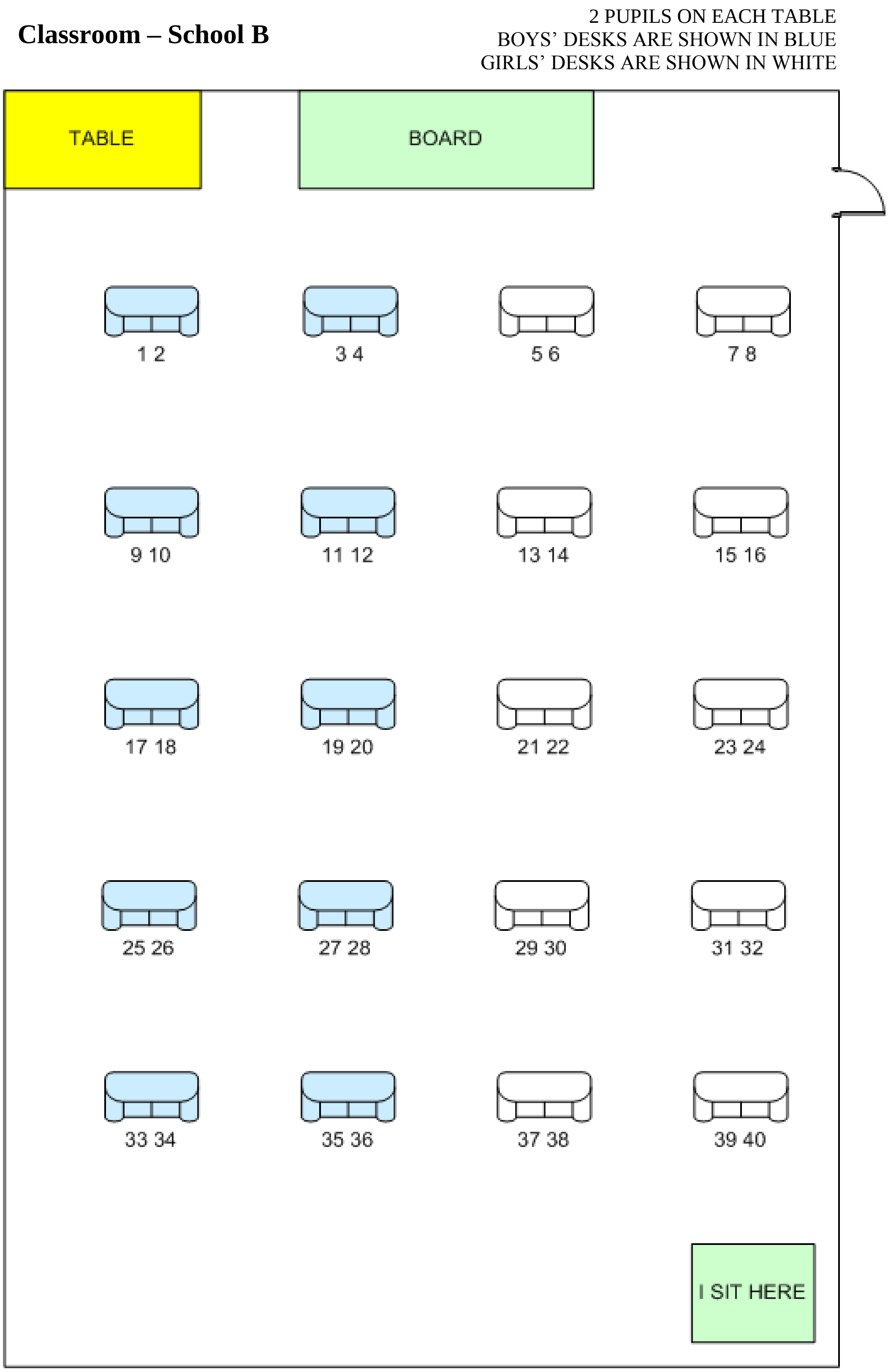


Figure 4.2: Plan of classroom in school B.

Chemistry teacher F3 was a very dynamic young woman with a sociable personality. She used a mixture of closed to open-ended questions to scaffold knowledge. She explained radicals, valency and balancing equations using analogies such as hooks to represent the valencies of elements. The pupils were asked to read the information in their textbook to check their knowledge on the topic being taught. Below is an excerpt of a chemistry lesson:

> Teacher F3: Let's take for example carbonate radical; write down the formula of calcium carbonate ... What is its valency?
>
> Boy Rishi (*raises hand and answers*): Two.
>
> Teacher F3 (*addressing the whole class*): What is the combining power of carbonate?
>
> *(The pupils check answer in their book and answer in chorus*): Two
>
> *(Teacher F3 dictates notes that pupils copy in their exercise book.)*: To write the formula of a compound, you have to know the symbols, valency and then combine; now write down the formula of the following compounds: magnesium nitrate, aluminium carbonate …
>
> *(She writes a list of other compounds on the board and asks pupils to work out the formulae; she goes round checking the work and comments on the boys' work):*
>
> The boys are clever … very good work. Vive les garcons! (*Well done boys.*)
>
> *(She also tries to encourage the girls to do well):* Come on girls, pick up the challenge.
>
> *(She checks their work and said*): Very good too.

The biology lessons were primarily whole class chalk and talk teaching. During observations this occurred 75% of the time. In one lesson in biology, pupils were expected to label the diagrams of generalised plant and animal cells drawn on the board. Biology teacher M2 then asked a boy and a girl in turn to write down the labels on the drawing. The girl was hesitant and shy, appearing to lack confidence. The teacher then asked the whole class how the labelling of the parts of the cell should be done. He commented on drawing skills and asked them to copy the diagrams from the board in their exercise books and to memorise their notes. In another lesson, teacher

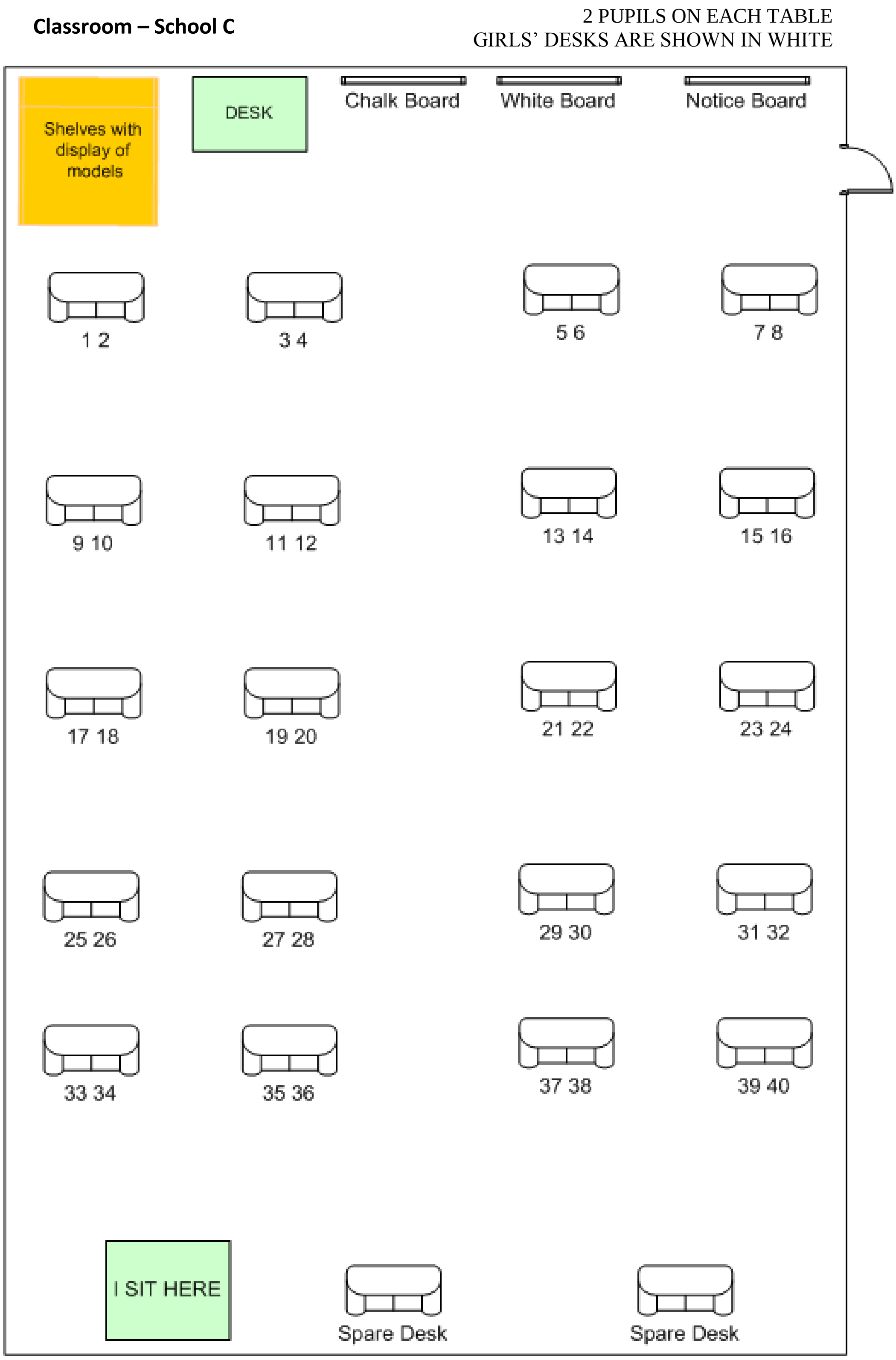
M2 checked prior knowledge of pupils by asking questions which at first focused on direct recall of facts on diffusion. He then asked pupils to open their textbook on the chapter dealing with osmosis:

> Teacher M2: You have seen diffusion. Today you are going to learn about osmosis … how it affects living organisms … we are going to see what happens, where it happens, for example in plant cells … you use potato strips to demonstrate process of osmosis.
> *(He draws on the board some potato strips placed in a dish containing pure water and other strips in a dish containing concentrated sugar solution. He refers to page 14 of textbook and asks Sophie to read. Sophie reads in a low voice. Teacher M2 comments negatively on her reading; he then asks pupil Roy to read and draw the pupils' attention to the word 'turgid'.)*
>
> Teacher M2: What does it mean?
> Boy Roy: There is a higher concentration of water.
> Teacher M2: Where? … in the potato strip or pure water?
> Pupils (*several)*: Water.
> Teacher M2: The potato strips … do they look the same?
> Pupils (chorus): They become larger in the pure water.
> Teacher M2: Why has it become larger?
> *(He points to boy Ram who stands up and tries to answer but finds it difficult to explain.)*
> Teacher M2: Who can help him?
> *(One boy raises his hand and answers:)* It absorbs water … the strip becomes stiff.

In this lesson, it was evident that the teacher relied on questioning to construct knowledge as there was no practical work being carried out.

School C

School C was only built in 2002 and I met some officials from the Ministry of Education during one of my observation sessions; they came to find out about what additional facilities were needed for the school's laboratories which were not fully equipped so far. The chemistry and biology lessons were held in the laboratories whereas the physics lessons were held in normal classrooms because the equipment for practical work were still not available in the school. The layout of the laboratories were similar to the ones in school A. The plan of the classrooms where the physics and accounts lessons were taught are shown in Figure 4.3.



4.3: Plan of classroom in school C.

The biology teacher M5 was a dynamic young man who used activity-based methods of teaching which varied from questionings to investigation work:

> Teacher M5: What are the different fields of biotechnology?
>
> Pupil Neelam: Genes.
>
> Teacher M5: What are genes?
>
> Pupil Sarah: They are chromosomes.
>
> Teacher M5: No, they are part of a chromosome … they contain characteristics of an organism … can you name another field in biotechnology?
>
> Pupils (*chorus*): Chemical engineering
>
> Teacher M5: Another field which is important?
>
> *(Pupils try to think.)*
>
> Teacher M5: I'll help you.
>
> *(Pupils smile.)*
>
> Teacher M5: This is concerned with business. We get the product at an accessible cost (*he is thinking of yoghurt*).
>
> *(Pupils gave answers like accounts, social studies, economics until they got to the right answer which was biotechnology. Teacher M5 told pupils to read information on biotechnology and after 10 minutes he asked them the following questions which pupils answered.)*
>
> Teacher M5: Is biotechnology a new subject?
>
> Pupils (*several*): People did not know they were doing biotechnology … they were doing it without knowing it.
>
> Teacher M5: Since when did it (*biotechnology*) start?
>
> Pupils (*several*): 8000 BC, 8000 years before Christ.
>
> *(The teacher's questions and pupils' answers went on until they finally started dealing with the role of micro-organisms such as bacteria, viruses and fungi in biotechnology. The teacher divided the class into 10 groups and assigned each group to look for information on different topics in biotechnology.)*

The teacher encouraged the pupils to make internet searches for additional information on biotechnology; the pupils were assigned group projects on activities such as yoghurt making, baking and cheese and wine manufacture and they had to make group presentations of their project in class. One even offered me a container of yoghurt towards the end of the lesson after the presentation. I hesitated at first and, on her insistence, I accepted it. The pupils were very much interested in the project work as it was relevant to everyday life and the group dynamics that the project generated were impressive. The project work gave the pupils an opportunity to carry out hands-on activities. Each member of the group contributed by looking for information on how to prepare the different activities, looking for materials and equipment, carrying out the activity itself, writing up the experiments and making a good presentation in front of the class.

The chemistry lessons used teaching methods such as questioning and demonstrations to develop the concepts of soluble and insoluble salts. As in previous cases, the questions ranged from closed recall to higher order open types with some problem-solving exercises which pupils did as classwork in groups. Pupils responded well to teacher F6, a young woman who was very sociable towards the pupils. There were some questions which were initiated by the pupils:

> Pupil Rita: Suppose we put silver sulphate and calcium chloride, we get silver chloride and calcium sulphate, is there a problem of separating them?
> Teacher F6: Yes, that is a very good question … you cannot get an insoluble salt with other reactions we mentioned earlier. That's why I advise you to use nitrate instead of sulphate … all nitrates are soluble. To be on the safer side, use nitrate.

Teacher F6 encouraged pupils to ask questions:

> Pupil Farah: Instead of potassium sulphate, can we use copper sulphate?
> Teacher F6: Yes. Now, why do we write copper-2-sulphate?
> Pupil Lina: Because copper has other valencies … here it is valency 2.
> Teacher F6: If you mix two insoluble salts together, what will you have?

The physics teacher M6, a middle-aged man who was known to me, was very relaxed in his approach and generated considerable pupils' interest during the lessons. He used mostly questioning techniques to recapitulate previous lessons and construct new knowledge. Occasionally, he would make some off-the cuff humorous comments to break the monotony and the class greatly appreciated them. Pupils copied notes which were dictated or written on the board. There was no evidence of practical work being carried out:

Teacher M6: What is another name for heat?
Pupils (*chorus*): Thermal energy.
Teacher M6: Is it hot now?
Pupils (*chorus*): No, it's cold.
Teacher M6: Why do you feel cold?
Pupil Rita: Body temperature is higher than outside temperature.
Pupil Sheena: Outside temperature is lower than body temperature.
Teacher M6: Why are you feeling cold? Are you losing heat?
Pupil Nazmi: I am losing heat.
Teacher M6: From where to where?
Pupil Nazmi: From the atmosphere to body.
Teacher M6: When you go to a fireplace, what happens to the heat?
Pupils (*chorus)*: It makes us feel hot.
Teacher M6: If I pour water on the table, what will happen?
Pupil (*chorus)*: Water flows.
Teacher M6: Heat is just like that; it flows from one place to another. (*He asks pupil in front row*): From where to where?
(No reply from pupil.)
Teacher M6: It flows from a region of higher temperature to a region of lower temperature. You like to drink coffee?
Pupils (*chorus)*: Yes.
(They smile.)
Teacher M6: Suppose you have a cup of hot coffee or chocolate and one saucepan full of water.
(He draws on board a cup containing hot drink and a saucepan containing water. He labels cup of hot drink θ1 and cup of water θ2.)

Teacher M6: Which one is correct? θ1 is greater than θ2 or θ2 is greater than θ1 … or θ1 = θ2?

Pupils (*several*): First one is correct.

It can be seen from the description of the physics lesson that the lesson was a question-answer type with intense periods of interactions between the teacher and the pupils, mostly chorus answers. This teaching style was evident in the other physics lessons observed in school C:

Teacher M6: What is expansion?

Pupils (*chorus*): Increase in size.

Teacher M6: Contraction is what?

Pupils (*chorus*): Decrease in size.

Teacher M6: Look at the floor; what is there?

(Pupils all look at the floor and say that there is a gap between the tiles.)

Teacher M6: What will happen if there is no gap?

Pupils (*chorus*): Floor will buckle on expansion.

The lesson on expansion was made quite lively by using examples which were familiar to the pupils' lives. The teacher asked them about the thermostat of an electric iron, alarm bells, gaps between floor tiles and cracks found on the walls of buildings to explain expansion and contraction. Pupils copied notes which were dictated or written on the board. There was no evidence of practical work being carried out but teacher M6 used examples in the immediate environment of pupils to promote understanding and critical thinking, for example when he asked them what would happen to the floor if there was no gap between the tiles. He made them reflect on what they had observed about the gaps between the tiles and related the pupils' understanding of the concept of expansion to an example in their immediate environment. The textbook was a major source of information and pupils worked on exercises set in it at the end of the chapter. In the lessons in accounts, the teacher used questions to construct knowledge and worked out examples on the board to show how a ledger is kept.

School D

The class I observed consisted of 34 pupils comprising 20 boys and 14 girls. The desks were arranged in rows; the boys sat together on the left hand rows whilst the girls were on the right hand rows. Biology lessons were taught in a traditional old style biology laboratory which reminded me of many similar private school laboratories with the tables in rows and the sinks and taps on the sides along the wall (Figure 4.4). The seating plan for boys and girls shows that there were instances when boys worked in a mixed group with girls during practical work. The table for practial work in Figure 4.4 could only accommodate a small number of pupils; some of the pupils had to work at their desks. Such a seating arrangement was also evident during chemistry practicals in the laboratory (Figure 4.4).

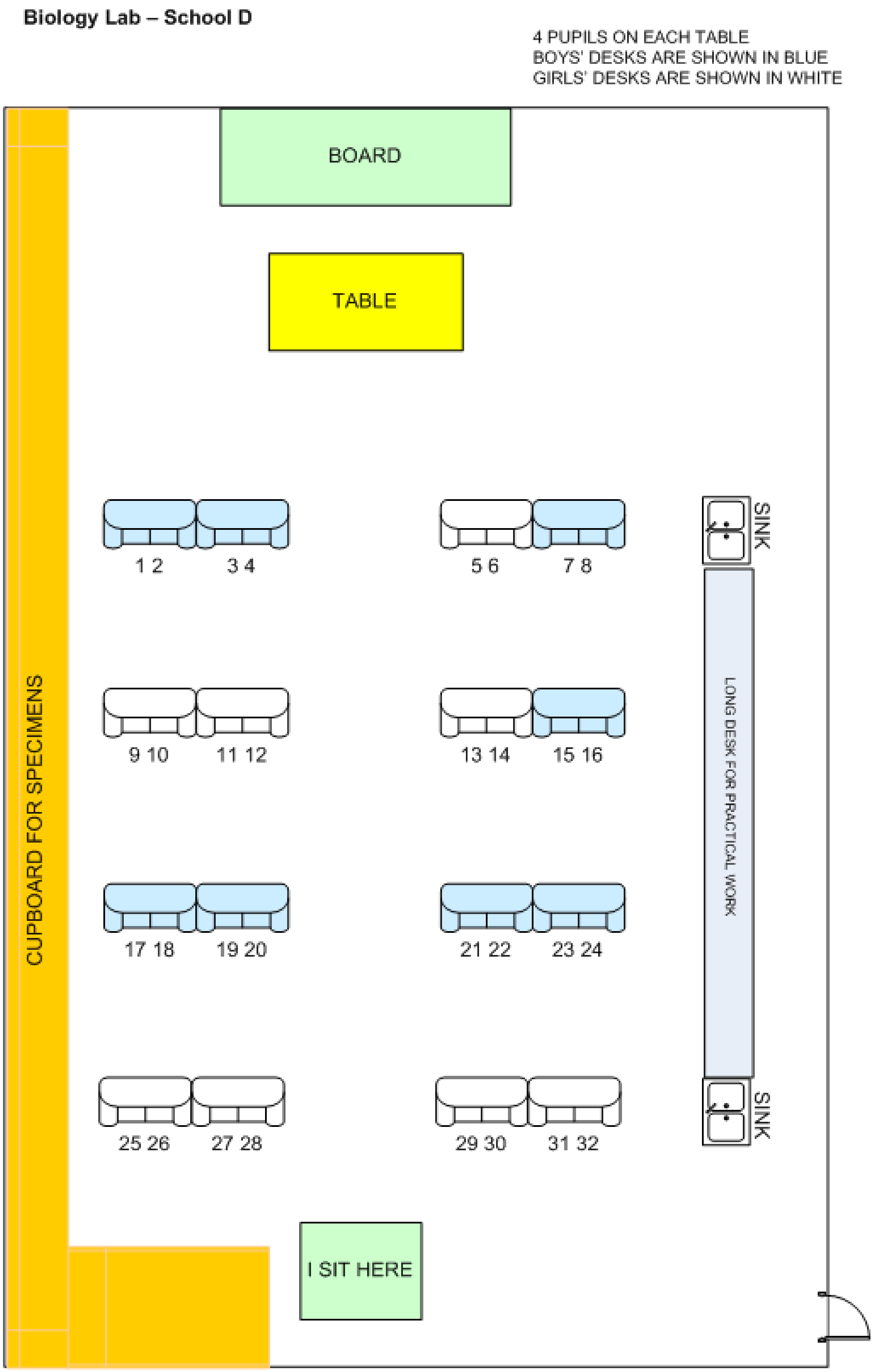


Figure 4.4: Plan of biology laboratory in school D.

Teacher M7 linked the topic on enzymes with the previous lesson on digestion to check prior knowledge by asking questions which included mostly low order direct recall ones. Traditional whole class teaching prevailed with questions, chorus answers, explanations and note copying featuring throughout the lesson:

> Teacher M7: Suppose you eat something which contains protein fried in oil, for example fish, what will the oil contain?
>
> Pupils (*chorus)*: Fats.
>
> Teacher M7: Digestion is brought about by chemicals called what?
>
> Pupils (*look in their book and several answer)*: Enzymes.

The teacher then explained about the roles of enzymes. He wrote some notes on enzymes on the board but he deliberately omitted some words and he asked the pupils to call out the missing words which the pupils did by answering in chorus. When pupils had difficulty in answering some questions teacher M7 either used prompts or gave some explanations followed by notes written on the board which he read and the pupils copied in their exercise books.

> Teacher M7: When undigested food is removed as faeces, what is it called?
>
> Pupil Rina: Assimilation.
>
> Teacher M7: No … not assimilation …
>
> Pupil Alex: Excretion.
>
> Teacher M7: No … (*there is silence for a few seconds, then teacher helps with prompt):* Defae ...
>
> *(Pupils look for answer in their book and call out in chorus)*: Defaecation.
>
> Teacher M7: What is another word for defaecation?
>
> *(Pupils look for answer in their book but there is no answer.)*
>
> Teacher M7 *(prompts)*: E …
>
> *(There is no response from pupils.)*
>
> Teacher M7: Egestion.

Though the topics on digestion and the role of enzymes contained examples that would have been familiar to pupils, such as the composition of their breakfasts, the teacher did not draw on these and there was a considerable number of closed questions which did not stimulate much interaction from the pupils.

Later on, I had the opportunity to observe a practical activity on osmosis using potato strips and solutions of different concentrations. Teacher M7 carried out a demonstration of the experiment, emphasised the experimental procedures and then asked the pupils to carry out the practical work as a group activity. The boys and the girls worked in mixed groups and it was the boys in most cases who did the experiments whilst the girls made the observations in their note books.

The physics lessons reflected a similar pattern as the biology lesson but differed in that the pupils were involved in problem-solving exercises during class work:

> Teacher M8: Let’s recap the last lesson. What is power, we said?
> Pupils *(boys answer in chorus)*: Power is the rate of doing work.
> Teacher M8: Power is work done over time taken. Each time we do power you should learn the formula: Power = work done divided by time. Work done is expressed as what?
> Pupils (*boys and girls together in chorus*): Energy.
> Teacher M8: We said before there are different kinds of energy; what are they?
> Pupils (*chorus*): Kinetic, potential, electrical.
> Teacher M8: The unit of power is? ... What energy unit is it?
> Pupil Jean: Joules.
> Teacher M8: Power is energy divided by time. What is power?
> Pupils (*repeat in chorus*): Power is energy divided by time.
> Teacher M8: Have you noticed watts on light bulbs?
> Pupils (*chorus*): Yes.
> Teacher M8: What does it mean?
> Pupils (*chorus*): It is its power.

Teacher M8 then wrote a problem-solving exercise on the board which pupils copied in their exercise book. The teacher explained how to solve it and then asked them to work out another similar problem. He went round to check how pupils were coping.

Afterwards he worked out the problem on the board by asking questions which pupils answered in chorus. Pupils were asked to work out similar problems from their textbook, an activity which pupils carried out collaboratively. The boys worked noisily whereas the girls worked quietly; one boy interacted with the teacher by asking a question on something which he did not grasp properly. Teacher M8 explained in Creole instead of English in that particular case. Answering in Creole can be problematic as pupils often have difficulty in conveying the meaning in English; they often translate Creole literally into English. The majority of the pupils in that class were considered to be of a lower ability and teacher M8 by making use of the vernacular language was trying to make sure that pupils understood what he was explaining. Later on during my conversation with him, I tried to obtain some clarification on that matter and he explained that pupils had difficulty in understanding when the lessons were conducted entirely in English.

Chemistry lessons were carried out in normal classrooms for theoretical work on balancing equations and valencies; practical activity took place in a chemistry laboratory which had been recently renovated (Figure 4.5). The pupils in the latter case were participating in a datalogging project in chemistry and Teacher M9 was teaching the reactivity series using computers, chemical apparatus and five unknown metals. Pupils worked in pairs. Worksheets with instructions were handed to pupils, explained to them and then pupils were asked to find out about the reactivity of the metals and to construct a reactivity series from the results obtained. Teacher M9 placed much emphasis on measuring and observational skills as the procedure involved filling five test tubes with 10 cm^3 of hydrochloric acid and then observing the number of bubbles that evolved:

> Teacher M9: Use a measuring cylinder to measure 10 cm^3 of HCl.
> *(He shows what a measuring cylinder is.)*
> Teacher M9: How do you measure 10 cm^3?
> *(Pupils look at the measuring cylinder; teacher M9 explains on the board what a meniscus is and demonstrates how to read a meniscus.)*

The boys and girls worked together and there was equal involvement of the boys and the girls during the practical activity. The pupils showed a great deal of interest in what they were doing. Some were discussing the results among themselves, while others were busy noting down their results. The teacher asked questions by addressing the whole class about the results obtained when each different metal was added to the acid contained in each of the five test tubes and then discussed the results of the pupils:

> Teacher M9: What results did you get?
> Boy Dev: The reaction of metal A was vigorous.
> Girl Bhavna: There were few bubbles in reaction with metal D.
> Boy Adil: Metal C gave no reaction.

Teacher M9 then wrote all the results on the board and then asked pupils to work out the reactivity series. There was a lot of excitement during the lesson and it was obvious the pupils were enjoying the work.

Chemistry Lab - School D

4 PUPILS ON EACH TABLE

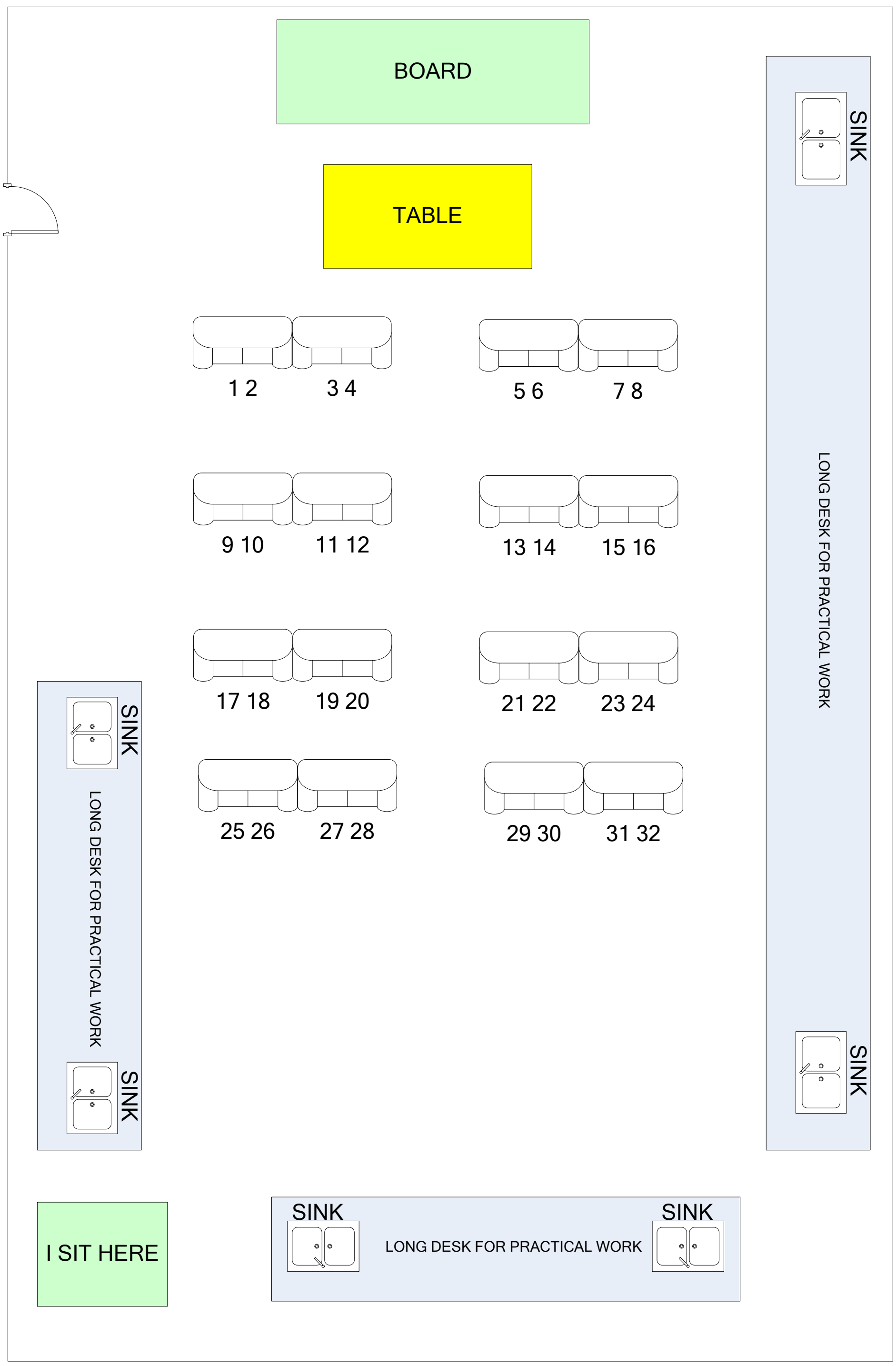


Figure 4.4: Plan of chemistry laboratory in school D.

Behaviour in lessons

Behaviour in science and non-science lessons was noted in all four case study schools. In school A, the teacher-pupil interactions were rarely interactions between the teacher and individual pupils; pupil involvement was generally through chorus answers, either whole class or groups of pupils answering together. The interactions were initiated by teachers. and pupils did not ask many questions. The example given below shows the chorus interactions between the teacher and the pupils:

> Teacher F2: Have you understood titration today compared to Monday when I did the demonstration?
>
> Pupils (*chorus)*: Yes.
>
> Teacher F2: Why?
>
> Pupils (*chorus)*: Because we did it by ourselves.
>
> Teacher F2: What was the main problem you had when you did it yourselves?
>
> Pupils (*chorus)*: Parallax error …
>
> Teacher F2: Three of you got solutions in your mouth … Why did it happen?
>
> Pupils Anusha, Fawzia and Rubina: We sucked the solution with the pipette too rapidly.

In fact, there were some individual interactions between teacher and pupils in certain lessons:

> Chemistry teacher F2: What kind of taste do alkalis have?
>
> Pupil Rani: Sour … soapy … milky.
>
> Teacher F2: No, never milky … (*pupils laugh*) … Alkalis have a soapy taste … You have tasted vinegar. What type of taste does it have?
>
> Pupil Rani: Sour.

Pupil-pupil interactions which took place during practical activities and group work in science in schools A, C and D enabled dialogue between the pupils but there were only a few instances of visible interaction noted in the accounts, commerce or economics lessons. Such pupil-pupil interaction during group work has been elaborated in the paragraphs dealing with teaching methods and gender aspects. Interactions in schools A, B and D helped to promote oral skills in the pupils but pupils' participation in discussions was not very evident in all lessons. During classwork, pupils discussed among themselves at times. The greatest degree of interaction among pupils was apparent in the project work in biology in school C and in the titration practical in school A. In school C, pupils documented themselves how to prepare cheese, yoghurt and wine and make compost using biotechnological techniques; they discussed the methods among themselves and carried out the practical activities. By interacting with one another they learned new concepts and the applications of science in their daily lives through the process of socialisation. Similar interactions during the preparation of insoluble salts produced group dynamics which helped the pupils to negotiate with each other on arranging collection of apparatus and turn-taking in doing the experiments, and agreeing on measurements and results obtained.

Use of resources

The teachers in all the four subject areas used textbooks very frequently during the lessons. Pupils were asked to read from the textbook in the three science subjects and then the teacher would ask questions to check their understanding or find out if the other pupils were following.

The three science laboratories in school A and the biology and chemistry laboratories in school C were fairly well equipped with attendants attached to each laboratory to assist the teachers during practical work. Such assistance was very obvious in the chemistry lessons I observed involving titration in school A. The laboratory attendant went round to make sure that the apparatus was functioning and that pupils were using the proper techniques during the investigation. During traditional chalk and talk teaching, the laboratory attendants stayed in the preparation room which was adjacent to the laboratory. In schools B and C, textbooks and the board were major resources in physics and chemistry but on one occasion Teacher M6 in school C used an empty bottle to illustrate the concept of rollers in bridges. In practical work in biology in school C use of laboratory apparatus, textbooks, charts, overhead projector and internet were made. The teacher of accounts in school C used charts to explain some concepts in that subject. In school D, physics was taught in the traditional chalk and talk method and only textbooks and the board were used as physical resources. Resources used in chemistry lessons in school D were more innovative as the pupils were observed using dataloggers to work out reactivity series and the lessons were carried out in the laboratory using materials and equipment for practical work.

Gender issues

As reviewed in Chapter 2, gender differences in pupils' behaviour towards science have been studied by several researchers. Several factors have been claimed as being responsible for such differences.

<u>Role models</u>

In the four case study schools where I observed the lessons in science and non-science subjects, there were nine male teachers and seven female teachers involved in the teaching of those subjects in the participating classes. The physics teachers were all men; of the four biology teachers, three were men and there were three women and one man teaching chemistry. In accounts, commerce and economics, there were equal number of males and female teachers. The issue of role models was raised during the pupil interviews to explore if this influenced their interest in the subjects studied in those schools. Pupils tended to respond well to the chemistry and biology teachers (in school A) who were both females. The physics teacher in school A was a male who was always very serious in his class but tried to help the girls when they had problems with their work especially where problem-solving activities were concerned.

<u>Gender-friendly strategies</u>

Practical activities have been reported by researchers to make science enjoyable and interest pupils to study science (Reiss, 2000; Osborne & Collins, 2001). However, practical work can be organised by teachers in a way that disadvantages girls. In school A, involvement of the girls in practical activities allowed the girls to manipulate equipment and act as scientists, work collaboratively and develop their practical skills:

> Teacher F2 (*reassures them*): This is the first time you are doing it … It must have been scary … don't worry next time you will be able to do it better.

Girls are reported to be motivated and to show an interest in science when teachers' attitude are encouraging and helpful (Jones, 1999; Sharpe, 2004; Krogh & Thomsen, 2005). Below is an example of how teacher F2 helped pupils to recall certain terms in a later part of the lesson on salts and crystallisation:

> Teacher F2: What is the exact word for concentrated solution? ... Starts with an S …
>
> *(Pupils try hard to find the answer but are unsuccessful.)*
>
> Teacher F2 *(prompts)*: Sat ...
>
> Pupils (*chorus)*: Saturated.

Cooperative learning is a strategy that has been found to promote learning of abstract concepts and help in removing misconceptions (Acar & Leman, 2007). Teacher F2 was very encouraging and helpful and gave the pupils an opportunity to work in small teams and develop their skills at doing practical work. Team work enabled the girls to interact with one another, build upon each other's strengths and develop their social skills and self-esteem. In chemistry during a demonstration lesson on titration and salts, questioning was used by teacher F2 to a great extent to develop knowledge and skills. The girls interacted more with the female teachers F1 and F2 and were passive during their physics lessons with M1. They seemed to have difficulties in problem-solving activities in physics where they had to work out calculations. This point will be explored further with physics teacher M1 in Chapter 5 that reports on the interviews.

In school B, there was some group work during the class activity but girls interacted mostly with girls sitting together and in only one instance did I see a girl working together with a boy. This reflected a particular gender segregation that to some extent existed in the classes I observed in this mixed school. Instead of encouraging her, teacher M2 asked the question to the whole class. This did not stimulate further thinking on her part. The physics teacher M3 gave more attention to boys as they made a greater impression on the teacher than the girls; this point will be further elaborated upon at a later stage in Chapter 5 that reports on the interviews.

Differential treatment of boys and girls

Another significant point noted in the physics class was the fact that the teacher hardly encouraged the girls to participate and looked mostly in the direction of boys while questioning the pupils. Such behaviours have been shown to affect girls' motivation and lack of participation in science lessons (Labudde, 2000). In one instance, though one girl raised her hand to answer a question on displacement and the angle formed, the teacher ignored her and kept looking at the boys' end and accepted the answer given by one boy:

> Teacher M3: What is the angle at A?
> *(One girl raises her hand and answers)*: 90 degrees.
> *(Teacher M3 ignores her answer and looks in the direction of boys and addresses boys)*: Are you sure it's 90 degrees? Which line indicates displacement?
> Boy: OB.

The lessons in commerce in school B were on cargo handling, services and communication and whole class teaching was observed. Teacher F4 used questioning techniques during the lessons. As had been the case in the science lessons in school B, the boys were more vociferous than the girls in interacting with the teacher. During the five lessons that I observed in this subject in this school, teacher F4 either read or asked the pupils to read the information in the textbook and explained after asking questions now and then to check pupils' understanding. I noted that Isabelle, who was picked by the teacher to read, did so in a very low voice and the teacher had to ask her to read louder.

In school C, an all girls' school with higher ability pupils, one notable feature in a physics lesson on expansion was that the lesson was made quite lively by using examples which were familiar to the pupils' lives. Teacher M6 asked them questions about the thermostat of the electric iron, alarm bells and cracks found on the wall of buildings to help explain expansion and contraction. These were examples related to their everyday lives and seemed more real to the girls (Brickhouse, 2001).

School D, a mixed–sexed school, was illustrative of the cooperative environment that can occur between boys and girls. The experiment on the reactivity series using dataloggers gave a glimpse of the interaction and collaboration between boys and girls. Each took turns to do the experiment and took turns in recording the readings.

Other issues observed

Classwork and homework were important features in all lessons observed. Teachers checked if pupils had performed the tasks given to them and homeworks were corrected in class at the beginning of the lessons. Those who failed to do their homework were sent to the board to work out problems with the help of the teacher. In school C I had the opportunity to see the work of pupils that was being displayed at the Open Day organised by the school. This included posters on scientific, health and environmental topics and project work carried out by pupils. Biology teacher M5 was very instrumental in encouraging the pupils to participate in such activities in order to motivate them to show an interest in science.

4.6 Discussion of results and conclusion

One of my aims in the observation of the lessons was to find out how science was being taught in the four case study schools. My other aim was to find out about the gender issues and to gather data about the factors that might affect the choice of science subjects at Form III level.

It was evident from the data in all the four schools that whole class teaching was associated with questioning to a great extent to promote learning in the pupils. Teachers' questions are important in teaching and learning in science lessons; if these questions are used effectively they can lead to good teacher-pupil and pupil-teacher interactions. Questioning was one skill that the teachers used most in the lessons I observed (cf. Wellington, 2000). The questions varied from lower order requiring direct recall to others that were of a higher order, which were more challenging and required understanding and analytical thinking. In lessons where whole class teaching took place, the questions ranged from low to higher order but the former dominated. Though the questions were directed to the whole class, the pupils raised their hands on only a few occasions to answer them individually. Chorus answers and several pupils answering at about the same time were a common feature and little opportunity was relatively given to assess the difficulties that pupils experienced in understanding the concepts taught. There was not sufficient wait-time given by the teacher to elicit many individual responses from the pupils. The traditional approach of whole class teaching was more focused on the mastery of content and not much attention was paid to the development of skills and encouraging critical thinking in the pupils through inquiry and investigations. The teacher-centred method used in biology, chemistry, physics and accounts, commerce and economics placed the teachers as the main dispensers of knowledge though textbook readings were used as additional sources of information.

Investigations and project work in biology created considerable interest and the girls were very resourceful in undertaking group activities and this fostered team spirit among them. In physics, the girls in school A experienced difficulties in working out problem-solving exercises, about which the teacher could have been more helpful and encouraging. His attitude was too formal and therefore the girls seemed to lack enthusiasm and motivation and they carried out the class work in a very routinised way. Considerable interest was aroused when practical activity was undertaken in chemistry lessons in school A and in biology in school C. Cooperative learning was a successful strategy and the girls worked in small groups, discussing the practical work, and they undertook class work by helping each other. The girls in school C were highly motivated and they participated positively in the lessons. Teaching methods in this school involved whole class discussions with questions ranging from low to higher order. In school C, physics teaching was carried in a normal classroom and was based on questioning and explaining but the teacher made the lessons interesting by using examples which were familiar from the everyday lives of the pupils. The teacher seemed to compensate for the lack of laboratory facilities by making extensive use of the board and the textbooks; he relied on the illustrations in the textbook to draw pupils' attention to examples and thus facilitate learning. Chemistry lessons in this school included some demonstrations on the separation of soluble and insoluble salts but the pupils hardly had the opportunity to manipulate any equipment or carry out practical work. The teacher heavily relied on questioning during the lessons.

Similarly, in school D, physics lessons were carried out in normal classrooms where the textbook and the teacher were the main resources; a chalk and talk method was mostly used. The teacher wrote some worked examples on the board and later gave class activities from the textbook for the pupils to work out. There was evidence of group work during the class activity. The teacher had to use Creole language, which is not an official language, to explain certain concepts. There is still on ongoing debate about the use of Creole in the classroom but the Ministry of Education policy recommends, so far as is possible, the use of English or French in classroom situations.

The non-science lessons that I observed with respect to teacher behaviour were not very much different from the science lessons as the teachers used whole class teaching, questionings and explanations using textbooks in a way similar to the science lessons. I could have used event sampling by entering a tally mark each time the teachers asked questions or explained during the science and non-science lessons but I felt that this was not nececessary to answer my research questions. This would have meant making more structured observation using an observation schedule. Reliability was enhanced by the use of other data collection methods. The fact that more girls were choosing commerce, economics or accounts in some schools was not related to the way the teaching of those subjects was carried out. From the interviews, discussed in Chapter 5, more light will be shed on this aspect.

Active participation involving laboratory and project work can increase girls' engagement in learning science (Freeman, 2002). Girls in schools A and C experienced laboratory and project work in two subject areas, namely chemistry and biology. In the other subjects observed, physics, accounts, commerce and economics, they were being taught in a didactic style which might not be mentally stimulating. Topics on reproduction and sexually tranmitted diseases and biotechnology had relevance to them as they were people-oriented whereas topics in the physical sciences were presented in an abstract way in school B and to some extent in schools A and D (cf. Aikenhead, 2003).

Schools B and D afforded me the opportunity to see how boys and girls were treated and reacted in a mixed situation. In school B there was a differential treatment of boys and girls with teachers paying more attention to boys than girls as the former showed more keenness to answer questions asked by the teachers. The girls were very passive and seemed to be inhibited by the dominating attitude of the boys. The biology and physics teachers in school B did not encourage the girls to participate actively in the lessons; neither did they instill any confidence in them when they experienced difficulties during classwork. The chemistry teacher, however, tried to praise both the boys and girls equally during the lessons. Later on, during my conversation with the pupils and the teachers, I found that there was a competitive spirit among the boys.

Interestingly in school D, biology and chemistry teachers involved the pupils in group practicals, where boys and girls occasionally collaborated. On the whole, topics in biology and to some extent in physics were relevant to the lives of the pupils, though some familiar examples were used in chemistry to make the lesson interesting, such as ‘kitchen salt’ and ‘vinegar’; topics like balancing equations and titration had little relevance to the everyday life of the girls concerned. The practical work on titration was enjoyable because it was an activity which involved all the pupils in manipulating apparatus in the laboratory. Even in commerce and accounts lessons, the boys in school B were more vociferous than the girls and attracted the teacher’s attention to a greater extent. Another point worth noting in physics was that all the teachers were male; the masculine image of science was very evident both through the pedagogy and the behaviour of the teachers in at least three of the schools.

The gender issues were not so evident in school D, something that the teachers seemed to show very little awareness about; this point would be clarified in the interviews with these teachers. It later transpired that some teachers had never had any training in pedagogy and were improving their teaching techniques through trial and error or from guidance from their senior colleagues.

Although the data from the observation of the lessons will be considered further with the data obtained from the interviews in Chapter 5, so far the key points emerging from the lesson observations are:

- Whole class teaching using questionings and explanations were the predominant mode of teaching. Opportunities for group work and cooperative learning occurred occasionally.

- There was a limited amount of practical work in biology and chemistry lessons and none in physics. Pupils engaged in practical work and seemed to enjoy it whenever they were given the opportunity to do so.
- Textbooks and boards were the main resources used.
- Pupils mostly answered in chorus to teachers' questions in all subject areas; teachers accepted such answers possibly because it enabled them to cover the content of the lessons within the specified time.
- Notes were copied by the pupils in a simplified form which pupils could memorise.
- Interactions in the lessons were mostly initiated by the teachers, though in some lessons pupils initiated some.
- By asking pupils to read from the textbook during the lessons, teachers were making the pupils interact with the text and reflect on what they were reading to some extent.
- There were more men than women teachers in physics and biology and more women teachers in chemistry and the non-science subjects observed and some teachers in the mixed schools directed their questions and responses to boys in preference to girls.
- Though gender differences were noted in the way teachers reacted to boys and girls in mixed schools, in a way that generally favoured the boys this aspect needs to be explored by methods other than classroom observation.

The results from the observation of lessons suggest that teaching of science was teacher-centred, using tradititional chalk-and talk-methods in most cases. Although questionings allowed for interactions between the teachers and the pupils, teachers tended to dominate the classroom interactions. In one mixed-sex school setting, there were occasions when the boys monopolised the teachers' attention by answering the questions before the girls but this was not the case in the other mixed-sex school. On the whole, girls were subdued and followed the lessons passively. Practical work and investigations were rare features in most of science lessons, more particularly in physics. There was evidence of group work and collaborative learning during project work and practical work. The topics in biology and accounts were relevant and familiar to the lives of girls whereas those in chemistry were of little relevance to the girls. Although some relevant examples were used in physics to compensate for the absence of practical work, it is necessary for classroom teaching to consider using gender-friendly approaches in subjects which girls are less enthusiastic about. The observation of lessons reported here offers important insights about classroom practices and some of the factors that influence the choice of science subjects beyond the compulsory level.

Chapter 5

Interviews

5.1 Introduction

The previous chapter focused on the analysis of data obtained in the observations of classroom lessons in the four case study schools. This chapter aims at contributing answers to the first and third research questions (Section 2.6) through a qualitative analysis of the data acquired in the interviews with teachers and pupils in the four case study schools. It also provides some information relevant to the second research question (about the role of parents on their children regarding the choice of subjects and career). Interviews were used, with observations, as a main method of data collection in order to obtain deeper insights into the topics that were being investigated. I felt that by focusing my attention on collecting more detailed information from the teachers and a small number of pupils, I would further enhance the data collected through the classroom observations of lessons. The interviews allowed both the interviewer and interviewees to discuss and express their views of the world in which they live from their own point of view. The interview data will be presented as four separate case studies, one for each school where the interviews were undertaken because of the specificity of each school and gender issues related to pupils and teachers; these data will then be brought together to give an overall picture of gender issues and choice of science subjects across the four schools. Before presenting an analysis of the data, a brief description of the methodology used will be provided.

5.2 Purpose of the pupils' and teachers' interviews

The interviews conducted were a follow up to the classroom observations and as such they aimed 'to obtain descriptions of the lived world of the interviewees with respect to interpretation of the described phenomena' (Kvale, 1996, p.30). Kvale remarks that an interview is an *inter-view,* that is, an interchange of views between two or more people on a topic of mutual interest and through the human interactions one can obtain a more in-depth insight into the topic being investigated. As stated earlier, interviews help the interviewer to understand the lived experience of the interviewee and know the meaning the interviewee himself or herself make of that experience (Seidman, 2005). Whilst I expected the observations of lessons to supply a great deal of the data to answer research questions one and three, I felt that the interviews would allow me to acquire an insight into various aspects of the study, such as getting the views and feelings of teachers and pupils about lessons in science and non-science subjects, their behaviour in lessons, the curriculum and its delivery, resources, and gender aspects that would help to answer the research questions further. Choosing subjects is a critical event in the lives of pupils because it determines their career trajectory (Cleaves, 2005). The pupils in this study had to decide on the choice of subjects at the end of the year and it was important that I probed into their thoughts, feelings and opinions about science. Additionally, the interviews helped to counter the threats to reliability and validity of the data collected so far, complemented and supplemented the other data collection methods and served as a methodological triangulation. However, I was also aware that triangulation might present logical and practical difficulties; for example, findings collected by one method might contradict those by another method and direct comparison could be a problem (Robson, 2002). The conversations with the teachers and the pupils served as a primary medium through which social interactions helped to complete the broad picture (Silverman, 2001). The results obtained in the pilot phase of the study indicated that an improvement in the skills of interviewing were required; they sharpened my use of different methods of interviewing and analysing the data whilst bearing in mind their strengths and limitations. The transcription process of the collected data in the study brought me closer to the data by bringing the discourse to life again and thus proved a real asset to the qualitative data (Denscombe, 2007). The advantages and disadvantages of the interview method have been discussed earlier in Chapter 3.

5.2.1 Selection of sample for potential interviewees

As stated in Chapter 3, I interviewed a group of five pupils in each single sex girls' school and in each mixed school one all boys group and one all girls group and, across the four schools, 16 face-to-face individual interviews of teachers. I was not seeking for generalisability and random sampling would only apply in a large population which was not the case in this study. Furthermore, interview participants must give their consent to be interviewed and the element of self selection is ever present in a study involving interviews (Seidman, 2005). During the observations of lessons in each school, I had focused my attention on certain pupils whom I hoped to interview at a later stage and when I approached those pupils, they all consented to be interviewed. However, one boy who particularly attracted my attention in school B and who initially agreed to be interviewed did not show up at the interview stage. Fortunately, another boy from that class agreed to participate in the group interview in that particular school. All the teachers whose classes I observed agreed to be interviewed.

5.3 Analysis of the interviews

The qualitative analysis of the interviews was carried out using the major categories of the interviews which focused on the teaching methods, behaviour and interest in lessons, resources and gender aspects and other relevant issues (Table 5.1). As described by Miles and Huberman (1994), the categories were induced from the interview data, the research questions, the categories used for the analysis of the classroom observations (Chapter 4) and my own understanding of the literature regarding the phenomenon under study. To determine specific analytical categories, I undertook an intensive and repeated reading of the transcribed material. I tried to retain the required degree of accuracy during the transcription of the interviews and also resorted to corrective listening to minimise any possible transfer errors (Schmidt, 2004). I was guided by my own prior theoretical knowledge and the research questions in the reading of the transcripts. I thus aimed to note any marked similarities and differences between the interviews. While reading the interview transcripts repeatedly, I took care not to relate the text passages too hastily to my own questions and not to overlook the text passages in which I did not initially see the connection to the question.

5.3.1 Presentation and analysis of the data from the interview transcripts

After having read several times the interview transcripts and checked them with my field notes, I picked out the recurrent categories and ideas emerging from them. I clarified initial categories and subsequently clear criteria for each category and sub-category were defined (Table 5.1). I decided to analyse the interviews by schools because it is possible that certain phenomena and events which I was searching might not be the same in the four case study schools. I then assembled the analytical categories into a guide for coding as I did for the observation data in Chapter 4 that is, relating particular passages in the text to one category in a version that would fit these textual passages (see Table 5.1). The same recording conventions for recording the data were used as in Chapter 4 (Section 4.8.1). I first tested and evaluated the usability of the analytical categories on a number of interviews and then refined the categories and their variants from the coding guide. Subsequently, I created several sub-categories for the major categories (Table 5.1).

Code	Category	Sub-category
T1.0	Teaching and learning methods	
T1.1		• Chalk and talk, whole class teaching
T1.2		• Practical work
T1.3		• Project work
T1.4		• Inquiry method
T1.5		• Other
B2.0	Behaviour in lessons	
B2.1		• Teacher-pupil interaction
B2.2		• Pupil-teacher interaction
B2.3		• Pupil-pupil interaction
B2.4		• Interest in science
B2.5		• Other
R3.0	Resource materials	
R3.1		• Textbook
R3.2		• Chart
R3.3		• Video film
R3.4		• Internet
R3.5		• Laboratory equipment
R3.5		• Other
G4.0	Gender issues	
G4.1		• Praise/encouragement/attention
G4.2		• Participatory/group activity
G4.3		• Image of science
G4.4		• Familiar examples relevance to everyday life
G4.5		• Learning style
G4.6		• Role model
G4.7		• Other
O5.0	Other	
O5.1		• Homework
O5.2		• Out of school activity
O5.3		• Choice of subjects/career
O5.4		• Other

Table 5.1: Codes, categories and sub-categories in analysis of interviews.

5.4 A summary of the interview transcripts

Table 5.2 provides a summary of the transcript data which evolved from the answers given by the pupils in the interviews. The summary also reflects the theoretical background of the study, the research questions and the categories derived from the observations of lessons.

Subject: science	**School A Girls**	**School B Mixed sex**	**School C Girls**	**School D Mixed sex**
Topics (content areas)	• Biology favourite subject; topics liked: reproduction and plants. • Acids topic favoured in chemistry. • Like physics but calculations are difficult.	• *Girls:* Like biology and chemistry, not physics; like study of human body, plants and animals. • *Boys:* Like biology, and physics but no experiments so far; prefer chemistry.	• Plants, • Human body • Reproduction • Pressure (topics favoured by girls).	• *Girls*: Like biology; study of body, health and smoking*;* like chemistry esp. reactions. • *Boys:* Do not like biology; like chemistry and physics.
Teaching methods	• Traditional teaching style in biology, some group experiments in chemistry. • No practicals in physics, rarely in biology.	• Class participation in chemistry. • No practicals in physics, some in chemistry and biology. • Hands-on experience needed. • Group work preferred.	• No experiments in biology and physics; three to four in chemistry • Enjoy group work. • Done research project. • Rote learning as notes are given in biology and physics.	• Some class practicals in biology and chemistry. • No group work in science. • Class work from textbook. • Traditional teaching in physics. • Rote learning.
Behaviour (attitude, interest)	• Teachers are helpful. • Like to work on their own. • Chemistry interesting • Science is important.	• Attitude of physics teacher not encouraging. • Physics difficult. • Biology and chemistry more understanding.	• Science important, e.g. oxygen to life, ecosystem, animals. • Like physics because of mathematics, also biology and chemistry. • Intend to choose science.	• Biology difficult to understand at times. • Group practical. • Drawing skills. • Science important for our future. • Science is fun.
Resources	• Textbook should be colourful. • Use internet at home not at school.	• Textbook is clear, simple and well illustrated.	• More gender-friendly examples required in textbook. • Textbook used is interesting. • More references should be included, esp. internet ones.	• Textbook should have more pictures, be colourful and have more experiments and multiple choice questions.
Gender issues	• Female teacher for biology only. • Learning style: memorise notes. • Examples relevant	• Male teacher unhelpful. • More hands-on activities required • Topics relevance to	• Teacher should be friendly. • Girls can equally do well as boys in science.	• Hands-on activities required. • Both boys and girls like examples relevant to life e.g.

	to life such as health and environmental issues. • Science has a masculine image, see more men doing science.	everyday life not clear. • Chemistry teacher is a role model. • Girls prefer female teacher for biology. • Girls lack confidence; boys laugh when girls try to answer. • Competition between boys and girls.	• Learning style: memorise notes. • Relevance to everyday life, e.g. pressure in physics; reproduction, transport system in humans. • Teacher to be a role model.	environment and health. Boys like social issues: smoking, drugs etc. • Boys prefer male teachers for science. • Girls prefer female teacher for biology.
Other	• Extracurricular activity outside, e.g. Environment club, health club. • Parents influence choice of subjects; also themselves. • Career: doctor, veterinary.	• Girls not choosing physics. • Parents guide in choice of subjects. • Science teachers and school encourage choice of science. • Career: architect, doctor, engineer for boys; doctor for girls.	• Extracurricular and co-curricular activities, e.g. Environment club; projects. • Teacher influences on choice of subjects. • Careers in science, not accountancy.	• Friends and teachers encourage them to choose science. • Career choice: home economics, pharmacy, accountant, doctor for girls. • Doctor, policeman, computer engineer and physics teacher for boys.

Table 5.2: Summary of transcripts from the pupils' interviews – schools A, B, C and D.

5.4.1 Profile of teachers interviewed in the four case study schools

Table 5.3 summarises the profile of the teachers who were interviewed in the four case study schools.

School	**Details of teachers**	**Subjects taught**			
		Biology	**Chemistry**	**Physics**	**Account/Economics**
A	**Sex**	Female (F1)	Female (F2)	Male (M1)	Female (F6)
	Qualifications	BSc PGCE	BSc PGCE	BSc	BSc (following a PGCE course)
	Experience (years)	20	8	4 (teaches part time in school A)	6
B	**Sex**	Male (M2)	Female (F3)	Male (M3)	Female (F4)
	Qualifications	BSc MSc	BSc MBA	BSc MSc	BSc MSc
	Experience (years)	3	2	1	1

C	**Sex**	Male (M4)	Female (F5)	Male (M5)	Male (M6)
	Qualifications	BSc PGCE	BSc MSc	BSc PGCE	BSc PGCE
	Experience (years)	5	2	25	20
D	**Sex**	Male (M7)	Male (M8)	Male (M9)	Male (M10)
	Qualifications	TD BEd	BSc PGCE	BSc	BSc ACCA
	Experience (years)	20	5	3	6

Table 5.3: Summary of teachers' profiles in the four schools.

All the teachers in the four schools have a first degree in their subject area with varying years of experience. The conventions used for preserving the anonymity of the schools and the teachers have been discussed in Chapter 3. The four teachers in school B do not have teaching qualifications; the same applies to physics teacher M9 and accounts teacher M10 in school D.

Table 5.4 provides a summary of the data from the teachers' interviews which was reconstructed from the interview transcripts and the field notes.

Subject: science	**School A Girls**	**School B Mixed sex**	**School C Girls**	**School D Mixed sex**
Teaching methods	• Teaching mostly by traditional methods in biology. • Demonstrations at times in biology. • Demonstrations in chemistry and physics. • Occasional practical work in chemistry. • Teacher's explanation, questioning and give notes in accounts. • Group work in physics and accounts.	• Class participation in science lessons. • No facilities for practicals in physics, some in chemistry and biology. • Girls good at doing homework. Boys are not. • In accounts and economics, textbook approach mostly; project work at times.	• Mixture of methods used; no practical work. • Outdoor activities; project work in biology. • Demonstrations in chemistry and physics. • Occasional group work. • Uses textbook for explanations in chemistry and physics. • Notes given by in chemistry and physics; pupils make own notes in biology.	• M7: Discussion and questioning; traditional expository method most of the time. • Demonstration with available materials; M9 involves pupils in demonstration; group work occasionally in mixed ability groups. • Problem-solving exercises on board; pupils to work out problems.
Behaviour (attitude and	• Interest in science when topics are relevant to pupils	• Bright girls good in maths; they choose science.	• Interest in science but in physics up to Form III.	• Great deal of efforts made by teachers to make pupils like

interest)	and their health. • Interest shown in accounts and economics: teacher uses familiar examples. • High achievers opt for science; others choose accounts because of better exams results in accounts.	• Boys are interested in science.	• Project work on environment in biology. • Exhibition work for Open Day. • Pupils are good at homework in all three science subjects and in accounts. • Highly motivated pupils.	science. • Extra after school hours' classes to promote science. • Chemistry more popular than other science subjects.
Resources	• Biology textbook is too overloaded; accounts, chemistry and physics textbook are appropriate but should be more colourful.	• Textbook is clear, simple and well illustrated.	• Textbook simple and clear. • Library equipped. • Resources for practicals not adequate.	• Sufficient resources. • Physics lab renovated. • Biology textbook is overloaded. • Language is simple.
Gender issues	• Learning style: girls like to memorize notes. • Boys work faster than girls; they tend to think and ask more questions. • Girls do not like to share; more selfish. • Girls lack confidence.	• Girls quiet and subdued; boys are noisy. • Boys tend to answer questions most of the time. • Girls get better marks than boys in physics. • Work presented neatly by girls; boys make mistakes. .	• Chemistry teacher as role model, encourages girls. • Girls are competitive and have confidence in themselves. • M6 encourages and praises girls to boost confidence in physics; no difference in learning style of boys and girls.	• Girls better at routine type of work. Problems with calculations. • Boys better in physical science. • Both boys and girls answer questions. • M7 uses familiar examples; no difference in learning styles.
Other	• Lack of interest in extracurricular activity, e.g. Environment club, health club. More educational visits required. • Parents influence choice of subjects; sometimes their friends.	• Pupils' choice influenced by SC results of pupils • Parents influence choice of subjects; teachers guide sometimes.	• Parents influence choice of subjects. • Least number of girls will choose physics compared to other sciences.	• Parents influence on choice of subjects

Table 5.4: Summary of transcripts of teachers' interviews.

5.5 Presentation and analysis of results

For reasons explained earlier, the interview data for each school are reported separately under the relevant themes which are related to the research questions and common threads and differences will be highlighted later during the analysis of results.

5.5.1 School A

Interview of pupils

Teaching methods

All four pupils interviewed from School A stated that they found science interesting because of some of the experiments they have carried out in biology and chemistry; however, they pointed out that they liked biology most because of the topic on reproduction. Rina complained about the lack of practical work in biology whilst others indicated they have had hands-on activities in chemistry but not in biology or physics. Interestingly, the girls stated that the physics teacher taught well and he gave them notes that they memorised:

> Pupils (*all together*): Biology is our favourite subject. Reproduction is what we like best. We learn about ourselves.
> Rina: The teacher explains and asks questions in class. We do not do a lot of experiments. We never used a microscope at all.
> Anusha and Fawzia: In chemistry we like experiments … the colour changes we see are like magic!
> (*Devi and Rina agree with Anusha and Fawzia).)*
> Devi: Also experiments using acids … they are used in medicines.
> Interviewer: For example?
> Pupils (*together*): Tablets against indigestion.
> Interviewer: How about physics?
> Rina and Selvina: Yes, we like physics but the calculations are difficult.
> Pupils (*togethe*r): We memorise the notes. The physics teacher gives us notes … he teaches well. We learn the other sciences by heart.

The pupils complained that they had to work in groups during practical work and did not get the chance to work individually or in pairs to develop their practical skills:

Devi: We do group experiments; there are too many pupils in class … we do not get the chance to do experiments on our own, to learn the skills. We like to work on our own and try experiments.
(*Others agreed.)*

Their statements show that they had some outdoor activities in biology:

Interviewer: Do you do any fieldwork?
Pupils (*together*): Only some. We observe nature outside in the schoolyard.

They showed interest on environmental issues and wanted to learn more about pollution. They took an active part in health, environment and UNESCO clubs; they wished there were a greater variety of activities at school.

Behaviour and interest

This category dealt with aspects relating to attitudes of pupils towards science subjects, their interest in science, preference for topics taught and teacher's attitudes in the lessons. The pupils prefer biology most because it dealt with their body and plants.

Interviewer: You said you like biology. Could you tell me why you like biology?
Anusha: Reproduction is what we like best … we learn about ourselves.
Interviewer: How about other topics? (*Probes.*)
Fawzia: Yes, we like plants too … they are important. They provide us with oxygen and medicinal plants cure diseases.

They reported that they found science interesting because of experiments they did in chemistry and osmosis experiments in biology.

Gender issues

When asked whether they would prefer male or female teachers to teach science, they indicated that they did not mind if they had a male or a female teacher for chemistry and physics but they replied unanimously that they would like a female teacher for biology only:

> Interviewer: Who do you prefer to be taught by? A male or female teacher?
>
> Pupils (*together*): Biology by a female teacher. There are many delicate questions which we cannot ask a male teacher; we are embarrassed … for other science subjects, we do not mind whether it is a man or a woman.

The question on their views of a scientist elicited a negative image they held on this matter because they were of the opinion that most discoveries are done by men. The masculine image portrayed by science was very obvious in what they said:

> Interviewer: When you think of a scientist, what comes to your mind? A man or a woman?
>
> Pupils *(together)*: A man mostly … as science is done mostly by men; women cannot do it.
>
> Interviewer: Why do you think so?
>
> Pupils: *(together)*: Most discoveries are done by men. Even at place of work, scientists are mostly men.
>
> Interviewer: Do you think girls can do science?
>
> Pupils *(together)*: Yes … but our parents do not like science; they say there are no jobs in science and it is difficult … but accounts can be difficult too. So, we like to do science though it is difficult. Many pupils fail in science; the exams are easy in accounts.

Although they held the views that science was a male domain, they were of the opinion that girls can do science well though it is difficult. They indicated that parental attitude towards science was negative. However, they expressed conflicting views about accounts, a subject which is very popular among girls; despite the fact that they found it equally difficult as science subjects, they thought that the examinations were easy in that subject.

<u>Resources and curriculum</u>

The pupils noted that the textbooks in science were not colourful and appealing, though the language was simple. They also mentioned that there was not enough equipment for class practicals.

Other

The pupils stated that they use the internet at home to get more information on scientific matters. All the five pupils interviewed showed a keen interest to study science and follow a career in science-related subject although it seemed a bit too early to decide on such issues. They said that the choice of science subjects was their individual decision, but contrary to their earlier statement, they stated that they were also encouraged by their parents to study science. Concerning their future career choice, three of them (Rina, Fawzia, Selvina) wanted to be a doctor and one (Anusha) would like to be a veterinarian.

Some of the pupils expressed their opinions individually but there were some occasions when they spoke together and it was difficult for me to distinguish who said what. From the pupils' opinions illustrated in the extracts above it is clear that science teaching is carried out in a traditional way and the pupils have little opportunity to get involved in active learning strategies such as group work, practical work and other hands-on activities.

Interview of teachers

Teaching methods

Teacher F1 stated that she taught by using traditional methods and carries out demonstrations mostly as she said that there are too many pupils in the class and this renders practical work difficult:

> I use demonstration mostly … the class size is too large; it is difficult to do practical. The equipment is not sufficient for class practical. Given the limited number of periods, I have to rush through the syllabus. I have no attendant for biology. A trained lab attendant for the physical sciences assists me. The pupils do not acquire skills. Most of the time it is demonstration or I explain using charts/diagrams. I

give test; I talk to the pupils afterwards about their work. I teach the standard traditional method, i.e. explain, question and give notes.

She is aware that the pupils do not acquire the skills for practical work but her main concern is to complete the syllabus. The fact that she has not got a laboratory attendant to prepare the practical is a problem even if she had the necessary equipment to engage the pupils in practical work. She admits that she teaches in the traditional way, uses questioning techniques and explains by using charts and diagram and give notes which the pupils are expected to copy and learn.

Similarly, chemistry teacher F2 stated that she uses demonstrations mostly but seems to cater more for the differences in abilities of the pupils and she found that the response from them was positive:

Interviewer: How do you deal with science lessons?
Teacher F2: Demonstration as most of the time there is not enough equipment for whole class practical. I am now following a PGCE course at the Mauritius Institute of Education which is interesting and helpful. It is very enriching and makes me think about what I am doing; it helps me improve my teaching and makes me more aware about higher and lower ability pupils. I try to help the pupils to be motivated. Usually I used to teach the same way to a whole class; at least I can do differential teaching now. The children are benefiting from that and are making more effort.

The physics teacher M1 indicated that apart from some occasional class practical, demonstration was the common method of teaching but he tried to involve some high achievers in the demonstration. Teacher M1's choice of pupils to do some tasks in the demonstration indicates that he is doing his best to motivate those pupils he expects to do well in physics by giving at least some pupils the opportunity to engage in practical activity and learn new skills:

M1: I use a different approach according to the topics; let's say in Mechanics, boys like sports explain spin effect using examples relevant to them. In Thermophysics I use appropriate familiar contextual examples with girls. This seems to work. In Forms I and II, I do teacher demonstration … not possible for class practical. In Form III sometimes I do class practical (once or twice) but most of times it is demonstration. Brighter students help me with the demonstration. I ask one or two students to come forward and I guide them how to do the practicals. The others observe and follow.

Interviewer: Can you say more?

Teacher M1: When I make them work in groups they chat a lot. They chat about other things, so I have to separate them.

He made some attempts to make the girls work in groups, a strategy which researchers have reported to have worked well with girls but this does not seem to work in his lessons. The girls tended to chat rather than interact with each other with the task which was assigned to them; he thinks that girls and boys have problems in physics because they are used to rote learning:

Interviewer: How do they learn physics?

Teacher M1: They learn by heart. Physics is not something to learn by heart. They cannot apply simple logic; this is a problem with boys and girls. My personal experience: boys are better at Particle Physics.

Teacher F6 elaborated on the way she dealt with the economics and accounts lessons; she uses questioning techniques in accounts but admits that she gives notes to the pupils in economics and contrary to her intentions, the pupils tend to have recourse to rote learning. Familiar examples help to make the lessons more relevant to the everyday life of the pupils; she mentioned that there are discussions and interactions during the lessons:

Teacher F6: In economics, I explain the notes which I usually give to the pupils. When they are given notes, they understand the subject better. They memorise the notes ... but they should not. Notes are given to help them understand new concepts in the topics. They can learn the definitions and understand. The pupils have problems understanding in English ... so I try to make them understand in Creole language. Then the pupils ask questions. The exams comprise Cloze test and small calculations. The examples are related to everyday life. There is essay writing in economics ... it not easy to get high marks.

In accounts, teacher F6 reported the following:

Teacher F6: I explain to them what is a business, why to keep account. I give them simple examples like their pocket money, how to save their money and recording of transactions daily. This is related to their daily life.

Interviewer: Yes? Can you explain more?

Teacher F6: I also discuss topics such as the daily expenses and salaries ... then I refer to a business. I explain systematically how to record transaction, keep a ledger, trading account and calculate profits, stock, etc. They understand the topic.

She pointed out that pupils have difficulties in accounts but she approaches the subject in a constructivist way by linking up of new knowledge with existing ones and she gives homework as consolidation work:

Interviewer: Do the students have difficulties in learning in your subject area? If so, what are they?

Teacher F6: Yes, many have difficulties at first with bank account such as credit and debit. I explain gradually in a stepwise fashion. I start with prior knowledge and move towards the unknown gradually. They have to know their maths, e.g. ratio. I ask more questions and give them less notes in accounts. I explain and then give them homework which I correct on the board. The exams questions are just like in mathematics. The majority of the students go for accounts; the able students choose science …; the laboratory environment has an

> alienating influence such as the gas burner. The students who interact more in class go for science.

However, from her statement, it appears that though the majority of pupils choose accounts, the high achievers opt for science. According to teacher F6, many of the pupils do not like science because of the hostile environment of the laboratory.

<u>Behaviour and interest</u>

Teacher F1 commented that the pupils in her lessons seemed to show interest in science when the topics taught have some relevance to them and their health:

> Interviewer: What are the pupils' attitudes towards science? Are they interested?
>
> Teacher F1: Yes, to some extent, for example in topics such as conception, sugar, diabetes, hypertension.
>
> Interviewer: Can you say more?
>
> Teacher F1: Most of the problems in science stem from the primary school. The pupils have fixed ideas in their head such as breathing is about plants taking in CO_2 and giving off oxygen. Primary science is to be blamed; their education is so content-based that they hate to think. There is also the language problem.

She casts the blame for misconceptions that pupils have in science to the way they have been taught in primary schools according to her, is too content-based and not enough opportunities for developing thinking skills; the pupils find it difficult to express themselves in English which is the language in which they are taught. In a forceful way, she added:

> Make science more relevant and interesting; reduce the content so that the syllabus is not bulky.

When asked about the pupils' behaviour and interest in science lessons, teacher F2 stated that the pupils do not attach much importance to school science and are influenced either by parents or peers in their choice of science subjects:

> Teacher F2: Not so much; scientific literacy is not so important to them. Parents influence them in their choice of subjects. Their influence is very strong. There is also peer pressure; some parents complained that their daughter should do science but the child decides by listening to their friends in some cases … There are cases where girls could not do well in science; parents want them to become a doctor but not a teacher. Science is done by the high flyers; many pupils choose accounts and economics as accounts is easy to pass. Exams results are high in accounts. Here the exam questions do not require much reflection. There is no essay type questions. Economics is difficult though.

According to this teacher, the girls are not interested in science, but parents seem to exert pressure on them to choose science because they want their daughters to become doctors. Girls are more attracted to subjects such as accounts and economics because of the nature of the examinations questions in these subjects. However economics is believed to be difficult.

Teacher M1 tries to make physics lesson interesting and relevant but administrative problems at school deter him from taking his students on educational visits to places where they can see physics in action. He believes that such visits would help to promote their interest in physics and show its relevance to them:

> Teacher M1: Make science more relevant to them; take them on educational visits; such as radio telescope at Bras d'Eau but there is no time to do so. There is also administrative problem. Visit to Rajiv Gandhi Science Centre can help.
>
> The event Transit of Venus gave rise to a lot of interest. There are not so much extra-curricular activities at school level; for science club, timetable restricts such activities.

Teacher F6 was questioned about the pupils' interest and attitudes in her lessons. She gave the following answer:

> Teacher F6: Before I was more syllabus conscious. Now that I teach the lower classes, I have changed my approach. I give concrete examples to study, for example, I ask them to compare prices before a cyclone and then after. Prices are high after a cyclone in Mauritius, so they would not buy if the price is too high. I then go to explain the theory of demand. In accounts, there is a flow of ideas, a hierarchy of concepts. They work out the problem and apply the formula given in maths. There is a structured way of showing information; for example for profits, I show them the systematic way to work it out. I engage them in group discussions; they are not as passive recipients. The lessons are more issue-based; they reflect social aspects.

The above extract clearly shows that in accounts and economics lessons, active learning strategies using familiar examples contribute to make the subjects interesting.

Gender issues

Questions were asked to find out if there was a difference in the way boys' and girls' learning of science. It is surprising that teacher F1 is mentioning that parents still place more emphasis on boys' education than that of girls. Parents' and cultural influence seem to play an important role in the education of girls and their choice of subjects:

> Interviewer: Have you taught boys and girls?
> Teacher F1: Yes.
> Interviewer: What do you notice?
> Teacher F1: Boys learn better; they are given all the opportunities, probably more opportunities than girls. They are to be the breadwinner in future while girls are to be married off in the majority of cases. At age 15 many of them are engaged. There is a cultural influence.

Parents influence their son's education and career. The girls who are choosing to study science are good in science. But it is sad that sometimes the best ones are not choosing science.

Interviewer: Can you say more?

Teacher F1: Parents influence them in their choice of subjects; background of pupils is important … cultural influence is there too. Parents influence their son's education. Girls can do secretarial jobs and book keeping … they can set up a business after studies. Pretty girls do not have to study. Though they use cosmetics and jewellery, they are not interested in their manufacture. This involves lab work.

Teacher F2 has taught both boys and girls in her teaching career and she said that she preferred to teach boys than girls. Girls take longer time to do their work but teacher F2 admits that both boys and girls are of the same ability. However, she has noticed that there are some striking differences between the boys and the girls she has taught.

Teacher F2: Yes, I like to teach boys more; they are more sensible than girls; girls tend to giggle. Boys are more open. They say whatever they think.

Interviewer: Can you say more?

Teacher F2: Girls are more introvert. With boys there is no time to relax as they work more rapidly. We have to keep them busy and working. This is no problem but class management is not difficult. The boys do more work in a short time while the girls they are more slow at work; one has to explain many times before they can understand.

Interviewer: How are they different?

Teacher F2: Boys are more alert … I get more response from them especially in practical classes. Boys are more active. What they can do in 10 minutes girls take 20 minutes. They manage their time well … work quickly; girls find the time not enough; they do not finish the experiment; there is no time to discuss and correct work. Ability is the same but boys are more rapid in their work. They are noisy when doing their work; they are looking at what their friends are doing but they

> help each other but girls are more personal … not willing to share and tend to compete with each other. Boys like sharing, including their own knowledge.

From her experience, boys tend to ask more questions than girls. However, she stated that bright girls do not hesitate to answer questions:

> Boys ask more questions in class; girls though they are not clear they do not ask. Girls ask their friends first, then the teacher. They lack confidence. They are afraid to let the teacher know that some concepts are not clear to them. This also depends on pupils; it is always the bright ones who answer.

Teacher M1 is of the opinion that girls seem hesitant to ask him questions as he is a male teacher and believes that they are more at ease with female teachers:

> Interviewer: How do the girls respond to questions?
> Teacher M1: With female teachers they ask more questions; they feel more at ease.

Teacher F6 tried to use examples which are familiar to the everyday life of the pupils in order to make them interested in the lesson and facilitate learning. Furthermore, the following statement indicates how Teacher F6 encourages the pupils to make their choice of subjects:

> Teacher F6: I motivate the students who are not doing science to take accounts … though some parents influence them not to do so. Accounts is a technical subject but once they have grasped it, the rest is OK. I talk to the students a lot … relationship is important. If they like a teacher, they like the subject.

Resources and curriculum

Teacher F1 was of the opinion that the Ministry of Education (NCCRD) textbook is a suitable one but the content is bulky and she does not have sufficient time to complete the syllabus. It is worth noting that to my knowledge, this teacher enjoys a high reputation among biology students but it appears that her main concern is to complete the syllabus. Lack of resources has been mentioned as one of her problems.

> Interviewer: How do you find the curriculum materials?
> Teacher F1: NCCRD textbooks are good on the whole. *Discovering science* is not relevant to context. Must make the syllabus less bulky … the number of periods for biology lessons are limited.

> Interviewer: Which textbook do you use?
> Teacher F2: NCCRD ones. Contents are good but some topics have to be supplemented; more information on pollution is needed. We also use other books, e.g., Discovering science which is very colourful, more appealing; the exercises are OK. Additional information is useful.

M1 finds the Ministry of Education materials suitable but sometimes too academic:

> Teacher M1: The NCCRD books are appropriate but dull to be honest. It should be more colourful; it is too academic; more evaluation questions are required. Equipment for practical lessons is not sufficient … equipment is not enough for a class size of 32-35. The Ministry does not send equipment from the stores in time; they send what they have.

According to Teacher F6, she uses resources which the pupils bring to the lessons, such as newspaper articles and make them watch relevant documentary films on the television. She complains that there are no audio-visual aids at school:

> Interviewer: Do you have sufficient resources?
> Teacher F6: I ask them to bring newspaper articles, for example on birth rate, ageing population in Mauritius and compare with other

countries, e.g. Singapore. They watch documentaries and consider social issues. There are no video films at school.

Interviewer: What is your opinion of the curriculum materials in your subject areas?

Teacher F6: Curriculum materials are OK. The language is simple but the questions are difficult.

Other

According to teacher F1, the Ministry of Education expects teachers to carry out extracurricular activities, but there are some logistic problems which teachers have to face. Science clubs and Environment clubs have been set up to encourage pupils' interest in science and science-related activities after school hours, but the attendance to such activities is poor as pupils have to attend tuition classes:

Teacher F1: Though there are Environment club and science club activities; many pupils do not come. They have other important things to do.

Interviewer: Like what?

Teacher F1: Tuition … There is a problem of going out. Pupils miss on classes; so do teachers as prior arrangements have to be made. Planning is a big job; it's like a mountain on your head. There is only one educational tour per form in a year. Last visit was to a glass factory on recycling of glasses.

When asked about other activities which were organized by the school to promote interest in science, Teacher F2 responded in the following way:

Teacher F2: Organise more visits, e.g. the Rajiv Gandhi Science Centre the planetarium gives only a short exposure on the topic. More visits are necessary but it is not so easy. The safety aspect is important. We are willing to take them but the decision rests with the Rector. There is only one visit in the last week of the first term; visits, we believe will be more helpful; make them aware about the importance of science.

Interviewer: How else can we increase their interest?

Teacher F2: Mauritius College of the Air (MCA) programmes are not very helpful; there is no audiovisual room at school; at home pupils do not watch as they are busy with tuitions.

Sometimes talks by outside people could be arranged but the audience is small for a big hall; in class it would be better. Career talks are given only to Higher School Certificate (HSC) classes. Very few pupils ask teacher for guidance. Teachers however do ask them what career they have in mind.

Regarding homework and extracurricular activities by girls, teacher M1 expressed the following views:

Interviewer: Do they do any homework?

Teacher M1: They do; they cooperate; boys do not.

Teacher M1: Mauritius College of the Air (MCA) programmes: it is not possible to show them in class. I don’t think they like science films.

Interviewer: Are the pupils influenced by parents or peers in their choice of subjects?

Teacher M1: Mostly peers, parents sometimes but not always.

When asked about other issues, Teacher F6 remarked:

Teacher F6: I ask them to observe business in the corner shop and supermarket, banks etc. Regarding choice of subjects, parents have a say. They meet the rector and get advice about options. Some parents are business-minded. They think with knowledge of accounts, their children can one day start a business of their own. Or they can study ACCA, become an accountant but in Mauritius, this field is being saturated but ACCA qualification can get them anywhere. There are not many jobs in science. There is no career guidance at school.

5.5.2 School B

Interview of pupils (girls)

When I asked the pupils their experience of science, they responded in the following way:

> Gita: Biology is interesting. I am familiar with it … my cousin is doing medicine. I like animals.
>
> Anita: I like chemistry – I understand it more than biology. Since Form I, I liked to do chemistry, about atoms and molecules; these are easier; balancing equation, chemistry in everyday life such as composition of air, water and hydrogen. After that I like biology as I learn about how the body carries out digestion, how the arteries take blood from the heart to the rest of the body and then back to heart. I also like animals and their importance. I like studying about humans better.
>
> Fazila: I like chemistry.
>
> Rita: I like both subjects, biology and chemistry.
>
> Interviewer: Do you like any other subject?
>
> Gita: I like math.
>
> (*Others say they like math as a good basic knowledge of math is needed to study science.)*
>
> Interviewer: How about physics?
>
> Priya: The class is too lively in physics; boys misbehave in physics. In chemistry Mrs F3 teaches well; we understand concepts well. Not in physics. There is more class participation in biology too.
>
> Gita: I feel confused in physics. If the teacher asks a question and we don't know the answer, he says: 'forget about it'. So we feel confused.

<u>Teaching methods</u>

When asked how they would like to be taught, they expressed some frustration because of they have been subjected to the traditional approach most of the time with little opportunity for carrying out practical activities:

> Anita and Fazila: We would like it to be taught in a livelier way.
>
> Interviewer: Can you tell me more?

Pupils: We do more practicals in biology, for example about enzymes and starch which we did two weeks ago. You understand better when you do practicals.

Isabelle: Sometimes teacher demonstrates but I would like to do it myself then I understand it better, for example you want to experience it yourself.

Anita: Then, the class won't be boring. The class would be livelier.

Priya: We do not do any practical in physics. In Form I we did some practical. We had good teachers. They explain and relate better with the children.

Interviewer: Can you tell me what you mean by good teacher?

Priya: They have good personality- they are more experienced and they have a way of presenting themselves and they have a pleasant character.

Isabelle, Fazila: Yes *(nod).*

Gita: We like to work in the lab, hold a test tube, wear a lab coat and be like a scientist (*Others agree*). We find physics difficult as we only learn from books.

Interviewer: How do you think teachers can make the teaching of science interesting?

Fazila: Have more activities in science such as field work in nature, more practical work.

Isabelle: More practicals.

Anita: Yes, more practicals.

Priya: Experiments and fieldwork in nature.

(*Gita nods and agrees with others*.)

From the above statements it is evident that the pupils' experiences of school science is text-book based and they have had very little encounter with equipment and materials in authentic hands-on activities. According to Anita, Priya, Isabelle, Gita and Fazila, more activities would be helpful to them and the lessons would be livelier and less boring.

<u>Behaviour and interest</u>

All the pupils are aware about the importance of science:

Pupils (*together*): We need scientists so that the country can be more developed and also we need to know more about what is happening around the world and about ourselves.

Their responses to other issues regarding their science lessons were:

Interviewer: How do you cope when you have a problem in science?
Gita: My mother helps.
Other pupils: Our parents or relatives.
Interviewer: Your teacher?
Fazila: In chemistry and biology but not physics.
Interviewer: How do you learn science apart from science lessons?
Priya: We watch TV when there are some documentaries at home; sometimes use internet or read books in science. Not all of us have internet.

<u>Gender issues</u>

The pupils were asked whether they had any preference for any particular method of learning science, and they replied:

Priya: We like to work in group; ideas are shared. We feel more confident. There is a competition between the boys and the girls in class … (*the pupils look at each other and then add*):
The boys laugh at us when we ask questions. They mock us so, we do not ask questions. The boys laugh for nothing. We then lack confidence.
Interviewer: Are there any differences in the way male and female teachers teach?
Pupils (*together*): In some subjects it's better to have female teacher. We relate more to a female teacher; in biology especially for reproduction topic (*biology teacher is male*). In chemistry we relate more to a female teacher. She is like an idol; we try to imitate her. In physics, we would like a female teacher. We are encouraged to study science. Competition with the boys encourages us to work harder. There should be more practical classes and visits to science centre.

> Interviewer: Do you think science such as physics is a boys' subject?
> Pupils (*excited, exclaim*): No! If you are good in maths you can do physics. Women can be good scientists. Boys feel that they are the ones who can do well in physics.

<u>Resources and curriculum</u>

When asked about their views on the textbooks used in science, the pupils replied:

> Pupils (*together*): It's OK; it is clear and simple and well illustrated. If we don't understand, our teacher explains to us.

<u>Other</u>

When they were asked whether they intended to study science for further studies, their replies were:

> Anita: No, I would like to do accounts and business studies … be an accountant.
> Gita: I will take biology and chemistry not physics. Physics is difficult. You need more accuracy. Chemistry, you can explain in your own words. Biology you can understand it and put it in your own words. I would like to be an air hostess, biologist or lawyer.
> Fazila: Yes I am taking science. I would either do law or laboratory work and be a scientist.
> Priya: I would like to be an oriental language teacher; possibly I will take biology.
> Isabelle: I am not sure to take science but 75% I may take science. I want to study law. My cousin advised me.

Regarding choice of subjects, they said:

> Pupils: We have counselling given at school on careers. Our school encourages us to do science; also our teachers. Parents guide us too on the choice of subjects; sometimes the choice is made by them.

Interviewer: Do your friends influence you?

Pupils: No, they do not.

Interview of pupils (boys)

As it was in the girls' case, the boys were initially made comfortable and then asked some warming up questions about diet, about science in everyday life and their preference for some subjects they said they liked. In fact all the boys showed a great enthusiasm to study science subjects:

> Interviewer: Some of you said you like chemistry. Can you tell me more about it?
>
> Pupils (*together*): Yes, it explains about matter and what it is. For example, it [*chemistry*] is related to everyday life; if an insect bites us, we take either vinegar or baking powder to act against the effects of the bites. Also, about acids in our stomach; we use an anti-acid.
>
> Interviewer: How about physics?
>
> Pupils (*excited and looking at each other*): We have calculations to do. We like that subject because we learn new things. It is not about maths only. We learn about principles applied to everyday life, e.g. sound, speed, forces. There is also physics in our body such as brain function, ears and eyes function. We deal with electricity. In physics, if there is a power cut, the fuse blows, you can replace it … can change it any time; a breaker can be used.
>
> Interviewer: Is the study of biology important?
>
> Kumar: Yes, biology helps you in your life.
>
> Roy: In biology, the process of digestion, you learn about HCl (*hydrochloric acid*) in our body and know about yourself.
>
> Rishi: We also learn about plants, oxygen and carbon dioxide, maintaining balance, greenhouse effect, deforestation and increase in level of carbon dioxide, about medicinal and cash crops.

<u>Teaching methods</u>

Pupils expressed the following views when asked about the way they were taught in science. The pupils felt that laboratory activities should be incorporated in their science lessons and stated that they were being taught science subjects in a traditional lecture-type manner most of the time:

> Pupils (*together*): We would like more experiments. We can see what is happening. When we read about anything we think it is false but when we see it, we remember more.
>
> Pupil Kumar: We learn in a parrot-fashion when we just read from the textbooks and we don't understand. If we do experiment, we can understand and write in our own words.
>
> Pupil Rishi: There is no need to rely on the textbook only.
>
> (*Others agree.)*

When asked about their learning style the boys' responses were:

> Interviewer: How do you like to work if you have the chance to do experiment?
>
> Pupils (*together*): We want to work on our own … because sometimes one member of the team may not get along with us. There is monopoly of the work by some members… others do more and other persons do not get enough chance to do the work and manipulate. One can be doing much more than the other and we would be told to do this … do that! (*Laughs.*) This can be a problem. Then we all get the same marks; there should be equal participation. So, we would like to work on our own but we need guidance, instructions and worksheets.
>
> Pupil Roy: Yes, instructions like worksheets.
>
> Pupil Sunil: We rarely have group discussions … not in biology and physics; but sometimes in chemistry. Teacher in physics is irritated when you ask questions when we are not sure about answers. If answer is wrong, our friends fool us. Our chemistry teacher explains well (*others agree*).

The boys indicated that they preferred to work individually rather than in group but recognised that it should be teacher directed. They felt frustrated by the teacher's attitude in biology and physics lessons:

Interviewer: How about other science subjects?

Pupils: We like it better when examples are given. We have some experiments in biology. We need more examples and more experiments and more time to understand it. We have to do practicals. The teacher is like a lecturer. We have to see what we are learning.

(*Here pupils felt a bit worried and I tried to reassure them that they are free to express their feelings as whatever they say will be confidential.*)

Pupils: The biology teacher just gives notes and we have to read and read (*laughs*). Not enough interest is generated. There is no interaction in biology; understanding the subject is difficult.

The above statements demonstrate that the pupils are unhappy with the way they are being taught in physics and biology. According to them, they are learning in a rote fashion way without having a good grasp of the subject. They are of the opinion that practical work in science lessons, more particularly biology would enable them to learn and engage better in the process of understanding scientific concepts.

<u>Behaviour and interest</u>

Clearly, all the pupils are interested to study science and are aware of the importance and relevance of learning biology, chemistry and physics and how scientific knowledge helps them to cope with various issues in their everyday life:

Interviewer: Is the study of science important?

Ram: Yes, biology helps you in your life. We will know more about ourselves.

Kumar: Science removes misconceptions and superstitions.

Rishi: No one can fool you if we know more about our body.

<u>Gender issues</u>

Interestingly the boys felt that a competitive spirit existed between the boys and the girls and sometimes they had to struggle hard to keep up with the work. The excerpt below indicates that the girls were performing equally well as the boys:

> Interviewer: What is your attitude towards the girls during lessons?
> Kumar: We compete with the girls. Sometimes they deter you to work.
> Interviewer: How?
> Ram: They want to show that they are better than us. This deters us.

They were all unanimously expressed the view that they had no particular preference for male or female teachers; the personality of the teacher and the way s/he deals with the lessons were more important:

> Interviewer: Would you prefer a male or female teacher to teach you?
> Pupils (*together*): There is no difference. There should be no comparison between a male or female teacher; if s/he explains well, helps you well, it is not important if she or he is female or male.

<u>Resources and curriculum</u>

The pupils' responses on the issue of resources were:

> Interviewer: What is your opinion of the science textbooks?
> Pupil Kumar: Physics one is complicated; there should be more pictures and diagrams.
> Pupil Roy: And more explanations … it is too direct and does not make you think. During the whole year we do easy questions and for the exams, we have tough ones.

<u>Other</u>

When asked about career choices, Kumar who is choosing biology, chemistry and physics said that he would like to be a mechanical engineer; Rishi has not decided yet though he is choosing to study chemistry and physics whereas Roy would like to opt for all three science subjects and be a doctor. Ram would like to be an architect and

Sunil had no idea as he is still not sure about their choice of subjects. It did not appear that parents or teachers had any influence on their choice of subjects or career.

Interview of teachers

Teaching methods

When asked about the teaching methods in biology and chemistry lessons, teachers M2 and F3 said that their teaching approach was according to the topics they were dealing with. Teacher M2 stated that he used questioning techniques to a great extent and because of lack of laboratory facilities, he organized practical work at times in the senior school, whenever it was convenient:

> Teacher M2: I use the textbook to explain the topics I am teaching; I give the pupils to work out questions from the book and then I correct them in class during the lessons. The pupils have had the opportunity to do only a couple of practicals in biology.

Teacher F3 expressed a similar opinion about her teaching methods but she carried out demonstrations in class and gave the pupils problem-solving exercises to do in class:

> Teacher F3: I use different strategies: I think of using one in one class and another in other classes; this class is a very mixed ability class. They lack laboratory work as we don't have a laboratory at the moment. We do bring something in class and carry out demonstrations. Well the topic 'Balancing equation' is more about theory … but even for that, we lack lab work. Even if you do demonstrations, some kind of manipulation is very important for the student. Some girls like spoon feeding; they like to copy notes and memorize. This is not the way I like to teach. I give some examples; they have to work out some problems. Then I correct them on the spot. I want them to get the easy and difficult parts.

She stated that there was not much project work in chemistry:

> Teacher F3: In chemistry, there is not a lot of project; in biology last year, there were some hydroponics experiments for Open Day. This year we are going to do experiments for Open Day … we are going to make beer.

Teacher M3 stated that he uses a teaching method that everyone can follow:

> Teacher M3: My teaching approach is one everyone will be able to follow. I plan my lesson by noting down the definitions from various textbooks; I make the students focus their mind on the topic I am teaching. I bring out interesting points; I teach them the way any teacher would teach, i.e. active learning and class participation.
> Interviewer: Oh yes?
> Teacher M3: Class participation works well; you know teaching is not a one way process. I discuss problems with them on the board. Those who are shy to ask questions, I ask them to write their question on a sheet of paper. I refer to other science textbooks, look at the definitions and create my own. I do not make pupils copy. I ask them to read the definition in their book, understand it and write in their own words.
> (*After a small pause, he continues*):
> I give them homework. The girls are good at doing homework; they are punctual with their homework ... not all students do homework; the boys are not. I correct the homework personally, record the comments and then explain what the pupils did not understand. Physics is a mathematical science. Those who are not confident in maths have trouble understanding the questions in physics. Physics give sense to maths, that is, without knowledge of maths it's difficult to understand physics. Not all know how to apply maths in physics.

F4 indicated that she uses teaching methods which she is not very happy about but encourages the pupils in her subject by using familiar examples and information from various sources:

> Teacher F4: We have only two periods per week to complete the syllabus. What I do in class, I don't agree myself. I read the books, tell them about the real world. For example, in the topic of communication and transport, I have no time to do the real things. We could have visited places; due to lack of time, I cannot use different teaching strategies. I tell them about the topic, they do the exercise. I give them more information on the topic; you cannot organize trips and excursions. Sometimes they go to places in other subjects. I make teaching of economics related to everyday life. About the strategies, they do projects in class. They use the internet at home. I encourage them to use the internet and get information. In the topic 'Advertising' they do group work; they go outside and find out.

<u>Behaviour and interest</u>

Teacher F3 asserted that she does not force the pupils to choose her subject, but would rather leave this decision to the pupils themselves:

> Teacher F3: I do not encourage them to take science; they have to think what they are going to study … it depends what they like. If they are not going to do it … I don't insist. Students are very much interested in science but some parents are very difficult.
>
> Interviewer: What do you mean?
>
> Teacher F3: Yes, certainly the parents influence the choice of subjects; some parents have seen me about the choice and want their children to become doctors.

Teacher F4 complained about the parents' role in subject choice:

> Interviewer: What is the pupils' attitude towards economics?
>
> Teacher F4: The majority opt for science at Form III. The parents' role in the choice of economics is important. If the parents are biased, so the pupils are biased. On the whole, the parents do not have an important role in the choice of subjects. However, pupils who choose

> economics pay a special attention to the curriculum materials. Family influences their children to do science.

<u>Gender issues</u>

When asked whether it mattered to the pupils whether the teacher was a male or a female, teacher F3 replied:

> Teacher F3: For me, it does not matter. It depends on the personality of the teacher. We should try to have a good relationship with the pupils. They like the subject once relationship is established.

She likes teaching in mixed-sex schools but she noted differences between the behaviour of boys and girls:

> Teacher F3: No preference whatsoever for teaching boys or girls. It's a good mix here. Boys are noisy … girls are subdued. Some boys are quiet but we have two extremes (*here)*. When I ask questions, it's the same students that answer. The boys answer and they make most of the noise. The girls are shy but they know their stuff.

According to Teacher F3, the very bright girls are definitely choosing science:

> Teacher F3: There are some girls who are definitely choosing science … the very bright ones. They are good at mathematics. They like chemistry. The boys are very keen to study science.

Teacher M3 held a favourable opinion about the girls but he pointed out that the girls had a low self esteem whilst the boys were more vocal and assertive:

> Teacher M3: Most girls are better in physics; they get high marks: highest is 97%; average is 50%. There is no difference in boys and girls; they are the same abilities; Interest in physics is the same for both. Girls work harder and are quieter but they lack confidence.
>
> Interviewer: How about the boys?

> Teacher M3: Boys are more distracted. They are more unstable. At Form III the students are changing in their physical development. I prefer working in mixed schools: the girls act as a dampening effect (*on the boys*). The girls are careful in their work; they are attentive and learn from their mistakes. The girls tend to write neatly; the boys keep on making mistakes and careless with their handwriting. The mistakes are mostly grammatical in nature.
>
> Interviewer: Earlier you said the girls lack confidence, can you say the same for the boys
>
> Teacher M3: Oh no! The boys are overpowering and assertive; they are noisy. That's why we change the seating arrangement in class to diminish the noise. Those who are noisy are made to sit in front so that they can be supervised easily. Also there is a lot of competition among boys and girls.

Though teacher F4 seemed to be unaware about gender issues, she commented that there was a difference in the way girls and boys interacted in her lessons:

> Interviewer: Have you noticed any gender bias in the textbooks?
>
> Teacher F4: To talk about gender bias, I have asked the pupils and they say it is balanced. By the end (*of the year*) they may change. My experience is very little. I can't say much on this.
>
> Interviewer: When in class, who asks more questions, the boys or girls?
>
> Teacher F4: Girls are shy. Boys have a lot of energy; so they dominate and attract attention. The girls only answer when asked to; they prefer to interact with other girls.
>
> Interviewer: What do you do to encourage the girls to participate?
>
> Teacher F4: I address the questions to them and help them to answer.

<u>Resources and curriculum</u>

When asked about her views on the textbook used, teacher F3 said:

> Teacher F3: I think the textbook is very good. The layout is good … it is coloured … it is enriching. What we don't like is the lab work. It is too activity-based. The experiments are not familiar, for example red cabbage; this is not easily available. It (*textbook*) gives you sites on internet. The pupils can go on the internet and look for information. I do not have a laboratory technician or attendant. I have to do everything myself.

Teacher M3 held similar views about the textbook used in physics:

> Teacher M3: The textbook is chosen by the head of department of physics. The presentation and language are OK. There is no gender bias. There are some pictures of women athletes. I refer to other books too. I encourage the children to read other books. This will motivate them. Science books should have more real life situations. It is complicated to explain some concepts if they are not related to real life situations.

He was concerned about the lack of equipment:

> Teacher M3: Equipment is lacking as laboratory is inexistent at the moment. There is no chance to do experiment. The lab is still under construction; we do not have practical activities; so, I can't say if there is any difference in the way girls and boys interact in the lab. Students read books in library. Video films are not available.

When asked about her opinion on the textbook she uses in her lessons, Teacher F4 replied:

> Teacher F4: The NCCRD textbooks. The complaint with many teachers is that the textbook is outdated. The post office has been privatised. It is referred as a government one. The OTS (Overseas

Telecommunication Services) is outdated; it is Telecom now. The book needs updating. Pupils must know the latest facts.

Interviewer: How do you use the books?
Teacher F4: Either I or the pupils read the text, and then I explain; there is no video film at school; e.g. for topics as advertising, they would observe advertising on TV and then they try to discuss about the characteristics such as persuasive or informative.

Other

Regarding extracurricular activities, teacher M3 added that pupils are not interested in them because of private tuitions classes after school hours:

Teacher M3: There is no extra-curricular activity. Only place we have been is Bras d'Eau where there is a radio telescope. There is a tuition culture.

Teacher F4 expressed the following views regarding pupils' choice of subjects:

Teacher F4: Whether will they choose it? It is still too early to say about this. We have to wait for the exams results of SC pupils. The pupils of Form III are influenced by the results of SC pupils. The pass rate is 96% but the quality is not good. The grades are not so good. The good pupils opt for other subjects.
Interviewer: Such as?
Teacher F4: Science.

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5.5.3 School C

Interview of pupils

The girls in school C told me that they had done a lot of research projects on endemic plants and about other plants. They were aware that science is important for them:

Pupils (*together*): We also find out about carnivorous plants in biology. Yes we think it is important to study science; we study about everything around us- about ecosystem, fish in aquarium, about importance of oxygen to life; such as a fish in an aquarium will die if there is no oxygen. In dry areas plants are needed for agriculture. We learn about the importance of animals.

Teaching methods

Interviewer: How else do you learn science?

Pupils (*Rita and Sarah*): We have an Environment club which we started. We grow more plants in school. We are planning to do more; there are lots of activities in Environment, e.g. Clean Up Campaign, Arpege project for protection of environment.

Behaviour and interest

As revealed from the pupils' interview in school C, the pupils have developed a liking for physics because of the teacher's attitude:

Pupils (*together*): We did not like the physics at first but we like it now; teacher is very funny. He makes a lot of jokes which make the lesson interesting. Teachers can make the class lively. Math teacher is not very nice but we like math; it is important to study science.

Interviewer: Which subjects do you like studying?

Pupils (*together*): We like science but other subjects too. We can apply what we learn in everyday life such as in the kitchen. Accounts is interesting sometimes but boring most of the time. We learn by heart. In chemistry there is not much lab work. The teacher did some demonstrations. We can only do science practical when we are in Form IV. The school may be better equipped next year.

Gender issues

When asked whether they thought science was a difficult subject for girls, the girls displayed much confidence but also acknowledged that there were certain limitations on what they can do.

Pupils (*together*): Girls can do science … they are more intelligent than boys (*laughs*). Girls mature more quickly, so they can do more work under stress better; this has been proved for CPE and HSC exams. The results for girls are better.

Lina: But when it comes to jobs such as design and technology, girls can't do it because they do not have the chance to learn it. Girls can't cut wood. Engineering and interior design … girls can do it.

Interviewer: Would you like a male or female teacher to teach science.

Pupils (t*ogether*): Male or female teachers … this is not important. Teachers should have a friendly character and teach in such way to make us like the subject.

<u>Resources and curriculum</u>

Interviewer: How do you find the textbooks?

Neelam: The books are both for boys and girls; there is no bias or discrimination. Girls and boys use the same textbooks. There are some pages where sometimes you see some women in the field; there should be other examples too.

Interviewer: What do you mean?

Rina: Well, women do other jobs. We should show them as scientists, engineers.

Interviewer: Do you think there should be changes made to the book:

Priya (*and others together*): Some of the questions tend to repeat themselves. It is too bulky.

<u>Other</u>

Regarding subject choice, they all showed a liking for science and Rita and Sarah were the ones who would choose science-related careers:

Pupils (*together*): We like science

Rita: I want to do research in science or be an engineer.

Sarah: I want to be a doctor.

Priya: I want to study law.

Neelam: I want to be a teacher.

Interview of teachers

Teaching methods

Teacher M5 tries to get the pupils involved in a range of activities but complained about the lack of resources for practical work; he tried to compensate for this by engaging the pupils in outdoor activities and projects:

> Teacher M5: I use a mixture of methods. The pupils enjoy practical work and doing projects, for example the biotechnology project. I make teaching activity-based. The pupils prepared exhibition for Open Day. They used ICT for preparation of leaflet for exhibition. As head of science I am concerned about the lack of practical work; even the parents have shown concerns about it. The pupils are involved in activities about the environment in the Arpege project. I make them read the information in the textbook, ask questions and then summarise the information in the book and they make their own notes. I encourage participation, emphasize group work and enquiry learning, asking questions, let them discover by themselves. They bring stuff in the school for investigations. They like that approach. They go out of the class and observe nature, flowering plants, and the endemic corner which they have set up in their project.

When he was asked about his teaching methods, teacher M6 replied that he would like to do experiments in his lessons but there is a lack of facilities in the physics laboratory:

> Teacher M6: I would like is to do experiment but there is no laboratory technician and no equipment too, therefore it is difficult to do experiments. I give them (*pupils*) notes and use examples and analogy.

> Teacher F5: I do not get technician's help as the school hasn't got one yet … therefore I do not plan experiments, Also, the pupils have to handle dangerous chemicals; this is a problem as there are too many of them in the class … not easy to plan experiments with so many of them … 40 of

them. They are not good at handling equipment such as test tubes … they can break them and it is not easy to find replacement for broken ones. At the moment we are hoping to get some equipment and we are made to understand that they have gone to the wrong school.

She said that she carries out demonstrations and group work to teach chemistry lessons:

> Teacher F5: I do demonstrations, use models and kits which I have at home. I bring them and use them in my lessons. The pupils also like group work especially in topics such as balancing equations. They check their work by discussing in groups. I also use the textbook a lot. I read the text in class, explain and then recapitulate the main ideas. They take notes.

Behaviour and interest

Pupils are particularly keen to do science; they like biology but lack of practical work has a negative effect on them. Teacher M5 expressed the following views:

> Teacher M5: The pupils are very academic in science and they realise that science is important for them. They like the subject and are very interested in science. I feel that they lose some interest because of lack of experiments. I do not influence the pupils but I feel in the teaching profession you can really influence people by the way you teach.
> Biology is bulky. Yet the pupils are interested about plants but not about soil. They like to study about the human body and animals.

Regarding choice of science subjects, Teacher M5 believes that the choice should be left to the pupils:

> Teacher M5: Pupils should choose to do what they want. Parents come to meet the teachers and the teachers help to guide the pupils and counsel parents on their choice of career. Parents are very supportive of the school. The Parent Teacher's Association helped in the purchase of equipment in the school. There are highly motivated pupils in the

school. They are very good at homework. The pupils are very competitive but the school does not encourage competition but it motivates them. The pupils are good in all subjects and there is a problem of choice of subjects.

Teacher M6: The girls are interested in physics up to Form III but they do not think of a career on the science side. The main reason is that there is no information what the cyber island is going to be in terms of jobs.

When asked about pupils' interest in science, teacher F5 praised the pupils for doing their homework well and watching science programmes at home:

Teacher F5: They are good at homework. Pupils bought MCA tapes to watch science programmes at home; there is a problem of watching them during school hours. They have educational trip once in a year. Exhibitions and Open Days are interesting as this helps them. They ask questions when they do not understand. They also like project work but they like working individually on the whole. Working in a group presents a problem.

Resources and curriculum

According to teacher M5, here seems to be some problems regarding the use of resources in the school:

Teacher M5: The language in the biology book is simple and the presentation is good. The library has many science books. The pupils can use an OHP to make presentations in class. There is a computer lab but only teachers have access to it. MCA films are available but these can be used in the viewing room. Here is internet but it is not connected yet.

Teacher F5: Textbook used is 'Discovering science'. I find it suitable especially it is colourful and there are lots of questions.

> Teacher M6: The pupils have internet at home. The school does not encourage them to use the internet here; navigation is expensive. They watch science programmes at home and we lend them CDs on educational programmes. They do not use the Rajiv Gandhi Science Centre. They do not understand the concepts if they are not given proper guidance. I give them homework but I have no time for checking each one of the exercise books. Once per term I do that. They do not take tuition at Form III but students rely on tuition at higher level. They come to their teachers for help when they have a problem.

<u>Gender issues</u>

Teacher F5 stated that she tried to make the pupils interested in science by talking about herself and using her as a role model:

> Teacher F5: I tell them … what I did before, how I studied science and where this has brought me, this inspires them and motivates them to study my subject. I also talk about the importance of science to themselves in their life. Some students who said they won't take science soon realize that they learn many things (*in science*) and that will help them in their life. However chemistry seems remote to their everyday life.
>
> Interviewer: How can we make science interesting?

It is evident that the pupils' engagement in science is better when the topics are relevant to their everyday life; they perform well in chemistry even if the work is difficult; because of their competitive attitude, individual work is preferred to group work:

> Teacher F5: Teach them science topics that are relevant to their daily life, for example, what interest the pupils, topics which are easy. They are also interested in topics which are not easy and they do their work well. The most difficult topics were balancing equations especially for the weak ones. The students are very competitive, so they work well. Girls are more for individual work as they are more competitive … they like to know how much marks their friends got in terminal exams. They like

assessment and they do ask questions; they are not shy or timid types. It does not matter what type of questions … they don't feel shy.

When asked if there was a gender bias in the textbook she used in class, she replied:

> Teacher F5: No, this has not drawn my attention. Teaching science should be the same for both boys and girls. Boys are good at gadgets.

> Teacher M5: The pupils have a passion for biology. This makes a whole difference. They like practical activities, investigations. They tend to compete with each other. Sometimes I arrange practical as a group work wherever possible. Some of the classes like group work but the academic types do not like to share. I tell them that the class is a model of society. By telling them what they see they know and understand the concepts in science.

Teacher M6, who is an experienced teacher, pointed out that there is no difference in the learning style of boys and girls but seems to understand that girls need praises and encouragement to study physics and his attitude is not the same with boys and girls

> Teacher M6: I have taught boys and their learning style is not different from girls. There is memorizing with understanding; there is no difference in the learning style of boys and girls. When I teach, I am a bit hard with the boys but not with the girls. Girls, psychologically need a lot of encouragement and they do great work. Boys don't care. They do it quickly.

Interestingly, he remarked that girls' familiarity with certain objects help them to understand concepts in physics better:

> Teacher M6: In a class today, I was using the example of the spanner with the girls. I used the same example with the boys; boys understand

> concepts to do with tools better. The girls have not been exposed. Familiarity with everyday life is important. Heating elements in the house such as kettle, iron etc. is closer to girls.

He added:

> Boys ask more questions than girls. The girls are shy and they have the feeling of being ridiculed by others. To encourage them, I put questions to them … and respond positively … this helps them to gain confidence. I find it easier to teach boys as the boys are more open. The girls do not like group work; they do not like to share; they do not share knowledge. They are working in competition; competition is high in this school. They get a prize. However, they are good as a team when the whole school is concerned; when they compete with another class. But the girls are conscious they have good abilities.
>
> Interviewer: Could you say more on this?
>
> Teacher M6: About 50% of the pupils will go for science subjects but of the three sciences, the least number has chosen physics. They do not know the importance of physics; they need guidance. A teacher can influence students to like or dislike a subject. We have to consider whether students can do science. It depends on the ability of students … we do not force them to take science; but they have the ability. Science is not a masculine subject. Role models in science are important.

Teacher M6 deplored the fact that the pupils lacked proper guidance and though they had the potential to do well in physics, but many will not be choosing physics. Similarly, teacher M11 said that science seemed to be popular with the girls who tend to work hard and compete in class; they worked equally hard in accounts and economics but he is aware that most of them will decide to choose science.

<u>Other</u>

When asked about other comments she had, her response was that the girls are not keen to participate in other activities because they do not have much time at Form III:

> F5: The syllabus is too loaded and at Form III they do not have too much time. They do not participate in a lot of activities. Many of the girls will go for science. They have already decided. I don't know if it's the parents' choice or theirs.

Regarding choice of subjects after Form III level, teacher M6 said:

> Teacher M6: The parents are the main ones who influence them on their choice of subjects; sometimes, their friends or the teachers give them career guidance.

5.5.4 School D

Interview of pupils (girls)

Bhavna, Rina, Lisha, Fawzia and Rubina are girls from Form 111 class at school D which is a mixed secondary school in a semi urban region. After greeting them and thanking them for having sacrificed their free time to meet me, I talked to them in a relaxed manner about general matters regarding their studies, their interest in several things regarding their studies so as to make them comfortable.

Teaching methods

Their statements indicate that they have acquired some practical skills and worked in teams:

> Pupils (*together*): The teacher also shows us how to draw. In biology, we do starch, iodine and Benedict tests. We would like more experiments. We work in groups of two to three in science. The teacher shows us how to do experiment.
> Interviewer: Do you like working in groups?
> Pupils (*together*): We want to work on our own. We want an opportunity to do experiment ourselves. It's not enough.

> Interviewer: What do you mean?
>
> Rubina, Rina and Fawzia: We do not get the chance to do the experiment on our own.

When asked whether they had group discussions in class, the following statements indicate that they have group work in other subjects sometimes but none in science:

> Rubina: No, not in science. (*Others agree by nodding*) … sometimes in other subjects. When we have discussions, we tend to go astray and talk about other things.

<u>Behaviour and interest</u>

When I asked them about whether they liked science, three of the five girls responded positively to biology topics that were mainly relevant to their body and health whilst the responses of the two other girls were negative because they found that biology was difficult:

> Bhavna, Fawzia and Rubina *(smile)*: Yes we like it especially biology. We like it because it is the study of ourselves, about cigarettes, smoking, health, what is happening in experiments, cells, our body …
>
> Lisha and Rina: (*give a negative nod of the head to express their dislike*).
>
> Interviewer (*addresses Lisha and Rina*): Well, can you say something about biology?
>
> Lisha and Rina: It is difficult to understand. The words are difficult to understand … complicated and strange.
>
> Rubina (*agrees with Lisha and Rina*): Yes. We have to learn a lot of strange words.

The girls in school D, with the exception of Lisha, liked chemistry and physics because of some experiments they enjoyed doing in chemistry and the equations in physics and chemistry:

> Interviewer: What about the other science subjects?

Pupils (*except Lisha*): We like chemistry; it's about reactions and chemicals. We like chemistry; we do some experiments, in practicals about solubility and we see how things dissolve; chemistry seems easy. We learn equations, for example, balancing equations which are easy; in physics too there are equations. If we understand the equations and math, then we can do physics. We like science, math, English and French.

They held positive views about management subjects such as accounts and commerce for the following reasons:

Bhavna and Rubina: We like management subjects too.
Interviewer: What is interesting about management subjects?
Lisha and Rubina: We like the teacher's way of explanation, project work is given, we get homework sometimes and we copy the notes from the board. Teacher gives us photocopies of notes.
Interviewer: When you don't understand, what do you do? Who helps you?
Pupils (*together*): Sometimes brothers and parents help. We ask teacher. We take books, read our notes and then try to understand.

<u>Gender issues</u>

All the teachers in the school teaching the pupils I interviewed were male and the girls stated that they would prefer to have a female teacher to teach biology; they also said that science was difficult:

Pupils (*together*): We would like to have a female teacher for biology for delicate topics. Scientific words are complex. The teacher explains the words but still it is difficult to remember.

<u>Resources and curriculum</u>

Interviewer: What do you think about the textbook you use for science?
Pupils (*all together*): It is not colourful … and difficult to understand.
Interviewer: What changes would you like to have?

> Pupils (*together)*: There should be more pictures. There are not enough questions. It should include more multiple choice questions … yes; have more questions, more pictures and drawings.

<u>Other</u>

When asked about choice of subjects and careers, the pupils stated:

> Interviewer: Who encourages you to do science?
> Pupils (*except Rina*): Our teachers and friends.
> Interviewer: How about your parents?
> Pupils (*together*): No, our teachers mostly.
> Interviewer: Do you go on educational visits?
> Pupils (*together)*: Yes. Outings to Rajiv Gandhi Science Centre.
> Interviewer: What career do you intend to pursue?
> Bhavna: Doctor.
> Rubina: Pharmacy.
> Fawzia: Accountant (*says will take only one science subject which is chemistry*).
> Lisha and Rina: Home economics; food studies.

Interview of boys

Pupils: Ravi, Jean, Amad, Sonu and Leck were interviewed in school D.

<u>Teaching methods</u>

When asked about how science was taught, their responses were as follows:

> Pupils (*together*): We do not carry out experiments often; sometimes in some lessons. In biology, there's the experiment on diffusion which we did. We read from our books and try to understand. Science is more interesting when there is more activity.

<u>Behaviour in science</u>

The boys in school D favoured chemistry and physics but seemed not to like biology though they were aware of its relevance to them:

All pupils (*except Leck*): Yes, we like chemistry and physics except biology. Our teachers explain well about the study of the human body, diseases, food, care of health, sexual reproduction, drugs and alcohol but we find chemistry and physics easy.

Leck: I don’t like studying science. It is difficult.

Interviewer: Could you tell me which of the three science subjects you don’t like most?

Pupils (*together*): Biology. It is difficult to remember; there are complex words.

Amad: Physics is easy and I like the way the teacher explains.

Interviewer: How about you, Ravi, Jean, Sonu and Leck? What do you think?

Ravi, Jean, Leck and Sonu: Yes, we like physics and chemistry but the equations can be difficult. We like physics because it is useful in everyday life. The experiments in chemistry such as preparing salts, sodium chloride, ammonium chloride and solubility are interesting.

Interviewer: Do you think the study of science is useful or not?

Pupils (*together*): Science is useful in everyday life.

Interviewer: How useful?

Jean and Sonu: About health, electricity and environment (*others agree*).

<u>Gender issues</u>

Their comments on the issue about the male perception of science were:

Interviewer: Do you think science is a boys’ subject?

Pupils (*together*): No. Both girls and boys can do it.

Interviewer: Would you like to be taught science by a male or a female teacher?

Pupils (*together*): A male teacher is preferable. We can relate better to him.

<u>Resources and curriculum</u>

Interviewer: What do you think of the science textbooks?

Pupils (*together*): Textbooks should be colourful. The language is simple to understand.

Interviewer: How would you like the books to be improved?

Pupils (*together*): Adding more pictures, more experiments. In physics, we would like more experiments.

Interviewer: Do you read other science books?

Jean and Amad: We get books in the library. At home, we watch films in physics about electricity and science is fun. There should be more films on science.

<u>Other</u>

Interviewer: Who encourages you to do science?

Pupils (*together*): Science teachers.

Interviewer: Do you go on outings and educational trips in science lessons?

Pupils (*together)*: For outings we have been to Rajiv Gandhi Science Centre but field trips … none so far.

Interviewer: Which career would you like to pursue?

Ravi: Physics teacher.

Amad: Doctor.

Jean: Policeman.

Sonu: Computer Engineer.

Leck: Policeman.

Interview of teachers

<u>Teaching methods</u>

When asked about the teaching methods he uses during his lessons, Teacher M7 comments were:

Teacher M7: I use discussion method; provide hints, guidelines, brainstorming at the start of the lesson to have an idea where students have reached in understanding. I check prior knowledge and give cues that things are not clear and draw facts from pupils. I use the expository method; give them hand-outs, photocopies and support materials from other books. I ask oral questions.

Interviewer: Are they able to answer questions?

> Teacher M7: They try to answer questions but sometimes they are not able to answer because of language problems … we have to use a language which is familiar to them. For our school, this is the main barrier; they can't understand questions in exams, so we do a lot of questioning. We repeat the questions now and again. The routine is to carry out repetition and drilling. For our school drilling is most important.

From the following statements, it is clear that Teacher M7 tries his best to get the pupils to make every effort possible to get them interested in activities and overcome whatever difficulties they have in coping with the lessons:

> Interviewer: How do you carry out the practicals?
>
> Teacher M7: We do demonstrations of practicals, specimens such as plants are easily available; this depends on the type of experiments. For example, flowers and food tests, the students bring the plants, lemons, oranges, grapes, rice, onions. They use onions for germination. They start doing some experiments in Form 1, then in FII. They are good at manipulation. Sometimes they do the work at home. For practicals, sometimes you have to provide them with materials for example with mustard seeds. They do the experiment on germination. So we give them some seeds which they try to germinate at home. When it comes to writing of experiments, they may give answers in our local language but find it difficult to write in English. So, we try to put some key words which are boxed and they choose from the right ones. They learn the key words and write the key words and make proper sentences with them. I think students have the belief that writing long sentences to questions will get them marks. Help in English from the English department would have helped but we cannot interfere with their work.
>
> Interviewer: Do you get the help of laboratory attendants for your science lessons?
>
> Teacher M7: The attendant is not attached to the lab; she is used everywhere in the school; she does a lot of different jobs in the school.

When asked about his teaching methods, teacher M9 stated:

> Teacher M9: The procedure used is dependent on the category of students and the resources available. I plan my lessons with objectives in mind. Time is not sufficient to complete the syllabus; so I do it in extension classes, especially classes which require demonstrations which are time-consuming in terms of planning and executing. The lab attendant is a multi-purpose one as she works on different locations. She is quite helpful but you have to do quite a lot on your own as she is only an attendant and not a technician. She cannot help with practicals. There are 36 pupils in a class and there is a problem of class management and it is difficult to do practicals. Group work works with some … it depends how you organise the lesson. I try to mix high achievers with low achievers but this is not helpful for the high ones. They are held back by the low achievers. They copy from their friends or from the board. Lots of class work is given; they memorise the notes.

He further pointed out:

> Teacher M9: I try to make the pupils understand what they are learning because application and problem-solving work is given. The problem of English language is evident. I teach in English but when there is a problem of understanding, I explain in Creole. When the concept is clear to the pupils, I explain in English … this seems to work to a certain extent. I make the students read from the textbook in class and step by step they do practicals. I carry out demonstrations and involve the students (*during the demonstration activity*); this gives the students a chance to handle apparatus and they do it in turn.

When asked about his teaching methods, teacher M8 made the following comments:

> Teacher M8: I use questioning techniques a lot; try to find out pupils' knowledge and difficulties. I do demonstration at times, give them examples which I work out on the board and give problems to solve by

applying what they have understood. There is no physics laboratory at the moment; it is being renovated, so I use the chemistry lab for demonstrations. Most of the lessons are held in classroom. The pupils have a language problem; so I have to explain in Creole most of the times. They answer in Creole and then I help them to translate their answer in English. I make sure that they understand what they are learning. I give them notes which they memorize.

Teacher M10 commented about the way he taught accounts:

> Teacher M10: I develop my own way of teaching according to the topics and the pupils I teach. I have already written a book on accounts. I explain from the textbook, make the pupils read the information they need for the topic they are studying. I ask them questions and give them exercises to do. I use examples which are familiar to them in their life, such as keeping a ledger, about profits, losses and about bank accounts. Sometimes, I make them work in groups at times.

<u>Behaviour and interest</u>

The following statement illustrates that a great deal of effort is made by the teachers to promote the pupils' interests in science:

> Interviewer: Are they interested in the subject?
> Teacher M7: Yes they are, but at Form III level they have already decided what to take in Form IV. We do extension classes to help them from 7:15 to 8:30 am once per week. We manage to cover 60% to 90% of the work.

Teacher M9 had the following views regarding the pupils' interest:

> Teacher M9: Interest in science is not so good. Chemistry is popular here and they get good results in chemistry exams. There are additional classes for those taking science subjects. The pupils are forced to do science to make up for the low numbers choosing science. Some of them have already decided what they are going to do … others are not clear on what

they are going to do. Brothers, sisters, relatives and parents also have already influenced them (*on their choice of subjects*).

Teacher M10 articulated the following statements regarding his subject:

> Teacher M10: They (*girls*) like doing accounts; out of 80 pupils taking the accounts exams, only 20% fail at Form III level. That shows that the performance in accounts is reasonable. Language may be a problem but I use both English and Creole to explain. The Form III syllabus is designed in such a way that it covers 35% of the S.C syllabus.

<u>Gender issues</u>

According to teacher M7, pupils are taught topics which may prove economically useful to them later in life and enable them to earn a living. They are made aware of the importance of biology and the possible career options which are available:

> Interviewer: Do they have any preference for any topic?
>
> Teacher M7: So far in science subjects, germination and grafting topics. We use moong daal (*a variety of beans*) for germination to get bean sprouts. Thus they can earn a living by applying techniques such as grafting, growing bean sprouts and mushroom culture.
>
> Interviewer: Is there any gender bias in their choice?
>
> Teacher M7: Not according to me. They may do well; better than accounts but the parents decide. 50% of the class consists of both boys and girls. We show to them job prospects but biology is of great concern. For example, importance of DNA for the police department; in nursing, private clinics and hospitals, training people to show them the scope in vocational training.. We try to motivate them.

Regarding learning styles, teacher M7, both boys and girls resort to rote learning and give very little opportunity for intellectually challenging task:

Interviewer: What is their learning style? Is there a difference between the boys and the girls?

Teacher M7: No there is no difference in the learning styles of boys and girls. I have not noticed any. They learn in a rote fashion. They ask some questions but they do not read anything outside their school books. They do not use library.

Interviewer: Are the boys more vocal in class?

Teacher M7: No there is no difference. They both answer questions. They say what they want whether it's wrong or right.

Interviewer: Do they enjoy group work?

Teacher M7: Yes, the boys and girls in separate groups. There is gender division.

Interviewer: You mean the boys and the girls do not work in mixed groups?

Teacher M7: Yes, boys together and girls together.

Group work seems to be favoured by both girls and boys but they are reported to be in separate single-sex boys' and girls' group. Both boys and girls try to get teacher's attention by answering questions.

Teacher M9: I use the same teaching strategy for both boys and girls. Girls are doing science better than before; I give them notes and they are good at reading notes and learning them. Girls work in groups made up of girls and boys in boys' groups.

He made the following comments regarding boys' and girls' handling of practical work:

Teacher M9: When they do experiments, the boys are much better at manipulating equipment … in mixed group, the boys manipulate, carry out the experiment, the girls record the results. The girls lack confidence. An exception is in the case of the bright girls; they are good too; these girls are self confident. Boys tend to work faster when doing practicals but they are not very organized in their work. The boys are in a hurry. Girls are neater; they use a more time to present their work neatly.

Interviewer: When you ask questions, who answers?

Teacher M9: The response from the pupils varies. When it comes to definitions, the girls are better; in calculations, the boys are better; mathematics is a problem with the girls. Another thing is that boys answer without thinking; the girls discuss with other girls and then raise their hands to answer. The boys laugh at them when they give the wrong answer. So, I help the girls by giving them some hints or key words. I know they have the answer and once I give them one word, they get the idea. Boys are different in that sense.

Teacher M9 also noted:

Girls use ICT to present their project work … they are more organised. Boys write theirs in a careless way.

Teacher M8: There is equal participation of boys and girls in physics. Girls who are good in mathematics do well. The boys like physics because it helps them to understand about appliances, fuses; some of them want to become electrician and mechanic. Many of the girls won't do physics as they find it difficult. However during lessons, the girls try to answer questions but the boys and the girls don't seem to understand the questions and I have to help them.

Interviewer: Can you say more about the difficulties they have in physics?

Teacher M8: The pupils try very hard in physics; they are aware that it is related to their everyday life. They are interested in physics, more particularly the boys.

Teacher M10 indicated that the girls favoured accounts rather than science:

Teacher M10: The girls turn out to be better in accounts; in accounts the work is quite routine type and figures are not so important. The pupils already know how to work out the exercises through practice. The questions are easily tackled by them. Students prefer to choose accounts instead of biology.

Interviewer: You mean girls prefer accounts to biology or other sciences?

Teacher M10: Boys go more for physical sciences but the girls are more attracted to accounts. The school has no gender policy; boys and girls are treated alike. They get prizes if they work well in their subjects. There is competition.

Resources and curriculum

Some constructive criticisms were made by teacher M7 on the textbook used in biology:

Teacher M7: There is an absence of detail. The literature is important; change the present way of presenting new things and make it more interesting. Every topic should have a reading area to provide information; should be colourful and the activities should be those that can be carried out. The topics on drugs are more interesting. We could hear the boys being more interested about smoking, nicotine, and its effects on the brain. I could hear their comments sometimes. They should be given more reading materials on such topics. These materials should be selected and adapted so that they can grasp the meaning better. Biological and social issues show relevance of the subjects; so awareness of social issues is important.

Interviewer: Are the resources in the school sufficient?

Teacher M7: There are lots of resources provided by the school. We also give them short photocopied notes and we tape our own voice and lend them the tapes.

Interviewer: Do they watch the MCA films?

Teacher M7: The language is foreign to them. It should be adapted to the local context and there should be animated films. The language is too high. Local presenters should be used more. Also schools do not get the films. The programs do not coincide with the school time-tables.

Teacher M9 is of the opinion that the textbook for chemistry is helpful but the presentation needs to be improved.

> Teacher M9: In the topic entitled 'Preparation of salts', there is not enough information on titration methods and the questions are confusing for the students but the language is simple and OK. I give the pupils the titles of MCA films and they watch them at home. The TV room at school is not so much in use.
>
> Teacher M8: There is little opportunity to do practical. There is a library which is sufficiently equipped and the pupils can borrow books to read. The physics book is OK but I have to give them notes which they memorize.
>
> Teacher M10: The recommended NCCRD book is not suitable for these pupils. It's too bulky and confusing for them. They need help with the language.

Other

> Interviewer: Do you have a great influence in choice of subjects.
> Teacher M7: No parents influence choice. They find the subjects difficult because of the math parts of science.
>
> Teacher M9: There are lots of formalities to be completed and visits are not organised regularly. The pupils have been to the Rajiv Gandhi Science Centre, but they just moved around without understanding anything. The visit should be well organised.
>
> Teacher M8: Compared to the boys, the girls are good at doing homework. We give extra tuitions to help the pupils improve their performance. Regarding choice of subjects, the majority are influenced by parents. The school gives them advice on choice; the boys go more for physical sciences and girls for accounts.

Regarding subject choice, he made the following comments:

> Teacher M10: Parents influence them to choose their subjects but the teachers guide them too. The social status of the parents and the family background are important when it comes to choice: those who are from good background will choose a professional career such as teaching, accountant; others will go for clerical, secretarial or hotel jobs. Not many will choose science subjects. Only 10 out of a class of 35 will choose science subjects. Many girls will not. The school criteria for subject choice depend on performance in the subject concerned.

5.6 Discussion

The qualitative analyses of the data from the interviews were carried out according to the themes which emerged from them and they were related to the research questions. The data helped to elucidate some of the reasons why the girls in the four case study schools were encouraged to or inhibited from taking science after the compulsory level. The group interviews of pupils demonstrated that pupils' school experiences of science subjects, the role of teachers and parents impacted to a certain extent on their final decision about choice of subjects at age fourteen whereas the teachers' interviews showed how the pedagogy and other associated factors influenced the girls in engaging in science and non-science lessons and their eventual subject choices.

Though there is a general awareness among the pupils in all four schools of the importance of science subjects, according to the teachers, it was mostly the bright girls who were expected to choose science. Most of the boys who were interviewed in the mixed-sex schools were more drawn towards science, namely physics. Among the girls who liked science, physics was least favoured; girls liked biology and chemistry in schools A, B. C and D but strangely enough two of the five girls in school D found the vocabulary of biology to be difficult, complicated and 'strange' though the topics were relevant and interesting to them. These girls were more particularly attracted towards accounts because they liked the teaching method of the teacher who gave them notes. The girls' dislike for physics in schools A, B and D is not surprising; the teaching strategies and the way they are presented are too abstract and objective and having little relevance to them. This is consistent with the research findings of Jones *et al.* (2000) and Miller *et al.* (2006) confirming that girls seemed to like biology, people-oriented majors and health professions. Other researchers reported similar findings (Bystidzienski & Bird, 2006; Christidou, 2006; NSB, 2006; NSF, 2007). Various other studies have shown that gender- inclusive science reflecting real world themes are more interesting for girls (Kelly, 1987; Rosser, 1993; Baker & Leary, 2003). Other researchers too have argued that girls are more likely to find science less alienating if it includes examples and uses resources which are in their local context and reflect their local cultures (Aikenhead & Jegede, 1997; Brickhouse, 2001).

5.6.1 Pedagogy

The interview data in the four schools show that the way physics was taught and some of the girls' difficulties with mathematics accounted for the girls' alienation from physics. They were less critical of biology and chemistry but they deplored the lack of practical work in most science subjects. Teachers generally relied on whole class teaching and occasional demonstrations according to the availability of resources and equipment. Notably, some teachers even brought their own kits and models to carry out demonstrations. There were two cases where the pupils themselves brought materials for practical work or projects they were engaged in. This was reported by the accounts teachers in schools B and D, the biology teachers in schools C and D and the physics teachers in schools A and C. Teachers admitted that activities in science would have contributed more towards interest and learning in science but they tried to justify their teaching method generally as a whole class activity by arguing that it was the only means to cover the overloaded syllabus and cope with the large class size and lack of laboratory equipment. Teachers stated that they used questioning, gave explanations from textbooks and set problem-solving exercises during the lessons. With the exception of one teacher in school B, all the teachers in science and accounts gave notes which the pupils memorised, a feature which indicated that rote learning was a common practice among the girls. One teacher reported that the boys had similar learning styles to the girls. The teachers' descriptions of their teaching methods in accounts, commerce and economics did not differ greatly from that in science subjects though the teachers stated that they used more relevant examples to explain the concepts. Some teachers were aware that girls were attracted towards science if gender-inclusive strategies were used but others stated that they taught science in the same way for girls and boys.

The responses of pupils, both boys and girls, in the interviews indicated their frustration with the way science was being taught in their schools. For example, girls in school A remarked that they rarely had practical work in biology and physics. In school B, the pupils stated that they understood better when they did practical work in science. In schools C and D, the same situation prevailed: the teaching of physics was teacher-centred. However, there was an exception in biology in school C and D. The pupils were to some extent engaged in investigations in the laboratory. The pupils' voices resonated with a clear call for a learning approach which is hands-on and participatory so that science does not appear boring to them. For example, in school C, Anusha's statement clearly illustrates such views: *we would like to work in the lab, hold a test-tube, wear a lab coat and be like a scientist*, and indicated that the girls would enjoy science more if there would be personal involvement through experiments. Furthermore, Priya's views summarise the expectations and experiences of the girls: *science should be lively. Now we learn by heart … too much rote learning … it is better to do experiments, science is fun then.* At the same time, some teachers were strongly of the view that the background of the girls was influential in determining their perception that science, particularly physics, is meant for boys. However, the girls came out strongly to claim that *women can be good scientists. Boys feel they are the ones who can do well in physics.* On the other hand, this characterisation of the views of boys was not shared by the boys in schools B and D; they felt that both girls and women can be good in science. The boys in school B stated that they had to compete with the girls to show that they could perform as well as the girls; such a view is an indication that a competitive spirit existed in that single-sex school.

Practical work

Investigation in science has been argued to be the very heart of science (Woolnough, 1991). The pupils were unanimous about their criticisms about the lack of practical work in science which caused them to find science boring. A number of researchers, (Hart, 2002; Cerini *et al.*, 2003; Angell *et al*., 2004; Sharp, 2004; Wellington, 2005) have argued in favour of practical work to interest and motivate pupils. More recent work by Abrahams and Miller (2008) has questioned the effectiveness of practical work as a teaching and learning strategy. In his most recent work, Abrahams (2009) has emphasized that the quality of practical activities is vital for understanding concepts in science and concluded that practical work should not be carried out only for the sake of enjoyment or fun.

Group work and cooperative learning

Both boys and girls in the four schools differed in their views about group work and cooperative learning. The pupils in all four schools preferred individual work to group work. It is possible that the benefits of cooperative learning had not been explained to them; another reason for their preference for individual work could be to their competitive spirit and desire to work on their own to manipulate equipment. This was more particularly evident in school C where boys and girls competed with each other. However, some of the pupils welcomed the idea of collaborating during project work as they found that, consistent with the work of Lave and Wenger (1991), social interaction during the activity and context was important for learning to occur. As stated in Chapter 2, researchers have found that group work and collaborative learning enhance full participation in science and students develop an understanding of the natural world when they are actively engaged as a social group in scientific inquiry (Matthews & Sweeney, 1997; Bell *et al*., 2010). Interactions among individuals are vital in deepening the understanding of scientific concepts and nature of the scientific endeavours. Diverse ideas, skills and experiences contribute towards bringing about understanding. Through individual and social processes, pupils can work like scientists to gain knowledge of scientific processes using collaborative inquiry learning with the support of their teachers. In conformity with the findings of Tippins and Nichols (1995), Matthews and Sweeney (1997), Abell *et al*. (2000) and Mc Neill *et al.* (2006), the interview data indicate that collaborative learning generally appeared to be favoured by girls in all four schools.

5.6.2 Teacher and pupil attitudes

Teacher's behaviour in the classroom can play an important role in motivating and encouraging the pupils to continue to study science after the compulsory level (Labudde, 2000). Pupils in the four schools complained that they expected their teachers to involve them more in activity-based learning. However, the pupils in school C reported that they liked physics because the teacher was encouraging and this was confirmed by the physics teacher in his statement. In that school, the girls' initial dislike for physics gradually changed into a liking for that subject because of the way the teacher taught and the relationship that eventually developed. In physics, particularly, the nature of the teacher-student relationship is more important for girls than boys (Krogh & Thomsen, 2005). Both boys and girls complained about the unhelpful attitude of the physics teacher in school B; it is to be noted that teachers in school B have no pedagogical training and it is highly possible that this particular teacher is more interested in imparting his knowledge of physics rather than paying due attention to the pupils' learning needs. In the mixed schools, teachers were aware that boys tended to call out answers before the girls had a chance to respond to questions (Kelly, 1988). Some teachers tried to encourage the girls to interact by directing questions to them and helped them to gain confidence. It is to be noted that girls' confusion and lack of interest in physics lessons in school B were at least partly due to the fact that the physics teacher there was neither very helpful nor encouraging. Both girls and boys liked their chemistry lessons in school B because of the good relationships established by the pupils and the chemistry teacher.

Girls in schools A, B and D indicated a preference for a female teacher to teach biology, especially in topics such as reproduction; this is not surprising as adolescent girls can probably relate more to a female teacher when it comes to addressing topics dealing with female-specific anatomy. The boys had no preference and stated that the personality and competence of the teacher was more important. Girls in school D stated that they would have preferred female teachers for physics and chemistry. In general, pupils stated that the sex of the teachers is not so important as their pedagogy and their attitudes towards the pupils.

Teachers were of the opinion that girls lacked confidence in science and could do science equally well as the boys as they had the potential to do so. In the mixed-sex schools, the teachers pointed out that the girls were as able as the boys to perform well in physics but stated they were subdued and very often hesitated to ask questions; contrarily, the boys through their assertiveness tended to dominate the science lessons in school B. This was also evident in the accounts and economics lessons.

5.6.3 Nature and culture of science

Masculine image of science

As pointed out in Chapter 2, science has been traditionally portrayed as factual, objective, male, masculine, culture- and value-free and dealing with phenomena rather than people and as a male-dominated field. Girls in schools B and C, however, perceived science positively and expressed the views that science was appropriate for both males and females. Whilst the girls in school A held the stereotypical image of the scientist as being a male, the girls and boys in schools B, C and D explicitly expressed the views that both males and females are capable of doing science. The girls in schools B, C and D vehemently challenged the stereotypical image of the scientist.

The statements about girls' attitude towards science are quite revealing; the girls' rejection of biology in school D was related to the fact that they found it difficult. It is interesting to note that some of the boys found subjects like biology hard in that same school. In that school, the teachers of all three science subjects were male and it is possible that the girls' perception of science in that school was reinforced by the gender of the teachers. However, most teachers claimed that the learning style of girls was more towards rote learning and that they worked at a slower pace compared to boys. The biology teacher in school D found that both boys and girls liked to memorise notes.

<u>Relevance of science</u>

In school C the physics teacher's comments about using examples familiar to the girls' lives to interest them in physics is consistent with studies carried out by Jones *et al.* (2000) that boys are more likely to identify physical sciences with their experiences of more physical, science-related activities such as model cars, tools and computers whereas girls showed preferences for feminine activities. The physics teachers in schools A and C made science appealing to the girls by using familiar examples which reflected real world themes. Some teachers were unaware of gender-specific pedagogy in the four schools and stated they used the same teaching approach for boys and girls.

5.6.4 Role models

Some teachers acknowledged that it is important to have role models in science; they suggested that talks by successful women scientists could have a positive effect on the girls' uptake of science subjects. Some of the girls used one of their teachers as role models because they succeeded in engaging them in their lessons by the teaching strategies they used. Girls in School B said that their chemistry teacher was a role model for them: *She (the chemistry teacher) is like an idol; we try to imitate her. In physics we would like a female teacher.* This statement reflects both their relationship with the teacher and their admiration for her as a scientist.

5.6.5 Role of parents

Many of the teachers interviewed cited that parents have an important role in the choice of science subjects; they had high aspirations for their children irrespective of their ability to do science. Family background such as having a relative who is in the engineering or scientific field has been found to be another predictor of whether girls choose science or engineering career (Gogolina & Swartz, 1992). Parents provide their children with cultural capital by transmitting to them the knowledge and attitudes needed to succeed in the education system (Bourdieu & Passeron, 1990). The importance of parental attitudes in this study is examined in the next chapter. Teachers also stated that pupils are influenced by their peers and teachers in their choice of subjects. Some schools provide advice on choice of subjects and career guidance to parents and pupils.

Key findings from the interviews of pupils and teachers

The findings from this study may be summarised as follows:

- Across the four schools pedagogy is traditional in approach and there were limited opportunities for group work while cooperative learning occurred only occasionally.
- There was a limited amount of practical work in biology and chemistry lessons and none in physics. Both teachers and pupils would have liked the pupils to carry out practical work but the teachers and the pupils stated that lack of resources and overloaded syllabus did not allow hands-on activities.

- Girls and boys were of the opinion that science subjects were not for males only; females were equally capable of doing science. Most teachers felt that girls had the potential to do well in science but the need for science subjects reflecting themes which are relevant and related to everyday life was emphasized by both teachers and pupils.
- In physics, some teachers tried to boost the confidence of the girls through girl-friendly teaching strategies, encouragement and praise but this was not always the case.
- Textbooks were the main resource used. Sometimes project work was undertaken in biology and economics and the girls brought to school (at the request of their teachers) some resources and materials for carrying out activities.
- In both science and non-science subjects, some teachers gave notes which pupils could memorise.
- Though pupils and teachers stated that both boys and girls were keen to do science, the importance of physics did not seem to be clear to the girls, even the bright ones. Physics did not appeal to the girls.
- In the four schools, there were more male than female teachers in physics and biology and more female teachers in chemistry; some girls would prefer to have female teachers in biology and physics. However, others felt that the attributes of teachers were more important than whether the teacher was male or female.
- In mixed-sex schools, boys tended to dominate in both science and non-science subjects by asking more questions; girls were often afraid to ask questions for fear of being ridiculed by the boys.
- Parents were stated by the pupils to have negative views towards science subjects because of the scarcity of jobs in science; both teachers and pupils were of the view that generally parents through the guidance of teachers influenced girls as to the choice of subjects. Influence of parents on the pupils' choice was another factor cited by the teachers.
- Out-of-school science activities occurred rarely. Girls used internet sources and educational programmes for learning science.

The findings from the interviews with pupils and teachers show that there are a number of factors which interact to a certain extent to influence the girls' uptake of science subjects at Form III level, but teaching methods seem to be the most important factor that deterred most girls from taking science after the compulsory level. The more able girls were interested to study science subjects regardless of the pedagogical approach used by the teachers. This can perhaps be attributed to the high expectations of the parents – something that will be investigated further in Chapter 6 – and the school. Lack of practical work was the most cited complaint by the pupils and even teachers admitted that this was a major impediment. However, as the schools gradually become better equipped, one would expect teachers to adopt activity-based teaching methods. Overall, the girls held positive views about science but negative views about how they were being taught.

Chapter 6

6.1 Introduction

It was important to get the views of the parents because of any influence they might have on the choice of subjects by the pupils at Form III level. Through the use of a parental survey questionnaire my aim was to find an answer to research question two which was: 'Do parents influence the choice of science subjects in Mauritius and if so how?'Some numerical data generated from the parental questionnaire partially clarified issues which emerged during the interviews with pupils and teachers. After piloting the questionnaires in a different class from the ones under study and after making a few modifications from the feedback received from the pilot, I administered them to the parents of the pupils whose classes I observed in the four case study schools (see Section 3.15.6 and Appendix 4). The stance adopted in the questionnaire reflected aspects of the research questions, particularly questions 5, 6 and 8 in the questionnaire which were about parents' perceptions of science and their influence on the choice of subjects after the compulsory level. I anticipated the survey to be like 'a fact-finding mission' (Wellington, 2000, p.101) and provide answers to the following question: Do parents influence the choice of science subjects in Mauritius and if so how?

6.2 Ethical considerations

As discussed in Chapter 3, I was careful in asking questions which the participants in the study would not find too sensitive or invasive of their privacy. The questionnaire asked some general details about the participant and some open-ended questions which would not require a great deal of time to complete. I was careful about how I addressed the parents and got their support to respond to my questionnaire.

6.3 Advantages and disadvantages of questionnaire

Questionnaires are considered by some researchers to be more reliable than other methods of data collection as they can, to a certain extent, elicit a higher level of honesty over interviews (Oppenheim, 1999; Gillham, 2002). The questionnaire allows respondents to reflect more about the questions and as the respondents are not in a face-to-face situation, some respondents are less inhibited than in an interview situation. However, at the same time it is difficult to identify misleading answers and questionnaire respondents are often less engaged than in an interview situation. This can distort results and validity can thus become a matter of concern. I tried to include some internal validity checks by asking some open-ended questions in another form, for example in questions 4 to 8 (Appendix 2), by asking respondents to give reasons for their answer to a closed question.

One benefit associated with questionnaires (Robson, 2000; Wellington, 2000) is the relative ease with which they can be administered. In a fairly short time, I managed to obtain a substantial amount of information from the parents with a high response rate. It is possible that questionnaires were more reliable in that there was minimum researcher bias as I had no personal contact with the parents. On the other hand, there might have been instances where the parents needed some clarifications or help with some of the questions and a personal contact with the respondents could have helped to provide a rapport with them. However, this was not evident from the responses; there were a few cases where some words were written in French and I checked these for the correct meaning they were conveying and the answers did not show that there was any misunderstanding of the questions asked.

6.4 The questionnaire

I had to show a copy of the questionnaire to the rector/principal of each selected school so as to obtain their cooperation; I thought that using the teachers and the rectors as personal contacts would increase the response rate (Wellington, 2000). I even talked to the pupils to make it more likely that their parents would complete the questionnaires within two to three days so that I could have them back as quickly as possible. I politely explained in the letter addressed to the parents the aim of the research; I also explained to the pupils what the questionnaires were about so that they in turn could explain to their parents the purpose of the survey should they have any doubt about some of the items covered. In all, 135 questionnaires were addressed to the parents through the pupils in the four schools. I asked the pupils to invite their parents to answer the questions in a family setting at home so that the views of either parents or other responsible parties (Section 3.16) were reflected in the questionnaires. There was a high response rate of 83% (112 completed questionnaires were returned).

I ensured that the questions were straightforward and formulated in simple English with no confusing jargon so that they would be as likely as possible to be easily understood by the respondents. Clear instructions were given on how to answer them. As stated by Robson (2000), careful thought was given to the length and order of the questions; awkward, embarrassing and leading questions were avoided. The layout of the questionnaire included space between the open-ended questions so that respondents could write their comments (Appendix 2). Questions 1 to 4 were straightforward and aimed at getting the personal background of the respondent and were closed, so quick and easy to answer and code. Where there was a YES/NO answer, respondents had to provide reasons for their answer. Similarly, questions 5, 6 and 8 each had a YES/NO answer section but there was an open-ended subsection which allowed for free responses. The open-ended questions took more time to analyse as the responses were of a qualitative nature involving opinions, feelings and value judgments and I restricted them to a few in numbers. Most of the questions were answered; in only a few cases did the respondents omit to answer. This was particularly the case for question 4a which referred to the level up to which respondents had studied science. I found that this omission was not surprising because these respondents' education in science did not go up to School Certificate level. The words 'respondents' and 'parents' are used interchangeably.

6.5 Results and data analysis

For data analysis purposes, the parents in the sample were classified into five categories that I decided upon based on the type of work they did:

1: Manual work (e.g. labourer)

2: Semi-skilled work (e.g. builder, mechanic)

3: Office work (e.g. clerk, secretary, administrative officer)

4: Professional (e.g. engineer, accountant, surveyor, lecturer)

5: Not specified.

The raw data for the samples in the four schools were processed and analysed using Excel software. The experience gained during the pilot proved helpful. Identifiers were given for each questionnaire; for example LS1, LS2, for school A, MG1, MG2, for school B, S1, S2 for school C and MO1, MO2 for school D samples. This ensured that questionnaires for the four schools were not mixed during data analysis. The bundles of questionnaires for each school were read, transformed into meaningful figures and tabulated. The processing of the closed questions was straightforward. The free response questions were read and appropriate coding frames were designed (Oppenheim, 1999, p.267). Questions 2, 2a and 2b asked for details of both parents and whether the child attending the school was their son, daughter or some other relation. The codes and categories for occupation were developed from question 2 which described the occupation of the parents. A new category was included for question 4 which asked about the parent's background education in science at secondary level. The codes and categories for the other questions relate to the ones used in the interviews and observations; for example, question 5 regarding the parent's perception of the importance of science in the questionnaire could be linked to 'behaviour and interest' category in Chapter 4 and question 8 which related to influence of parents on the choice of subjects to category relating to 'Other' in Chapter 5 where themes such as subject and career choices emerged.

The data for the four samples were combined so as to obtain an overall picture of the responses made by the parents. The data for each school are then presented separately for closed answers and then selected excerpts from the open questions are presented.

6.6 Combined data from schools A, B, C and D

Table 6.1 shows the aggregated data for the four samples from schools A, B, C and D. Question 1 refers to the sex of the respondent who was filling in the questionnaire. However, it is to be noted that both parents were expected to discuss the questionnaire and complete the questionnaire jointly. The response from question 4 shows that only one of the two parents of each pupil completed the questionnaire. In Table 6.1, the column 'Sex of respondent' indicates that slightly over half of the questionnaires were completed by the mothers (59 mothers against 53 fathers).

Category	Mother	Father	Sex of Respondent	
			Male	Female
Manual Work	56	28	13	28
Semi-skilled	22	38	19	15
Office Work	11	15	10	6
Professional	5	10	4	5
Not Specify	18	21	7	5
	112	112	53	59
			112	

Table 6.1: Combined data from all four schools.

A comparison of the occupation data in Table 6.1 reveals that 56 of the 112 mothers were involved in manual work whereas only 28 of the 112 fathers were in that occupational category; 38 fathers and 22 mothers were in semi-skilled occupations. A small number of parents were in office or professional work and 18 mothers and 21 fathers did not specify the type of occupation they were in.

6.6.1 Respondents' science education

Figure 6.1a shows the science education background of the respondents in the four samples. It indicates that most of the parents (71 out of 112) in the various social categories had a background of science education at secondary level. However, there were a fair number of parents who did not study science and this was more evident among those who were in the manual and semi-skilled categories. These were presumably parents who did not have the opportunity to study beyond primary level. Compulsory science education at secondary level up to Form III was introduced in Mauritius in early 1980s (see Section 1.4) and it is possible that those parents in the office work and professional categories who did not study science did their secondary education in some private secondary schools prior to 1980.

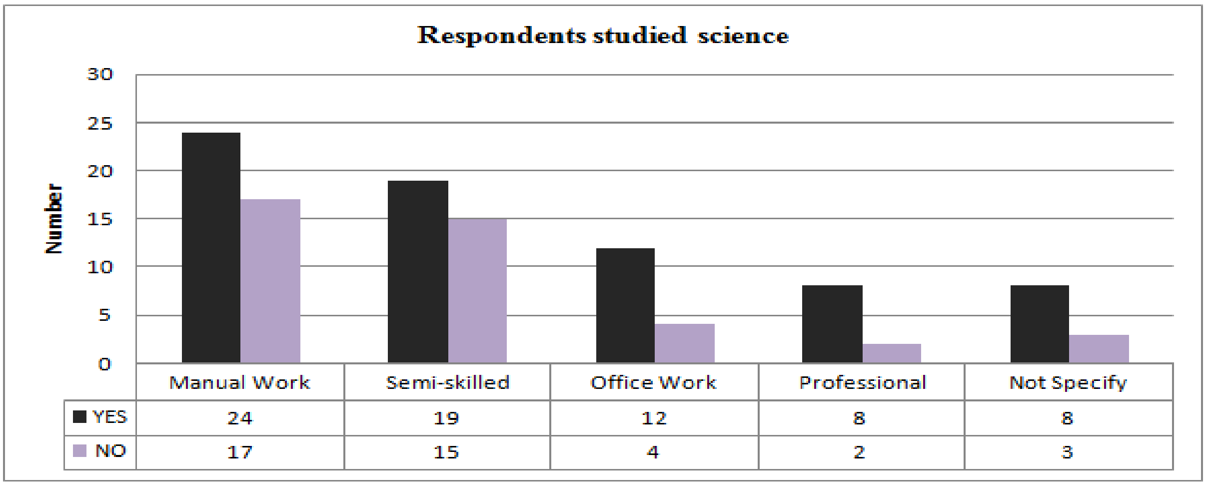

Figure 6.1a: Respondents from all sampled schools who studied science.

6.6.2 Science important to study

Figure 6.1b shows that the study of science is highly valued by the great majority of respondents irrespective of their social status. For example, 106 out of 112 parents attached a great importance to the study of science.

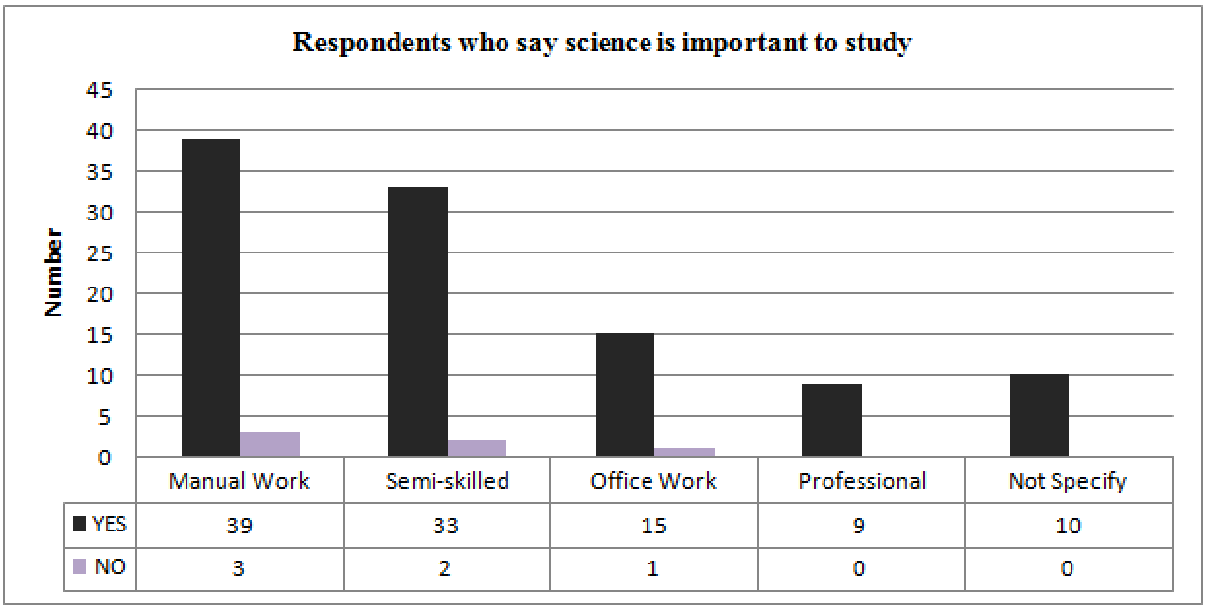

Figure 6.1b: Respondents who say that science is important to study in all the sampled schools.

6.6.3 Influence of parents on the choice of subjects

Figure 6.1c illustrates whether parents say they have an influence on the choice of subjects at Form III level.

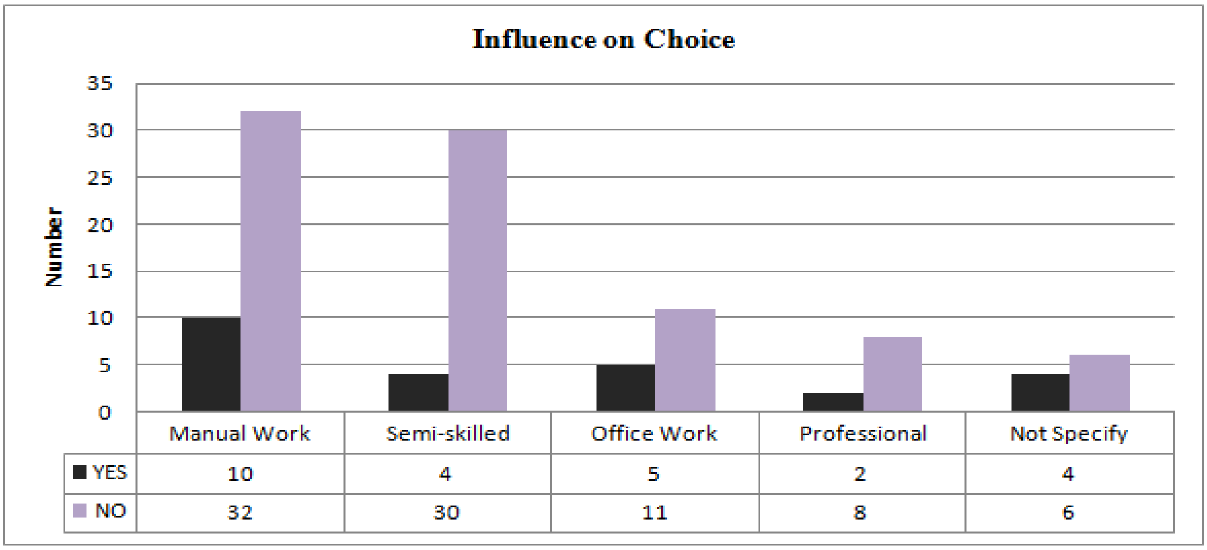

Figure 6.1c: Parental influence on choice of subjects for all schools.

The majority of parents in each occupational category listed in the study claimed that they did not influence their children on the choice of subjects at age 14 (Figure 6.1c). It was interesting to note that this was seemed most evident among the semi-skilled workers. However, some parents stated that to a certain extent they do exert an influence in their children's choice of subjects. Excerpts from the individual schools will be used later to illustrate the views of the parents on this aspect.

6.7 School A

Table 6.2 summarises the background information on the parents in School A, their influence on the choice of subjects and the importance they attach to science.

Category	Mother	Father	Sex of Respondent		Study Science		Science important to study		Influence on Choice	
			M	F	YES	NO	YES	NO	YES	NO
Manual Work	22	6	3	8	5	6	10	1	3	8
Semi-skilled	5	15	9	3	5	6	11	1	1	10
Office Work	1	3	3	0	2	1	3	0	2	1
Professional	0	4	2	0	1	2	2	0	0	3
Not Specify	3	3	2	1	2	1	3	0	1	2
	31	*31*	*19*	*12*	*15*	*16*	*29*	*2*	*7*	*24*
			31							

Table 6.2: Data from school A

School A is a single-sex girls' school in a semi-urban region. It is evident that a majority of the mothers (22 out of 31) were employed in manual work whilst 15 out of 31 of the fathers were in semi-skilled occupations and a limited number were office workers or professionals.

6.7.1 Respondents' science education

The data from Table 6.2 show that slightly over half of the parents involved in manual and semi-skilled occupations did not study science.

6.7.2 The importance of studying science

In response to the question *Do you think the study of science is important?*, it was found that the great majority of respondents (29 out of 31) acknowledged the importance of science. As indicated in the quotations below, parent LS7 expressed the opinion that the study of science is important for progress and to make life comfortable whilst parents LS15 and LS31 were of the view that science is important as it helps us to understand life and make discoveries and parent LS24 pointed out the career opportunities offered by the study of science:

Parent LS7 (*semi-skilled*): Science is making the world and civilisation progress and it has helped a lot in making people achieve comfort in everyday life.

Parent LS15 (*manual work*): Science is based on facts and a basic knowledge in science is necessary for everyday life. We get to know life and understand it better.

Parent LS24 (*professional*): Because it enables a child to become a doctor or engineer and it is a very interesting subject.

Parent LS31 (*professional*): It helps us to explore and discover the world in which we live and make scientific discoveries.

In response to the question: *Would you like your daughter to study science after Form III? Give reasons for your answer,* parent LS7 recognises the wide range of opportunities offered by the study of science whereas parent L15 is more concerned with the financial cost that studying a science subject at higher level entails:

Parent LS7: Yes. It will be first of all because it's quite an interesting field and also with wide range of job opportunities. As a parent, I will be proud to see my daughter studying science and later working in a science field.

Parent LS15: Firstly, my daughter has a preference for accounts and economics. Besides, it costs quite a lot of money to pursue studies in science subjects in higher classes and more at tertiary level.

In response to the question: *What would you like your daughter/son to do as a career?,* parent LS7 would like his daughter to embark on a scientific career whilst parent LS15 would prefer his daughter to follow a career in the financial sector:

Parent LS7: Veterinary surgeon.

> Parent LS15: Would like daughter to be Chartered Financial Analyst (*CFA*)...There are few CFAs in Mauritius and it is a highly demanded job.

6.7.3 Parents' influence on choice of subjects

It is noteworthy that only a minority of parents (7 out of 31) from the different social categories said they have an influence on the choice of subjects. The results from Table 6.2 show that a minority of parents involved in manual, semi-skilled and office occupations stated that they influenced their children on the choice of subjects.

In response to the question: *Do you influence your daughter/son in the choice of subjects? If yes, how? If no, who influences her/him?,* parents LS7 and LS15expressed the following views:

> Parent LS7: No I do not influence her; it's her choice.
>
> Parent LS15: I advise her about the pros and cons of different fields of study and the long term consequences.

The above excerpts show that parent LS7 claims he does not influence his daughter on the choice of subjects but earlier he stated that he would be proud to see his daughter choosing science subjects. On the other hand, parent LS15 expressed the view that he advises his daughter on the choice of subjects.

6.8 School B

Table 6.3 and the extracts given below illustrate the views held by the parents of the pupils in School B.

Category	Mother	Father	Sex of Respondent		Study Science		Science important to study		Influence on Choice	
			M	F	YES	NO	YES	NO	YES	NO
Manual Work	0	0	0	0	0	0	0	0	0	0
Semi-skilled	7	8	3	4	5	2	7	0	1	6
Office Work	4	5	3	3	4	2	5	1	2	4
Professional	5	5	2	4	6	0	6	0	2	4
Not Specify	6	4	1	2	3	0	3	0	1	2
	22	*22*	*9*	*13*	*18*	*4*	*21*	*1*	*6*	*16*
			22							

Table 6.3: Data from school B.

School B is a mixed-sex school situated in an urban area. Strikingly, the sample did not have any of the parents involved in manual work; they were all in semi-skilled occupations, in office work or were professionals.

6.8.1 Respondents' science education

The majority of the parents in School B have studied science at secondary level with the exception of four out of 22 parents.

6.8.2 The importance of studying science

As indicated in Table 6.3, almost all of the parents have positive attitudes towards the study of science. In responses to the question: *Do you think the study of science is important?*, parents MG8, MG15 and MG19 tended to hold science in high esteem. Parent MG8, who is a housewife whose spouse is a manual worker and has a son studying in school B, said:

> It helps us to understand our surroundings. It helps in the development of general knowledge.

Parent MG19, who has a son studying in school B, indicated that he did not study science at secondary level:

> Because I wasn't interested in it.

However, he values the importance of science, stating that science equips people with knowledge:

> Because in science, we get to know a lot of things, so people will not be able to fool us.

Parent MG15, who is female and a Muslim, occupation not specified, has a daughter studying in school B and has not studied science. She recognises the need for scientific and technological literacy:

> Subject was not yet introduced in school. Science is important because now everything around us is science, new technology and to know how it works.

In response to the question*: Would you like your daughter to study science after Form III? Give reasons for your answer,* parents MG8, MG15 and MG19 expressed positive views on this issue.

Parent MG8 would like her son to study science after Form III:

> He is very good in science. He seems interested in this subject.

Similarly, Parent MG15 stated:

> Parent MG15: Yes. It is important and to increase her knowledge.

Parent MG19 would like his son to study science after Form III and his response to this question was:

> Yes. It is very advantageous.

In response to the question*: What would you like your daughter/son to do as a career?,* parents MG8 and MG15 were in favour of a career in science and technology whereas parent MG19 was for a career in the financial sector as it is lucrative in terms of earning potential.

Parent MG8 responded:

> Computer engineer. It is a very interesting job as we are in the computer age.

Parent M19: I want him to work in big enterprises, such as banks. Because he will get a good salary and obtain loan facilities.

MG15: Doctor or teacher for science subject.

6.8.3 Parents’ influence on choice of subjects

In response to the question: *Do you influence your daughter/son in the choice of subjects? If yes, how? If no, who influences her/him?*, as in the case of school A, the parents on the whole stated that they do not influence their children on the choice of subjects.

Parent MG8: No. He chooses his subjects on his own.

However, parent MG19 would influence his son on his choice of subject:

By explaining him, how important these subjects are and its importance in his future life.

Similarly, parent MG15 would influence her daughter on the choice of subject:

As I have some ideas and as I know how she works in the subjects, I help her choose her subjects.

The views of parent MG15 on the choice of subjects are typical of a minority of parents in school B.

6.9 School C

Table 6.4 presents the data for school C. School C is a single-sex girls’ school located in an urban area. The respondents are mainly females.

Category	Mother	Father	Sex of Respondent		Study Science		Science important to study		Influence on Choice	
			M	F	YES	NO	YES	NO	YES	NO
Manual Work	11	5	0	8	5	4	8	1	2	7
Semi-skilled	4	9	3	3	4	3	6	1	0	7
Office Work	6	7	4	3	6	1	7	0	1	6
Professional	0	1	0	1	1	0	1	0	0	1
Not Specify	6	5	3	2	2	1	3	0	1	2
	27	*27*	*10*	*17*	*18*	*9*	*25*	*2*	*4*	*23*
			27							

Table 6.4: Data from school C.

6.9.1 Respondents' science education

Table 6.4 shows that the majority of the parents have a science background up to secondary level. Those parents who said they did not study science at secondary level were mostly from manual and semi-skilled occupations.

6.9.2 The importance of studying science

Science appears to be highly valued by the parents in school C. Only two parents had contrary views. In response to the question*: Do you think the study of science is important?,* parent S10, who is a female professional of Chinese origin and has a secondary level background in science, replied:

> Study of science is important. There are many prospects in this field.

Parent S13 is a male of Hindu origin, has a science background and is a professional:

> Study of science is important. Science is the basis behind everything in life so a good understanding is important.

In response to the question: *Would you like your daughter to study science after Form III? Give reasons for your answer*, many parents stated that they would like their daughters to study science after Form III:

> Parent S10: Yes. I would have liked her to choose science subjects but unfortunately she has opted to study economics and accounts.
>
> Parent S13: By studying science she would have a broad choice of careers later ranging from being a teacher, engineer or other professional.

In response to the question: *What would you like your daughter/son to do as a career?,* Parents S10 and S13 seem to, have high career aspirations for their daughters. Both parents would like their daughters to choose a career in the health sector. Whilst parent S10's statement tends to indicate that as a parent she may have a personal reason for that choice, parent S13 recognises that it is his daughter's ambition to become a doctor.

Parent S10: Dietician. Because youngsters eat too much junk food.

Parent S13: Doctor (medical practitioner). This is her ambition.

6.9.3 Parents' influence on choice of subjects

Clearly, the great majority of parents (23 out of 27 respondents) said that they do not influence their children on the choice of subjects.

In response to the question: *Do you influence your daughter/son in the choice of subjects? If yes, how? If no, who influences her/him?,* the following excerpts show that the parents differed in their views:

Parent S10: Own choice.

Parent S13: Yes. We guide her so that her choice reflects the career she would take.

Though parent S10's statement reflects that she has an influence on the career choice of her daughter, she does not seem to influence her on the choice of subjects. Parent S13 reported that his role is more like a guide.

6.10 School D

School D is located in a rural area and the most of the parents are involved in manual work; there are only a minority in semi-skilled occupation. The results from the parents' sample from are presented in Table 6.5.

Category	Mother	Father	Sex of Respondent		Study Science		Science important to study		Influence on Choice	
			M	F	YES	NO	YES	NO	YES	NO
Manual Work	23	17	10	12	14	7	21	1	5	17
Semi-skilled	6	6	4	5	5	4	9	0	2	7
Office Work	0	0	0	0	0	0	0	0	0	0
Professional	0	0	0	0	0	0	0	0	0	0
Not Specify	3	9	1	0	1	1	1	0	1	0
	32	*32*	*15*	*17*	*20*	*12*	*31*	*1*	*8*	*24*
			32							

Table 6.5: Data from school D.

6.10.1 Respondents' science education

Out of 32 parents, 20 have studied science at secondary level, whilst 12 do not have a science background. In the latter case, the parents are involved in manual and semi-skilled occupations.

6.10.2 The importance of studying science

An overwhelming number of parents (31 out of 32) in school D attach a great importance to the study of science. They stated that science is interesting and vital as it enables them to know what is happening around them and to their body. They appreciate that many jobs require knowledge of science subjects. In response to the question*: Do you think the study of science is important?,* the excerpts given below indicate their views.

Parent MO9, who is male, of Hindu origin, does manual work and has not studied science as he has only studied up to primary level, replied:

> Science is important. Because nowadays everywhere we use science.

Parent MO28, who is female of Hindu origin, does manual work and has not studied science, said:

> So as to know what is happening in the world. So as we know what is happening to ourselves.

In response to the question: *Would you like your daughter to study science after Form III? Give reasons for your answer*, the parents' views indicated that science offered good possibilities for jobs:

> Parent MO9: Yes. If my daughter after her education wants to search for a job, I think if she has a science certificate she can find it easily.

> Parent MO28: Yes, because my daughter is very good in science. Because my daughter loves doing science so as one day she can become a professional scientist.

In response to the question: *What would you like your daughter/son to do as a career?,* parents MO9 and MO28 said they left the choice of the career to their daughters:

> Parent MO9: Depends on my daughter. Because I can’t make her choice. Everyone has the right to choose everything at every time as it concerns her education.
>
> Parent MO28: Because she is doing something brave and great.

The parents’ statements tend to show that they believed that their daughters had the right to decide on their choice of career.

6.10.3 Parents’ influence on choice of subjects

The parents on the whole claimed that they do not exert any influence on the choice of subjects. In response to the question: *Do you influence your daughter/son in the choice of subjects? If yes, how? If no, who influences her/him*?, parents MO9 and MO28 had contrasting opinions on this issue. The following statements indicate their views:

> Parent MO9: No one because she will take part in the exams, not us.
>
> Parent MO28: Yes. By encouraging her to take this subject and my daughter knows why she is choosing her subject.

The parents in school D are predominantly manual workers and yet they would like their children to aim high so as to improve their status in life and choose a career that suits them. The views expressed by the majority of the parents in school D suggest that they let their sons or daughters decide on the choice of subjects. Parent MO28 represents the minority of parents who claim to influence her daughter to choose her subjects by encouraging her to study science and become a professional scientist but she also mentioned that her daughter loves doing science.

6.11 Discussion

The parents' questionnaire aimed at finding out if parents had any influence on the choice of subjects at the point of choice, which is at Form III level. What emerges is that the majority of the parents, irrespective of their social background, claim that they do not influence their children in choosing their subjects at that level. The data also indicate that parents do not make any distinction regarding the importance of science to either boys or girls. There are some cases, for example in school B, where having a relative as a role model in the family is a predictor of whether a girl chooses science (cf. Gorgolina & Swartz, 1992; Jacobs, 2005). Some parents claimed that they influenced their children in respect to the question of choice of subjects and this is probably due to the concerns they have regarding the aspirations of their children. For example, one parent who said that she influenced her daughter on the choice of subject stated that she encouraged her daughter in the subjects she (the daughter) liked and in which she performed well. Others stated that while they left the choice to the children themselves, they expected them to have some guidance from teachers on this issue of choice.

Parents provide their children with cultural capital by transmitting the skills, values and knowledge needed to succeed in the current education system (Bourdieu &Passeron, 1990). Schools A and C are single-sex girls' schools and schools B and D are mixed-sex; it is both noteworthy and encouraging that the parents give equal importance to the study of science irrespective of the gender of their children (cf. Koballa, 1990; Andre *et al.*, 1999). Though the choice of subjects and eventual career trajectory are critical moments in the educational development of their children, parents in this study on the whole leave the choice to their children. Overall, 87 out of 112 parents claimed that they do not influence their children in choosing their subjects. Peer and teacher influence can be both an asset and a liability if proper choice is not made at that crucial moment. Adolescence is an important transitional period in the life of young people and one wonders whether a right choice is made at that time if proper guidance is not provided. Parents who state that they do not influence their children justify their stance by convincing themselves that their children are capable of making the right choice because the latter are more aware of their potential. Parents are perhaps conscious of the fact that adolescent girls are creating or developing their own identities and their choice of academic subjects should be left to them (Solomon, 2003). Furthermore, it is possible that women scientists, teachers and peers could be having an effect on the interest of girls in academic subjects and influencing their choices (Bleeker & Jacobs, 2004). Breakwell (1992) suggests that peers may be influential in the choice of subjects to a certain extent but points out that it is not a dominant factor.

The results for the four schools suggest that parental influence on the choice of subjects, at least in the parents' view, is not a strong factor in the choice of science subjects. Furthermore, there does not seem to be any difference in the results obtained from the four different schools. Other studies have shown that girls generally tend to pay more attention than boys to the advice of their parents when choice of subjects and career are concerned (Dawson & O'Connor, 1991). Additionally, perceived supports from parents, teachers and adults that girls trust have been found to be important reason for girls' choice of science subjects (Kelly 1988). The findings from this study indicate that the majority of parents leave the choice of subjects and careers to their daughters with the belief that they may be sufficiently guided by the schools and confident of their daughters' capabilities in the subjects of their choice. Further discussion on the issue of parental influence will be presented in Chapter 7.

Chapter 7

Discussion, conclusions and further work

> Boys learn better; they are given all the opportunities, probably more opportunities than girls. They are to be the breadwinner in future while girls are to be married off in the majority of cases (Teacher F1 in school A).

7.1 Introduction

The aim of this study has been to investigate the factors which encourage or inhibit girls to study science beyond the compulsory level in Mauritius by seeking answers to the following three research questions:

1. How is science taught at Form III level (the last year at which science is compulsory) in the case study schools in Mauritius?
2. Do parents influence the choice of science subjects in Mauritius and if so how?
3. What are the factors that influence girls to study science beyond the compulsory level in Mauritius?

The discussion of the current international literature about gender issues and science education in Chapters 1 and 2 shows that science, more particularly physics, is generally not popular with girls after compulsory level of schooling and this has been a matter of concern among researchers and educators in many countries. With the exception of a few countries notably Botswana, Malaysia, India, Uganda, China and Poland, this is almost a worldwide phenomenon (ROSE Project, 2005). The gender and science problem has mostly been discussed in developed countries and data are still scarce in developing countries and newly developed ones.

The focus of this study is on girls and my intention is not therefore to compare boys and girls; I am simply looking to see, in single-sex and in mixed-sex schools, what makes girls more likely to continue with their studies in science at the end of compulsory level in Mauritius. As discussed in Chapter 1, an increased enrolment of girls in science and technology at the point of choice will help to sustain gender equality policies regarding scientific literacy and provide a critical mass of scientists and technologists needed to contribute towards national development in Mauritius (MRC, 2004). As discussed in Chapter 2, the lack of in-depth Mauritian research relating to girls' choice of science subjects has serious implications for a balanced development and representation of both genders in the country. Gender policy in Mauritius advocates gender-equitable treatment at all levels including the schools. Though there is a policy of equal access to secondary science education, male pupils tend to outnumber females in these subjects at the point of choice (CSO Statistics, 2010; MES Statistics, 2010).

In this chapter, I focus on the findings of my research and discuss them in relation to my research questions, relate them to previous work reported by researchers in other countries and finally develop a conceptualisation of what needs to be implemented in Mauritius with regards to gender and science problems. As noted in Chapter 3, the goal of the classroom observations, interviews and parents' questionnaires was to achieve a better insight and understanding of the factors influencing the choice of science subjects at Form III level. The data obtained from the different methods show that gender is a cross-cutting issue; school factors, socio-cultural roles, philosophical clashes about western science, modernity and national imperatives have been considered; additionally, data from the parents' questionnaires help to shed some light on their perceptions of science and their influence on their daughters' on choice of subjects and career. The findings of this study provide answers to the three research questions that guide this study into the factors which influence girls to choose or not to choose science subjects beyond the compulsory level in Mauritius. As presented in Chapter 2, Figure 7.1 illustrates the theoretical framework on which this study is based and this includes the following:

- Self-identity (self esteem, confidence)
- Pedagogic reinforcement (teaching and learning)
- Social roles (of teachers, parents, peers)
- Philosophical clash (modernity, nature and culture of science) and
- National imperatives (scientific literacy, skills needed at national level).

There are many under-researched areas in Mauritius in the theoretical framework. I am not claiming that I can examine equally each level of the framework given at Figure 7.1 but as this is school-based research, I am dealing principally with what is actually happening in that setting.

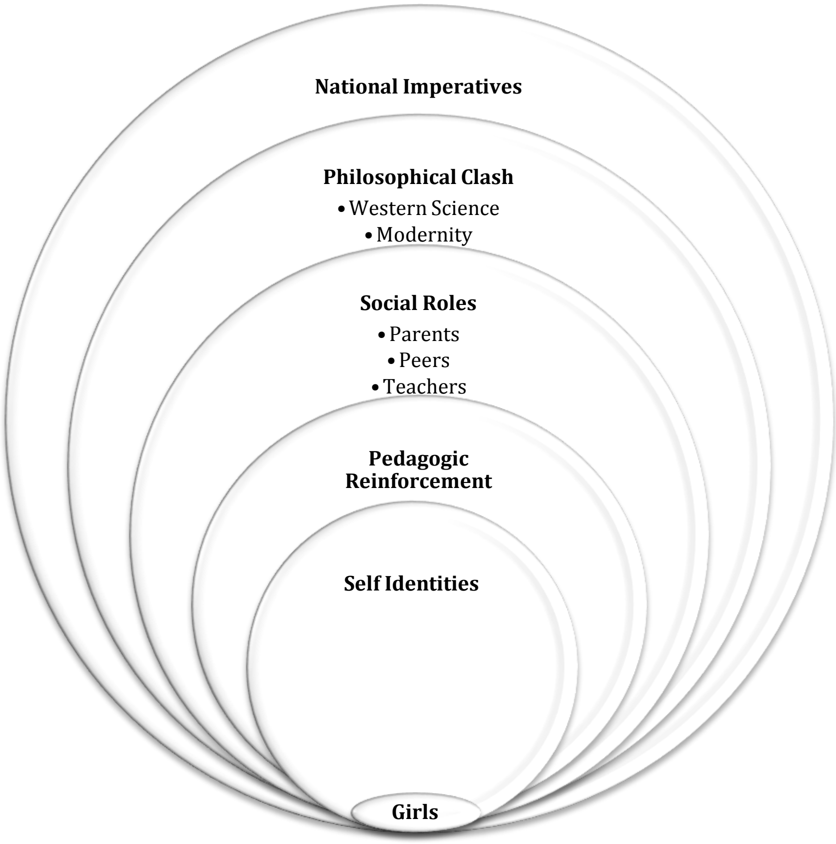

Figure 7.1 Tentative theoretical framework on which the present study is based.

As first presented in Chapter 3, Table 7.1 sets out the research questions, the methods used to answer them and the main outcomes of the analysis of data.

Research Questions	**Methods used**	**Main outcomes of data analysis**
1. How is science taught in Form III (the last year at which science is compulsory) in the case study schools in Mauritius?	Observation of lessons Pupils' interviews Teachers' interviews	Teaching approaches especially. chalk and talk method, practical work, project work; behaviour of teachers and pupils and use of resources.
2. Do parents influence the choice of science subjects in Mauritius and if so how?	Parents' questionnaires	Parents' experience, perceptions of science and influence on the choice of

		subjects and career; other influences.
3. What are the factors that influence girls to study science beyond the compulsory level in Mauritius?	Observation of lessons Pupils' interviews Teachers' interviews Parents' questionnaires.	Pedagogy, relevance of science topics, behaviour of teachers and pupils, learning style, image of science, role models, self-identity and socio-cultural factors.

Table 7.1 Summary of research outcomes from the research questions and the data used.

7.2. Research Question 1

How is science taught at Form III level in the case study schools in Mauritius?

The findings from this research show that girls' alienation from science is due to several factors but that the pedagogy of science is found to be the most important factor. Observation data indicate that teaching of science in the case study schools varied from traditional class teaching, where the teacher uses questioning techniques to draw out pupils' ideas to explore and extend their thinking, to class discussion, demonstration, some practical work, copying notes which were either dictated or from the whiteboard, use of textbooks and project work. Of this wide range of teaching methods, questioning and answering tended to predominate in all four schools more particularly in physics, biology and to some extent in chemistry lessons. Studies carried out by various researchers have shown that use of appropriate pedagogy helps in the understanding of science concepts (Reiss, 2000; Osborne & Collins, 2001; Osborne, *et al.*, 2004; Frost *et al.*, 2005) and encourages girls' participation in science.

The classroom observations showed that with the exception of some lessons, namely chemistry in school A, biology in schools C and D, science is taught as a whole-class activity with explanations, statements of facts and ideas and feedback on work. The contributions made by the pupils helped the teacher to promote learning, but there was little opportunity for critical thinking. In the lessons I observed, teachers used a mixture of open and closed questions and thus there was very little intellectual challenge for pupils. As stated in Chapter 4, in school A, pupils for all three science subjects were taught in laboratory settings; in school B pupils were taught in classroom settings; and in schools C and D pupils were taught physics in classroom settings. Though the classroom setting is an indication that science teaching was carried out using traditional chalk and talk methods, many of the science lessons that were observed in the laboratory setting were pedagogically similar to the lessons held in the classroom setting.

Teachers seemed to focus more on teaching than on learning. They acted as dispensers of knowledge, though at times they were facilitators, helping the pupils to construct knowledge through questioning techniques. In the interviews, the teachers argued that though they would have liked to use more activity-based strategies, they had several constraints which did not allow them to do so. These constraints were a lack of laboratory facilities, overloaded syllabuses and large class sizes. The excuses given by the teachers are not entirely convincing for a number of reasons. First, according to the Ministry of Education's policy, all secondary schools are expected to be adequately equipped for practical work in biology, chemistry and physics. In the case of school B, the laboratories were still under construction; similarly, the physics laboratory in school C and D were in the process of renovation. The second reason given by teachers for not doing practical work is large class sizes; there were 35 pupils in each class observed in the four schools. However, group activities could have been organised to engage the pupils in biology, chemistry and physics; there were examples of group work in chemistry in school A and D and in biology in school C, but not in school B. The teachers could have easily changed the setting by moving the chairs in school B and groups of pupils could have carried out some activities together. A third reason given by the teachers for not involving the pupils in activity-based activities was that of an overloaded syllabus; teachers tended to teach in a didactic way without much thought about engaging the pupils in active learning. Most of the lessons I observed were textbook-driven where teachers and pupils read the information in the textbooks and the teachers explained the concepts. Though such an approach may work with some pupils, it is time consuming and this results in the teachers not being able to cover the syllabus in the allocated time.

Multiple teaching strategies can help to develop pupils' interests and remove negative emotions they may have towards science (Reiss, 2000; Osborne and Collins, 2001). Pupils expressed dissatisfaction because of the kind of teaching they were receiving during their science lessons which were too didactic and did not involve them much in practical work. The teachers confessed that they would have liked to involve the pupils in hands-on activities but were compelled to teach in a didactic way. I wonder to what extent the reasons given by the teachers are valid. It seems that teachers are trying to justify their practices for using the traditional chalk-and-talk method. In fact, there seems to be little will on the part of the teachers to change their pedagogy. As shown in Table 5.3, the science teachers in school B lacked experience in pedagogy and from the observation of lessons it was noted that the physics teacher had very little classroom control. Pupils found the lessons in science boring. They learned mainly by rote and even in the non-science lessons the pupils tended to memorise notes given by the teacher; for example, Teacher F6 in school A elaborated that she dealt with the economics and accounts lessons by using questioning techniques in accounts but admitted that she gave notes to the pupils in economics, contrary to her intentions. Occasionally, discussions and interactions took place during her lessons. A similar teaching approach was used in the non-science lessons in schools B, C and D.

Both boys and girls in the interviews indicated their dissatisfaction and displeasure with the way science was being taught in their schools. As pointed out in Chapter 5, girls in school A stated their lessons in biology and physics were taught in the traditional chalk-and-talk method most of the time. In school B, the pupils claimed they had a better understanding of science concepts when they were taught through activity-based methods. Similarly, in schools C and D, the teaching of physics was teacher-centred; however, girls had the opportunity to carry out practical work in biology in schools C and D. As discussed in Chapter 5, the pupils stated they would prefer a learning approach which is hands-on and participatory so that science could appear enjoyable and appealing to them. Both boys and girls value interactive practical work as stated earlier but the focus of this study is on girls; the findings of the interview data regarding the value of activity-based methods in engaging girls in science are in agreement with the findings of Wellington (2000), Hart (2002) and Angell *et al*. (2004). Sharp (2004) further emphasises the value of practical work though Millar (2008) and Abrahams (2009) argue that it can be given too much emphasis in science lessons and emphasise the need for it to be accompanied by appropriate talk. The boys in school B and the girls in schools A, B, C and D expressed great concerns about the limited number of experiments in chemistry and total absence of experiments in physics. They asked for more *hands-on activities.* There is a need for teachers to change their teaching strategies in order to motivate the girls to continue with science.

The interview data indicate that collaborative learning appeared to be favoured by girls in all four schools (Tippins & Nichols, 1995; Matthews & Sweeney, 1997; Abell *et al*., 2000 and

McNeill *et al.*, 2006). The observation data showed that group work gave the opportunity for pupils to cooperate with their peers in schools A, C and D but was absent in school B. The girls in school B complained that there was *No group work in science* whereas the girls in school C said *they enjoy group work* though the teacher of physics in school C is of the opinion that *the girls are competitive and do not like to share their knowledge* with their peers. In school B, competition between the boys and the girls was an issue which encouraged the girls to work hard, a point which was reported by girls and confirmed by the physics teacher and the chemistry teacher: *Competition with the boys encourages us to work harder.* The evidence from the interview data shows that the chemistry teacher even encouraged the competitive spirits of both girls and boys. Inquiry-based experiments in groups gave the pupils in schools A in chemistry, C in biology and D in biology and chemistry some experience of how scientific knowledge and understanding could be developed by carrying out investigations in a team spirit. However, it must be noted that the absence of group work in school B could not be due to the physical setting of the classroom but more to the inexperience of the teachers; school B actually has more freedom to arrange the tables and chairs for group work. Girls sat with girls and boys with boys and this gender segregation could have contributed to the lack of interaction between the boys and the girls; the teachers in school B made no attempt to encourage collaborative work in biology and physics. To some extent, class participation which was observed in chemistry lessons in schools B and D contributed to making the lessons interesting, a point which Acar and Leman (2007) noted in their study. The teachers reported that class discussions which took place among the pupils in schools B and D were mainly in single-sex groups, boys with boys and girls with girls. In the non-science subjects, group work was an occasional feature as exemplified by the accounts teacher in school D: *Sometimes, I make them work in groups at times.*

The biology teacher in school D was an exception; he tried to make use of available materials that pupils brought into the lessons and tried to involve them in practical work in biology as it gave the pupils the opportunity to engage in some hands-on activities: *I carry out demonstrations and involve the students (during the demonstration activity); this gives the students a chance to handle apparatus and they do it in turn*. On the other hand, the physics teacher M8 complained about the lack of laboratory facilities in his subject area and justified the teaching methods he used: *I use questioning techniques a lot; try to find out pupils' knowledge and difficulties. I do demonstration at times, give them examples which I work out* *on the board and give problems to solve by applying what they have understood. There is no physics laboratory at the moment; it is being renovated, so I use the chemistry lab for demonstrations. Most of the lessons are held in classroom.* The statements from pupils in school D corroborated the teachers' reports; they did some class practicals in biology and chemistry. Despite all the efforts made by the biology teacher, the girls are not opting for science subjects but choosing accounts. This suggests that there is a limit to what pedagogy on its own can achieve.

Teaching approaches were suggested by teachers and also by pupils to be important factors inhibiting pupils' understanding of science. It is clear that in spite of the necessity for different skills required in science, such as critical thinking, reasoning, and problem-solving, didactic teaching approaches and rote learning appeared to be very common for both boys and girls. Learning is perceived as a memorisation of facts. The teachers' interview data in schools A, B, C and D show such a teaching/learning approach. Indeed, this learning style is confirmed by Teachers F1 and F6's statement: *Pupils memorise notes … but they should not. Notes are given to help them understand new concepts in the topics*. Similarly, in school A, the physics teacher M1 cited *the girls learn by heart* and that though *there was no difference in the learning style of boys and girls*, he felt that from his personal experience, girls tended to find calculations difficult. Rote learning is evident in the statements of teacher M7 in school D: *there is no difference in the learning styles of boys and girls. I have not noticed any. They learn in a rote fashion*. In school C, the pupils similarly reported that rote learning was used: *Rote learning as notes are given in biology and physics.*

Gurrian and Ballew (2003) noted that both boys' and girls' achievements can be improved if their different learning styles are taken into consideration.Teachers' attitudes towards the girls and boys differed in school B. Differential treatment of boys and girls by teachers was noted in this school where boys received more attention in physics lessons because they tended to call out the answers or they were preferentially addressed or received attention by the teacher (cf. Spender, 1982; Spear 1985;Tobin, 1988;Delamont, 1990; Labudde, 2000; Reiss, 2000). This conforms to the work of other researchers where female students were found to be quieter (Fennema *et al*., 1980; Morse & Handley, 1985). Boys dominated in the mixed-sex school B; generally, teacher praise and encouragement were not directed to the girls; this was especially evident in school B. Boys by raising their hands more than the girls tried to get teachers' attention; girls who seemed to have more anxiety learning science would have benefited had the teachers given them some praises or encouragement. The observations of lessons and the pupils' interviews indicate that the physics teacher did not have much classroom control. His inability to control could be attributed to his lack of professional training in pedagogy. As noted in Figure 7.1, pedagogic reinforcement is clearly a very important factor in developing an interest in science. How teachers can enhance pupils' learning should the dominant concern of teachers (Wellington and Ireson, 2008).

It is to be noted that the nature of student-teacher relationships is important and it was evident that the attitude of the physics teacher towards the pupils was not very encouraging in school B because he failed to make the lessons appealing and interesting by not making use of appropriate strategies that would create a more conducive learning environment. This is considered to be an important factor if learning is to be enhanced in physics (Krogh & Thomsen, 2005; Murphy & Whitelegg, 2006). Remarkably, in school D, both boys and girls were reported to respond equally to teachers' questions but according to these teachers *they say what they want whether it's right or wrong.*

Overall it is clear that the girls in the four case study schools expected to be engaged in practical work and activity-based methods of learning science and were frustrated by the teaching methods used by their teachers in most lessons. They tended to memorise notes given by their science teachers and this was a feature which took place in the non-science lessons too. Teachers in the schools where science subjects were taught in a traditional way conceded that they would have wished to do so but could not because of practical reasons. The teaching approach employed by science teachers was a very important factor in determining the choice of science subjects. It is essential that girls develop an interest and liking for scientific issues and for this to happen, experiencing science in action using activity-based methods is important for girls.

7.3. Research Question 2

Do parents influence the choice of science subjects in Mauritius and if so how?

As indicated in Figure 7.1, parents play an important role in the education of their sons and daughters. During the interviews some teachers mentioned that parents to some extent influenced the pupils in their choice of subjects**.** As presented in Chapter 6, the parents' questionnaires showed that despite the fact that they had a diversity of experiences during their schooling, some having had the opportunity to study science at primary level only whilst others up to a higher level, parents almost without exception fully supported the notion that the study of science was important.

A majority of the parents stated that they would like their children to take up science after Form III level but to choose or not to choose science was a decision that was in most cases left to the children themselves. The most cited reason was that the pupils were capable of knowing their abilities and their interest in the subjects they were likely to choose. Most of the parents were supportive of the aspirations of their daughters and would like them to choose a career that would give them financial security and satisfaction. Parents trust that their children will make the right choice of subjects possibly through career guidance advice received from their schools. Some teachers claimed that parents were more supportive of their sons' education rather than their daughters'. This does not seem to be the case because the responses of parents show that they are broadly supportive of their daughters. There seems to be a significant mismatch between what teachers and parents are saying. However, in a limited number of cases, it was pointed out by the parents that teachers and family members such as aunt, cousins and uncles had some influence on the choice of subjects. Contrary to the findings of other researchers (e.g. Breakwell, 1992; Dalgetty & Coll, 2004), peers did not seem to have any influence though this factor was mentioned in the teachers' interviews and some parents. Given the fact that the pupils have not reached a state of maturity and as a result cannot be guaranteed to choose what is right or wrong for them, leaving the choice of subjects entirely to them in the absence of counselling and guidance may jeopardise their future career prospects. Though the parents say they do not claim to influence their children in the choice of subjects, their expectation of their daughters' choice could be attributed to values and cultural beliefs which the adolescents may have acquired during their earlier childhood days (Eccles, 1985; Kelly, 1988).

Although it is not the objective of this study to compare pupils' participation in biology with that in the physical sciences, the analysis of the interview data shows that most of the girls in all four schools do not like physics. The girls in schools A and D do not attach much importance to school science and teachers stated that girls are influenced either by parents or peers in their choice of science subjects. The issue of the influence of peers was not evident in this study though peers influence has been stated by researchers to have an important influence on the construction of gender-stereotyped identities in young people on the choice of science subjects by researchers (Johnston & Stelepeng, 2001; Reid & Skryabina, 2003; Dalgety & Coll, 2004).

The findings from the parental questionnaires show that parents believe that girls are sufficiently empowered to make their choice of science subjects and future career; who empowers them is a question which requires further research and is beyond the scope of this study. Again, as shown in the framework (Figure 7.1), there is a clash of social roles between the teachers and the parents.

7.4. Research Question 3

What are the factors that influence girls to study science beyond the compulsory level in Mauritius?

Analysis of the observation and interview field notes and interview transcripts indicates that there existed multiple factors influencing the girls in their decision to choose or not to choose science beyond the compulsory level. These ranged from their experience of school science, which incorporates pedagogy and curriculum, the behaviour of teachers and other pupils, their preferred learning style, the relevance of the science topics they were taught and socio-cultural factors as illustrated in Figure 7.1. For example, observations of lessons in all four schools provided valuable information on the prevailing situation regarding pupils' behaviour and interest in science lessons, including how the lack of experiments and hands-on activities result in frustration and negative attitudes towards science, albeit some of the girls had high career aspirations in science.

Behaviour and interest, terms which were described in Chapter 1, appeared to be other important factors which were responsible for the pupils' intention to choose or not to choose science. For instance, in schools A and B, girls have equal preference for biology and chemistry but not physics for the following stated reasons: *Biology is interesting…Chemistry is easy…physics: I feel confused…we would like it to be taught in a livelier way.* This statement indicates that the girls in those two schools have little interest in physics, evidence which is in agreement with the findings of other researchers (Jones *et al.,* 2000; Osborne *et* *al*., 2003; Miller *et al*., 2006). The girls in school B cited that they found biology and chemistry were *more understanding (to them)* whereas the boys in schools B and D favoured chemistry and physics and seemed not to like biology though they were aware of its relevance to them, as revealed in their statements of the boys in school D:*Our teachers explain well about the study of the human body, diseases, food, care of health, sexual reproduction, drugs and alcohol but we find chemistry and physics easy*. Some of the girls' choice of subjects may be influenced by their interest and liking of biology and chemistry (Reiss, 2000, 2004; Reid & Skryabina, 2003; Osborne *et al*., 2004) whereas the boys showed a preference for physical sciences (Murphy, 1986; Whyte, 1986; Dawson, 2000, MES Statistics, 2010).

Girls tend to see that the physical science is a gendered subject having a masculine image, objective and remote from the affective aspects of knowledge (Keller, 1985; Watts & Bentley, 1993; Harding & Parker, 1995; Rennie, 2002). On the other hand, girls perceived biology to be more 'feminine' because of its personal relevance to their everyday life. The girls in school A had a negative image of science; they stated that most scientific discoveries are done by men; they reported on this aspect in the following statement: *Science has a masculine image; see more men doing science.* The girls in all the four case study schools maintained that science occupations were not predominantly for males; indeed this point was strongly pointed out by the girls in school C – they deplored the fact that women are often depicted in menial occupations such as working in the fields and factories. Notably, the girls' perception of science in school C was different from that of the girls in the other schools: they were of the opinion that: *Women can be good scientists. Girls can equally do well as boys in science*. In school C, teachers acknowledged the fact that the use of appropriate pedagogy would encourage the girls to do science (Eisenhart & Finkel, 1998; Osborne and Collins, 2001). At the same time, in spite of finding science difficult, the girls in school A and D remarked that *both girls and boys can do it.*In regard to their preference for science topics, the majority of the girls in all four schools stated that they liked biology because they wanted to learn more about themselves, plants, animals, the environment and health issues (Christidou, 2006; Miller, 2006). Only two girls in school D found biology difficult because the words were strange to them.

In all the four case study schools both teachers and pupils were aware that familiar examples related to the everyday lives of the girls helped the latter to be interested in science (Hoffman, 2002; Baker & Leary, 2003). Physics was alienating to the girls because very often, the examples used were related to tools with which girls were less likely than boys to be familiar such as spanners and mechanical devices (cf. Osborne and Collins, 2001; Angell *et al*., 2004). The physics teacher in school C made some attempts to use examples like electric iron, kettles and other objects familiar to the girls. The teachers stated that the boys had no difficulty in understanding physics concepts when tools and mechanical devices were used as examples in their lessons.The relevance of school science to the lives of pupils, more particularly girls, has been argued at length. Familiar relevant real world themes have been found to interest girls in science (Kelly, 1987; Rosser, 1993; Baker & Leary, 2003; Bystydienski, 2004; ROSE project, 2005; Christidou, 2006; Jenkins & Pell, 2006). This point was evident in all four schools. For example, Teacher F1 in school A commented that the pupils in her lessons seemed to show interest in science when the topics taught have some relevance to the environment and health: *Examples relevant to life such as health and environmental issues.* This view was echoed by other teachers. In school C, the pupils cited topics such as *pressure in physics; reproduction, transport system in humans.* In school D, both boys and girls liked examples relevant to life, e.g. environment and health. Boys like social issues such as smoking, drugs. Interestingly, even the accounts teacher M10 reported that he used *examples which are familiar to them in their life, such as keeping a ledger, about profits, losses and about bank accounts.* Recent work by Oon and Subramanian (2010) carried out in an Asian setting, further supports the findings of earlier researchers regarding the low interest of girls in physics. Though Mauritius has a mixture of cultures like Singapore, it has a different historical past which cannot be compared with Singapore.

7.4.1 Self esteem

Figure 7.1 illustrates self esteem as one of the factors that are necessary if girls are to take of science subjects after the compulsory level. Teachers in all four schools stated that girls lacked confidence in science subjects but had the potential to perform well in science. The physics teacher in school C claimed that girls worked hard and could do well in physics but had a low self-concept: *Most girls are better in physics; they get high marks: highest is 97%; average is 50%. There is no difference in boys and girls; they are the same abilities; Interest in physics is the same for both. Girls work harder and are quieter but they lack confidence.* However, it was found that most of the girls who were interviewed held science in high esteem; this was evident from their future career aspirations. They wanted to be doctors, pharmacists, veterinarian, dieticians and teachers. The boys in the sample had a preference for chemistry and physics but disliked biology and aspired to become engineers, architects and even doctors, which in Mauritius is a prestigious occupation. Only two boys in school D stated they would like to choose a career which was not in the field of science; they both wanted to become policemen. The majority of the girls in schools A and D stated that they found accounts subject to be easier than science subjects and were more likely to choose accounts though they acknowledged the importance of science in everyday life. The teachers in these schools professed that the results in accounts are better than in science subjects and the girls were influenced by these results in deciding which subjects they were to choose at Form III level. In school D, science does not seem to be a popular subject among girls because of the poor examination results obtained. Difficulties experienced by some girls in mathematics were cited as obvious reasons for not liking physics. Girls in school C stated that their mathematics teacher was not very *nice* but they worked hard in that subject because they were aware that they should have good mathematical skills in order to perform well in physics. The account teacher M10 stated that *boys go more for physical sciences but the girls are more attracted to accounts.* The physics teacher pointed out that the boys in school D *like physics because it helps them to understand about appliances, fuses as some of them wanted to become electrician and mechanic*. It is worth noting that despite the low interest in science subjects, chemistry enjoys a better status in this school as the pupils' performance in the examinations are better than in the other sciences. There are additional classes after school hours for those taking science subjects to consolidate the work done during normal school hours. The teachers in school D stated that pupils are forced to do science to make up for the low numbers choosing science. The pupils in school D articulated their negative interest in science in the following ways: *I don't like studying science. It is difficult … Biology is difficult to understand at times.* In such cases, teachers ought to find out what kinds of activities are likely to generate interest in science lessons in order to dispel such negative attitudes. These sorts of activities have been extensively discussed in the works of Cerini *et al.* (2003), Braund & Reiss (2004) and Osborne *et al*. (2004).

On the other hand, brighter students in schools B and C and D were interested to pursue science-related occupations such as doctors, engineers and veterinarian; a trajectory which will undoubtedly be beneficial for the country's national, social and economic development

(Robinson & Gillibrand, 2004; Jugessur, 2008). Pupils at that level need the encouragement of their teachers, parents and counsellors so that they perceive the importance of science and become more motivated and interested in science. In the single-sex school C, where the intake is from higher ability, socio-economic and cultural backgrounds, the girls seemed to be more polarised towards science (Haussler & Hoffmann, 2002); this was not the case in other single-sex school A which had an intake of pupils of average ability.

Assumptions about gendered identities were other factors which came out in this study. These identities are both social and personal. For example, in school A, teacher F1's comments are indicative of the situation of girls in that particular school: *Boys learn better; they are given all the opportunities, probably more opportunities than girls. They are to be the breadwinner in future while girls are to be married off in the majority of cases. At age 15 many of them are engaged. There is a cultural influence. Parents influence their son's education and career. The girls who are choosing to study science are good in science. But it is sad that sometimes the best ones are not choosing science.* The cultural influence of parents on the girls' choice of science subjects was emphasised by the chemistry teacher F2 in school A but this was not evident from the parents' responses in the parental questionnaires. The chemistry and physics teachers in schools B and C were of the opinion that girls lacked confidence; in school B, the girls were reported to be intimidated by the boys: *boys laugh when girls try to answer*. This point is confirmed by the physics teacher in school C: *Girls lack confidence … shy and have the feeling of being ridiculed by others.* The teachers' views about the girls' identities tend to conform to their gender and social role.

In school D, teacher M10 articulated the following statement regarding the subject of accounts: *They (girls) like doing accounts; out of 80 pupils taking the accounts exams, only 20% fail at Form III level. That shows that the performance in accounts is reasonable.* When asked whether boys tended to dominate in his lessons, he replied that the boys were generally not very vocal as was the case in school B: *They both answer questions. They say what they want whether it's wrong or right.*

As shown in Figure 7.1, there may be a philosophical clash between Western science and local culture. Parents from certain cultural and social backgrounds may exert an influence on whether pupils choose or opt out of science. By virtue of their social origin or ethnicity, some pupils may find Western science not in conformity with their identity (Aikenhead & Jegede, 1997; Aikenhead, 2001b). The parents seem to be more open on this issue whereas the teachers are more closed in their perceptions. This point did not come out very clearly in this research and may need further probing given the multicultural diversity of Mauritius. In schools A and D, with regard to socio-cultural factors, teachers pointed out that parents exert some influence on the choice of subjects. Studies carried out by Andre *et al.* (1999) and Carlone (2004) indicate that socio-cultural factors are influential. Teacher F1 felt that this was the case in her school: *Parents influence them in their choice of subjects; background of pupils is important…cultural influence is there too. Parents influence their son's education. Girls can do secretarial jobs and book keeping … they can set up a business after studies*. However, this does not seem to be the case in all four case study schools. Beliefs and values tend to vary with the socio-economic and cultural background of parents and their children; this is an issue that needs to be looked into in another research. Schools A and D are located in a catchment area where the majority of students are from a multicultural semi-urban background where cultural beliefs are entrenched and their interest in science is different compared to schools B and C which have a student population who are more academically motivated and where their cultural identities have a lesser priority, perhaps due to the influence of modernity in their background. Societal development has been found to influence learning in science (Giddens, 2001) in Western countries and this may be true in Mauritius too.

As the framework in Figure 7.1 points out, in the interest of the nation certain imperatives have to be followed; Mauritius as a fast developing country has witnessed economic and social growth and much emphasis is being placed on providing equal opportunities to both boys and girls. Modernity is an important issue in a current transient phase. The country is facing many challenges due to modernisation and young people's ways of thinking and social patterns are influenced mainly by Western societies but cultural diversity could account for perceptions to vary in different communities (Sjoberg & Schreiner, 2005). Some learners may have their own sense of the world and cultural differences may impact on their learning of a science which has a Western construct and is culturally less relevant to some pupils. In the latter case, contextualised science learning would be more meaningful by taking into account real-world problems and being grounded in the social and local constructivist perspective. There is a lack of evidence on how culture and social roles impact on the learning of science in Mauritius; girls in Mauritius are becoming more fashion-conscious using film stars as role models. In developing countries, it is felt that a culturally relevant pedagogy, with the belief that knowledge of local cultures is integrated into the learners' familiar environment, would make science more appealing to the learner (Jegede, 1997; Aikenhead, 2003). There would thus be a linking of science content with the culture.

Regarding the influence of role models, there was variation in the findings. There are certain attributes that women bring to science which could encourage girls to study science (Bentley & Watts, 1986). Though some girls would have preferred to be taught by female teachers for biology, others felt that the gender of the teacher was not important: *they should be friendly character and teach us to like the subject. Teaching style of teacher is more important* (cf. Eggleston *et al.*, 1976; Buck *et al.*, 2002). As pointed out in Chapter 5, this view was strongly expressed by the pupils, boys and girls equally, in school B where the chemistry teacher is female*: In chemistry we relate more to a female teacher. She is like an idol; we try to imitate her. In physics, we would like a female teacher. We are encouraged to study science. Chemistry teacher is a role model.* In school C, similar views were held by the girls who said that they like their physics teacher, a male: *Teacher should be friendly and be a role model*. Boys in school D had a preference for male teachers in science whereas girls in schools A, B, C and D preferred female teachers for biology, especially for topics like reproduction. Female role models have been reported by researchers to be associated with a mother figure (Keller, 1986; Hoffman-Barthes *et al.*, 2000). In all four schools female role models in physics are conspicuously absent. This might be another factor that deters the girls and leads them to finding physics difficult and alienating. Girls in school C expressed the view that women should be shown *as scientists and engineers so as to inspire them.* The teacher of chemistry in school C stated that she tried to motivate and interest the girls in science by using herself as a role model: *I tell them... what I did before, how I studied science and where this has brought me, this inspires them and motivates them to study my subject. I also talk about the importance of science to themselves and their life.* She pointed out this had a positive effect on some students who earlier had no intention of choosing science. Talks and narratives of women doing science and those involved in engineering fields can serve as real life examples to girls to pursue careers in science (Murphy *et al*., 2006). It appears that the prevailing culture in the school is for bright girls who are good at mathematics to choose physics.

In this study, choice of science subjects does not seem to be related to the Mauritian culture which is ethnically and religiously diverse. Though there are certain factors which can be changed, there are elements in the Mauritian culture which cannot be changed (one cannot change one's ethnicity or country of origin, for instance). Furthermore, time limitations prevented me from investigating whether such factors had any effect on the choice of subjects.

Regarding extracurricular activities, it was found these were not organized on a regular basis in all the four schools; on the rare occasions where these took place, learning and interest in science seemed to be enhanced. Girls in schools A, B, C and D stated that they enjoyed engaging themselves in outdoor activities in Environment projects such as Arpege and visits to Rajiv Gandhi Science Centre. Informal classroom-based contexts have been known to make an important contribution to learning in science lessons. The impact can be significant and long lasting (Braund & Reiss, 2004). For example, in the affective domain, outdoor activities can be enjoyable and there can be a desire to discover new things and try to know more about them. Furthermore, working in a natural context can prove stimulating and the experiences gained in such natural setting could be valuable and rich. Extracurricular science interventions have been known to result in increased positive attitudes, better science performance and decreased gender stereotyping (Hong *et al*., 2008). Indeed, Teacher M1 felt that it would *make science more relevant to them; take them on educational visits*. This opinion was voiced by other teachers too but administrative and logistics appeared to be problematic. Educational programmes on the media were useful in some cases but it was reported that girls had very little time to watch them because of their heavy schedules and private tuitions. The teachers pointed out that girls were found to show a keen interest in homework and projects.

7.4.2 National imperatives

National imperatives (Figure 7.1) aim at transforming the country into a knowledge hub in the region and improving scientific literacy (MRC, 2004; Jugessur, 2008). Though many educational reforms have had the objective of improving science education in Mauritian schools to improve scientific literacy, so far, they do not seem to have brought significant improvements in the gender aspect of science education; the straightjacket approach to the teaching of science fails to engage many girls in science at age fourteen. Given the low interest of girls in science, more particularly physical sciences, it is imperative for the Mauritian education system to pay close attention to girls and the science problem. Increasing the interest in science and improvement of scientific literacy by providing more opportunities for girls to explore science through hands-on activities such as experiments, investigations and projects in school would be one of the answers. The utilitarian aspect of the importance of science was voiced by Priya in school B: *We need scientists so that the country can be more developed as we also need to know more about what is happening around the world and about ourselves.* This remark indicates the awareness among the pupils of the critical need for human resources in science to face the challenges both at the individual and national levels. It is therefore imperative that more attention is given to the pedagogical aspect of science and resources needed to facilitate learning of science. As stated earlier, resources appeared to be the main reason given by the teachers for using a textbook-centred teaching during the lessons. Use of ICT to facilitate learning and encourage interest in science has been initiated: one example is the data logging project introduced in 10 pilot schools. The Ministry of Education intends to provide computers to all schools so that access to Information Technology is facilitated. Training of teachers to use ICT is already under way but ICT-based lessons in science may only appeal to ICT literate girls and may not reflect real-life examples which girls find interesting (Oon and Subramanian, 2009a, 2000b).

The current lower secondary science policy has been in existence since the late ‘70s after science became compulsory from Forms I to III and a common secondary curriculum in science was introduced in all schools. The curriculum has been reviewed and updated almost every five years but science education still does not seem to be popular at upper secondary level. There is a need to update the curriculum so that it becomes more contextual and gender friendly to girls so as to improve their opportunities to participate at all levels of society and meet the present day challenges of globalization. Compulsory science is being introduced on a pilot basis in some secondary schools to promote scientific literacy of pupils; females make up 52% of the Mauritian school population and it is high time that science is taught up Form V level using appropriate strategies so the girls can be at the competitive edge of development (Education and Human Resources Strategy Plan, 2008-2020; OECD, 2011).

7.4.3 Implications for policy

The Education and Human Resources Strategy Plan 2008-2020 of the Ministry of Education, Culture and Human Resources (2008, p.9) has emphasised the need for major reforms in the current education and training sector. Education is highly regarded as a key element of economic and social development in what is a small geographically isolated island state and an educated population is believed to lead to economic progress and an increase in the country’s wealth. As pointed out in the in the abovementioned plan, earlier initiatives such as the Master Plan on Education (1991) failed to respond to the new demands which were set by a shift in the economy from a mostly agricultural to a more industrial and diverse one (p. 21). As shown in Chapter 1, the statistics regarding the enrolment of girls in science subjects beyond the compulsory level are not very encouraging despite efforts made by the Mauritius Research Council (2004) and initiatives by local researchers in the field of science and technology. Mauritius is well situated because of its proximity to the Sub-African sub-continent to serve the countries in the region by becoming a knowledge hub and achieve its goal of economic competitiveness and social development; there is an urgent need to make full use of the potentials of girls and women in the national population. Neglecting the untapped talents of the female sector of its population will be detrimental to the creation of wealth and run the risk of Mauritius falling behind in this knowledge-based world. As shown in Chapter 1, though gender gaps in participation are narrowing in some areas such as chemistry and biology, there still exists a need to increase the number of girls who enroll for science subjects; those girls who are opting out of science may not be able to realise their potential and they represent an important untapped human resource. Mauritius cannot continue to deprive itself of the full scientific potential of almost more than half of its population. Rapid changes at societal and economic levels are bound to call for a scientifically literate population and a more knowledgeable and skilled workforce in future; currently under-represented groups such as girls and women would be a potential solution.

This research has shown that Mauritius will be better able to meet future challenges by supporting more girls to study science beyond the compulsory level so that eventually more women would enter the science and technology professions. Additionally, as Mauritius is aspiring to become a knowledge hub in the Sub-African continent (Education and Human Resources Strategy Plan 2008-2010, p. 126; Jugessur, 2008), the development of human capital especially of girls in the scientific field is a necessity. The newly-styled Ministry of Gender and Equality should ensure that greater efforts are made at the education level to recruit more girls into science and encourage gender mainstreaming so that more women are recruited in scientific fields and thus meet national needs and enable the country to progress. Though there is a pilot-based project to make science compulsory up to Form V level (age 16), so long as the pedagogical approach adopted by teachers and rote learning method by the girls do not change, girls' engagement in science will not change greatly. Their lack of confidence and their perception of science as a male domain will remain unchanged and this will inevitably impinge on their eventual choice of subjects. From my personal observations in schools since the data were collected, it appears that though there is something of a paradigm shift in Mauritian society and economy, the teaching of science in schools has not improved and traditional chalk-and-talk methods still dominate science teaching and learning. A more gender-friendly science curriculum reflecting real world themes and applicable to everyday life could help promote an increased interest in science (ROSE, 2005). Policy makers must also recognise that appropriate pedagogy in science education in the early years at primary level enables children to unpick concepts and gradually scaffold knowledge and understanding of science concepts at secondary level.

Gender issues need to be recognised by teachers both at initial teacher education (Skelton, 2007) and in-service teacher training and their real concerns should be to increase the number of girls choosing to study science beyond the compulsory level. In this study, it became apparent that a majority of the science teachers were not aware of gender-friendly strategies to make science more interesting to girls at the lower secondary level of education in Mauritius (cf. Murphy & Whitelegg, 2006). Though there are some initiatives in this direction by including a module on ‘Gender issues and science education’ in the teacher education courses at the Mauritius Institute of Education, the teachers do not seem to have made great use of them in the lessons I observed, some stating that they were unaware of gender issues. This study has shown that apart from the pedagogical factor, issues such as girls’ identity, teachers’, parents’ and peers’ role and the nature of science could be other contributory factors (Figure 7.2). For girls to find science more interesting and engaging, there are two important things that must change: firstly, good pedagogical practice by teachers in recruiting more girls to science should be rewarded by performance-linked incentives such as an award, an increment in their salary or a promotion. Secondly, curriculum materials could be developed to sensitise teachers on gender issues in science education and have examples of women acting as role models in the scientific and technological fields. Through workshops involving teachers, relevant ministries and NGO’s, the issue of gender and science could be discussed and relevant programmes and projects could be initiated and implemented in schools. Improved pedagogy and instructional materials would contribute in a certain way to improve the scientific literacy of girls by enabling more girls to enroll for science courses and follow career paths in the scientific and technological fields and eventually participate equally as males in national development.

This study has used a research approach which has shed light on the reality of the science classrooms and other relevant factors in the four school settings. In Figure 7.1, I presented a tentative theoretical model for this study and the answers to the three research questions show that it is difficult to disentangle which factors are more important than the others. As a science educator in Mauritius, I approached the whole study hoping to explore why girls are discouraged from taking science subjects beyond the compulsory level. In that sense, the research has a clear aim. By objectively undertaking classroom observations and transcribing the interviews and describing all phases of analysis and interpretation with my supervisors, I made every effort to ensure that the findings are objective, free from bias and will stand up to critical scrutiny by others.

7.5 Conclusions

This study has illuminated a number of aspects about girls and the issue of the choice of science subjects in Mauritius after Form III (the last year at which science is compulsory). Though the research was carried out in only four schools in Mauritius, it is possible provisionally to generalise from the findings. Mauritian state schools are provided with similar resources and facilities; teachers are appointed by the Ministry of Education on well-established criteria and, as a rule, transferred from one school to another at regular intervals; therefore the answers from the research questions in this thesis are likely to apply to other similar schools, despite the adoption of a case study approach. Furthermore, a common national science curriculum is implemented in all schools and a national science inspectorate monitors the teaching of science in all schools.

During the course of my research, everything that I have learnt indicates that an important factor regarding the low enrolment of girls in science at the end of lower secondary level is the way science is taught in schools. The teaching of science tends to be didactic and dominated by rote learning. Most of the frustrations experienced by the pupils reside in the way science is presented to them; the pupils additionally have to learn and understand a science which fails to use local and familiar examples. It is evident that teachers in all the four schools are more interested in teaching the content knowledge and not paying enough attention to the learning aspect. Activity-based methods such as girl-friendly strategies would have helped to make science more appealing to the girls (Whitelegg, 1996, Murphy & Whitelegg, 2006). I did not ask any questions on the teaching of science to the parents and parents do not observe lessons in the classroom, so parents are unlikely to mention that the way science was taught by the girls influenced their choices of subjects.

Changes in the teaching of science will be crucial to increasing the uptake of science subjects by girls after the compulsory level. The results of this research show that the teaching of science in the case study schools was textbook-based with only limited opportunity for involving the pupils in hands-on and minds-on activities. Moreover, like much of the published literature in developed countries, the girls had a keen interest to study science but they generally found it difficult and uninteresting, in part because of the lack of engagement in practical activities. Indeed, the interview data from the boys in the mixed-sex schools indicated their frustration about the lack of practical work in science lessons but, as I pointed out before, my aim in this research is not to compare the boys with the girls in the lessons I observed. Research has shown that both boys and girls claim to like practical work in science lessons even though its effectiveness in conceptual understanding is ambiguous (Abrahams, 2009). Even Singapore, which boasts of a high level of economic development reflecting a high academic achievement, recent research shows that physics is becoming unpopular (Oon & Subramanian, 2010). Mauritius is using Singapore as a model and one wonders how far this is relevant.

Factors other than pedagogy, namely the nature and culture of science, student identity and parental influence mostly seem to be subsidiary. However, in school C, the situation is different because, even though resources are lacking, science seems to be popular with the girls. Regardless of the teaching approach, of role models, parents and the general culture, it is the esteem in which science is held in the school that was a single important factor for the choice of science subjects. This can be attributed to the school ethos where priority is given to the study of science.

It is encouraging to note that the majority of the parents in the four case study schools valued science education equally for both boys and girls though they maintained that they did not influence their children in their choice of subjects. Some teachers felt that some girls lacked interest in the subject and were more inclined to choose subjects where they could pass easily. Girl-friendly teaching strategies were not utilised by teachers to arouse interest in the girls; indeed, many were of the opinion that girls and boys had similar learning styles. There is a need for an increased teacher awareness of gender issues and the different ways in which boys and girls interact with their teachers in lessons.

This study makes a distinctive contribution to science education and gender issues in Mauritius as it enabled me to explore the factors that influence fewer girls than boys to study science beyond the compulsory level and look into how teaching is carried out at the level of Form III as this is the stage when decisions about subject options are made. Many girls do not seem to be aware of the importance of science subjects and they tend to drop them at an age when they are still developing mentally, physically and emotionally. As there is no in-depth study from a gender perspective carried out in Mauritius except for some superficial surveys as discussed in Chapters 1 and 2; carried out by the Ministry of Education (2000), the Mauritius Research Council (2001) and an intervention study by some researchers in a few schools (Goel *et al.*, 2000; Ramma *et al.*, 2000), my research is original in the sense that it sheds clear light on gender issues and science education by using an integrated methodology that has not been applied by other researchers in this new area in Mauritius. The parents I surveyed provide further support for the methods used in my research; parents' views about their perceptions of science and their influence on the choice of subjects and careers by their daughters have not been studied in Mauritius before and the findings from the three different methods in this research help our understanding of the low enrolment of girls after the compulsory level.

The framework I originally proposed in Figure 7.1 needs to be altered as there is a series of tensions and competing issues at every level, so I am proposing a consolidated framework (Figure 7.2) to explain what my research indicates: there is a clash in what the girls want and what teachers feel, a clash in the social roles of teachers and parents, and a clash in the identities of the girls. There is also a clash of national imperatives: though there said to be equal access to science education in the national policy documents, this is not translated into action in schools, as shown by the findings of this research.

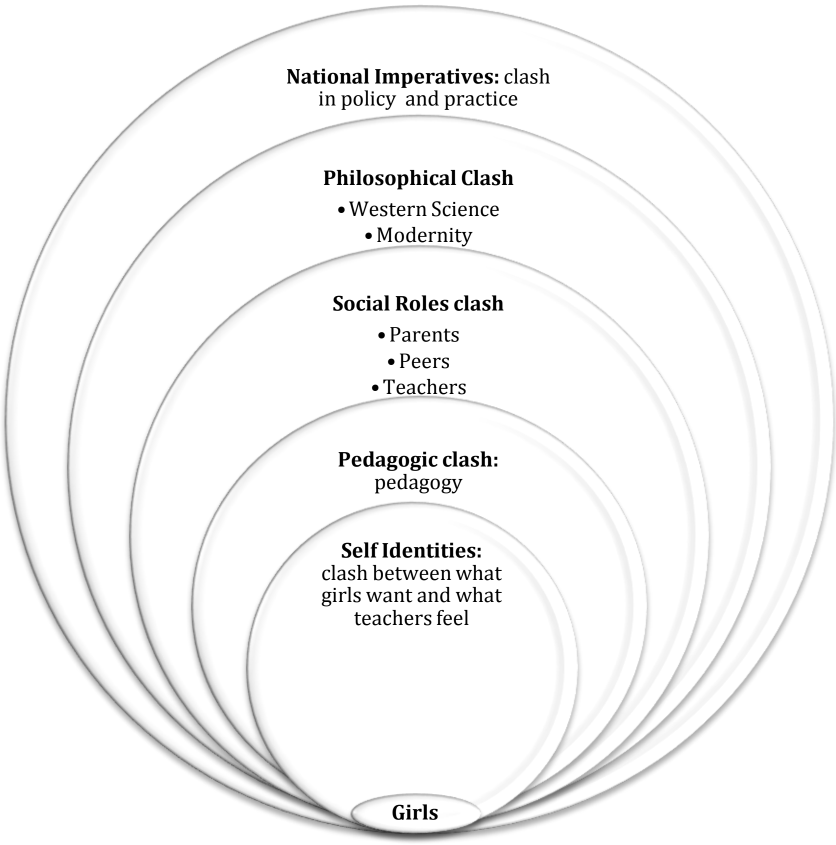

Figure 7.2 Consolidated framework on which the present study is based.

7.6. Limitations of the study and further work

Ideally a study with more schools would have made me more confident to generalize for the whole of Mauritius but inevitably, in a PhD thesis, one is limited with respect to the number of schools where field work can be conducted. I was fortunate that I have lived and worked in Mauritius for more than twenty years, but it is always possible that an outsider might have noticed certain important features relevant to my research questions that were simply too familiar to me.

I could have conducted a different study in which I undertook action research in one or two classrooms to see whether approaches to teaching might have changed the intention of girls to take science (or the actual uptake of science) after Form III. In a technical sense, action research is a form of intervention where the researcher can test the results of an intervention. My study is a comparative one as I am comparing four different schools, laboratory and classroom teachings in four different subject areas and even comparing professional parents with those in menial occupations.

The issues of reliability, validity and ethical issues have been discussed in Section 3.20; in this flexible qualitative research I made every effort to reduce elements of bias, used data from different sources to confirm or refute emerging findings. Furthermore, rich description of data gave credibility to the findings.

I could have chosen additional non-science subjects such as French as well as accounts and economics for comparison with science. Equally, it was not possible to examine the pupils' work or the textbooks due to time constraints, while, documents such as curriculum materials were not looked into in any detail. Pupils had difficulty in mastering the science concepts as presented in the textbooks and examination of the textbooks would have helped in shedding some light on the gender and science problem. Although there are limitations in the study, further research in girls' uptake of science could act as a beacon for gender equality in action.

7.6.1 Further work

I will conclude by proposing a number of additional avenues that could be explored, all of which would help shed further light on the issue of the uptake of science by girls in Mauritius after the point at which the study of science is no longer compulsory:

- Further research could be carried out with younger children to evaluate the teaching of science at primary level. This could shed more light on how science is perceived by pupils in primary schools and their expectations of secondary school science. Such a study could be carried out by academic professionals of relevant institutions such as the Mauritius Research Council and the Mauritius Institute of Education. Observations and interviews could be undertaken with teachers, pupils and parents to obtain empirical data.
- Follow-up studies with older children, for example those who chose science at Form IV level and even older ones at Form VI level, could be undertaken to find out about their career trajectory. To what extent have their aspirations changed? What are the career prospects in science?
- Textbook analysis could be carried out to explore gender stereotyping in the three science subjects and how this impacts on the study of science of girls. This exercise could be accompanied by interviews with textbook authors.

- Science enrolment at University level could be examined to find out about female undergraduates' participation in science. The University of Mauritius would be a suitable institution to undertake this study.
- The ways science teachers are trained and whether there is a follow-up on their practices at school level after their period of training has ended could be investigated.
- Continuing professional development of teachers through workshops and seminars to upgrade their pedagogical content knowledge and skills so as to keep abreast with latest developments in science education could be introduced and evaluated.
- The influence of role models in science is an area which could be explored further. This could be approached by inviting women scientists to give talks on their work and highlighting how scientific literacy is indispensable in this fast developing world. A subsequent survey by researchers would help to show to what extent this intervention has been successful in attracting girls to science.
- In-depth interviews with parents to probe their views on science education in Mauritius would complement the questionnaire data obtained in this thesis.
- Finally, studies could be undertaken to find out if there is any link between ethnicity and choice of science subjects at upper secondary level of education.

> Science should be lively. Now we learn by heart…too much rote learning…it is better to do experiments, Science is fun then (Priya, School C).

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APPENDIX 1

Semi-structured interview of pupils

Pupils were chosen at random from the Form 111 classes in the sample schools and interviewed in group. I used the following questions to guide me on the semi-structured interview. The interview took place at a time when there will be least disruption in their lessons. Prior permission was sought from the authorities concerned before the interview.

1. How long have you been studying science?
2. Which of the three sciences do you like most or least?
3. Why? Can you say more?
4. Do you think it is important to do science? Why?
5. How is science taught in your school?
6. Do you learn much that way? Why?
7. How do you think teachers can make the teaching of science interesting?
8. Why do you think so?
9. How do you learn science? (reading science books, watching TV, internet etc)?
10. How do you cope when you have a problem in science? Who helps you?
11. What are your views on the textbooks used in science?
12. Can you suggest how they should be in your opinion?
13. Would you prefer a male or a female teacher to teach you science? Why?
14. Do you intend to choose science for further studies? Why?
15. Any other comments:

APPENDIX 2

Semi-structured interview of Teachers

Questionnaire

Personal details

1. How long have you been teaching?
2. How long have you been in this school?
3. Which subject(s) are you teaching in this school?
4. Have you followed a professional course in teaching science?
5. Which year? Where?
6. How was the course helpful?

Teaching Methods

7. What are the teaching methods you use in your science lessons?
8. Do you get any help from lab attendants to organise your lessons?
9. If so, are they helpful?
10. How do you encourage your pupils to show interest in science?
11. What according to you should be taught in science?
12. How do you stress the importance/relevance of science to the daily lives of your pupils?
13. Do you teach boys and girls the same way?
14. Is there any difference in the learning style of boys and girls?

Curriculum materials/Resources

15. Which textbooks do you use in your science lessons?
16. How do you use them?
17. What is your opinion on them? How can they be improved?
18. Do you have sufficient laboratory facilities/equipment in your school?
19. How do you cope in practical work with large classes?

Attitude towards science

20. Are the pupils interested in science?
21. How do they show their interest for the science subjects?
22. What do you do to encourage them in science?
23. Any other comments?

APPENDIX 3
PARENTS QUESTIONNAIRE (corrected version used for main study)

Dear Parents/ Responsible Party

I am carrying out a survey on science education in Mauritius. I would be very grateful if you could fill in the questionnaire below. I would be very grateful if parents could fill the questionnaire jointly by discussing it together where applicable. Feel free to answer the questions in either English, French or Creole. Please rest assured that all information will be kept confidential and in strict anonymity.

Thanking you,

Jayantee Naugah.

PARENTS' QUESTIONNAIRE

Please tick in the appropriate column or box.

1. Sex of Respondent :   Male ☐   Female ☐

2. Characteristics of Parents

	Mother	Father	Responsible Party/Guardian
Occupation			
Education level			
Graduate			
HSC			
SC			
CPE			
Other			

2a. Ethnic group

Hindu	
Muslim	

General Population	
Chinese	
Other	

2b.The child attending this school is your:

Daughter ☐ Son ☐ Other ☐ Please specify :

2

3. No. of children in the family: ___________

Please indicate the age, education level (SC, HSC, Graduate) of your children/wards and
their occupation if applicable in the table below) :

Children profile	Age/Yrs	Education	Occupation
First child			
Second child			
Third child			

4. Did you study science at secondary school? YES ☐ NO ☐

a. If yes, up to what level

SC	
HSC	
Degree	
Other	

b. If no, give reasons for your answer:

5. Do you think the study of science is important? YES ☐ ☐
NO

a. Give reasons for your answer.

____
_

____
______

6. Would you like your daughter/son to study science after Form III? YES ☐ ☐
NO

a. Give reasons for your answer.

____

____

____

____

3

7. a. What would you like your daughter/son to do as a career?

____

b.Why?____
____

8. Do you influence your daughter/son in the choice of subjects? YES ☐ ☐
NO

8a.If yes, how?

____
____

8b. If no, who influences her/ him in choosing the subject?

LS24

Dear Parents/ Responsible Party

I am carrying out a survey on science education in Mauritius. I would be very grateful if you could fill in the questionnaire below. I would be very grateful if parents could fill the questionnaire jointly by discussing it together where applicable. Feel free to answer the questions in either English, French, or Creole .Please rest assured that all information will be kept confidential and in strict anonymity.

Thanking you,

Jayantee Naugah.

PARENTS' QUESTIONNAIRE

Please tick in the appropriate column or box.

1. Sex of Respondent : Male [✓] Female [ ]

2. Characteristics of Parents

	Mother	Father	Responsible Party/Guardian
Occupation	Housewife	Personal Manager	father Personal Manager.
Education level			
Graduate		✓	
HSC	✓		
SC			
CPE			
Other			

2a. Ethnic group

Hindu	
Muslim	✓
General Population	
Chinese	
Other	

2b. The child attending this school is your :

Daughter [✓] Son [ ] Other [ ] Please specify :

3. No. of children in the family : 4

Please indicate the age, education level (SC, HSC, Graduate) of your children/wards and their occupation if applicable in the table below) :

Children profile	Age/Yrs	Education	Occupation
First child	16 yrs	form V	Student
Second child	14 yrs	form III	Student
Third child	10 yrs	Std V	Student
forth child	2 yrs	-	

4. Did you study science at secondary school? YES ☐ NO ☑

a. If yes, up to what level

SC	
HSC	
Degree	
Other	

b. If no, give reasons for your answer:

Because I like to do management and business

5. Do you think the study of science is important? YES ☑ NO ☐

a. Give reasons for your answer.

Because it enables a child to become a doctor or engineer. and it is an interesting subject

6. Would you like your daughter/son to study science after Form III? YES ☑ NO ☐

a. Give reasons for your answer.

Because I want her to become a famous doctor. and I want her to be more experienced.

7. a. What would you like your daughter/son to do as a career?

Doctor or Dentist

b.Why? Because of great incomes and she/he likes to cure people

8. Do you influence your daughter/son in the choice of subjects? YES ☐ NO ☑

8a. If yes, how?

8b. If no, who influences her/ him in choosing the subject?

friends & Teachers.

Mauritius Institute of Education

Reduit – Mauritius

School of Science & Mathematics

Tel : 454 1031/35 – 466 1940 Fax: (230) 467-4378

28 January 2005

Dear Sir

Further to the meeting with you yesterday regarding a research project I am carrying out, I would be very grateful if permission could be granted to me to have access to the secondary school for field work purposes.

The research is about the teaching of science at lower secondary level from a gender perspective. The aim is to find out how science is being taught at Form III level in a mixed school.

I would like to carry out observations of 15 lessons in science (5 in each science subject) and 5 lessons in a non science subject such as Accounts and Economics at Form III level; interview the teachers involved in teaching those subjects and some pupils at Form III level.

I would like to assure you that all information obtained from the participants will be strictly confidential and their anonymity and that of the school will be respected. This research will undoubtedly benefit the school and help to improve science teaching and learning.

Thanking you for your collaboration

Yours truly,

J Naugah (Mrs)
Head
School of Science and Mathematics

INTERVIEW OF PUPILS SCHOOL A

INTERVIEW TRANSCRIPTS

Group of 5 pupils.

CLASS: Form III

Date: 11th October 2004 Time: 9.15 to 1000 hrs.

Location: Quiet small office next to Biology Lab.

I arranged with the Rector to have an interview date fixed. I showed him the semi-structured interview schedule for the pupils and asked him permission to interview them. After obtaining his consent, I contacted the teachers in all 3 science subjects and informed them about the interview and gave them a list of names of pupils I have identified for the interview.

I welcomed the pupils, invited them to be seated and to feel relaxed as I am not trying to scrutinize their work in science. The fact that they have seen me observing their lessons several times helped them to feel at ease and I was accepted by them without any suspicion.

I explained to them what my research was about, ensured them strict confidentiality about they were going to say and asked them if they had any objection whatsoever about being interviewed. They agreed to the interview and I requested their permission to be taped again assuring them anonymity and confidentiality .I then started the conversation on a friendly way talking about general science topics. Here is a transcript of the interview which was taped. At the same time I took some quick notes.

Interviewer: Good morning I am going to have a chat to you about science and your interest in science. How do you find science?

Pupils (all together): Yes, we like science.

Interviewer: Can you tell me why?

Pupils (*togethe*r): Because of experiments especially in Chemistry and in Biology because of experiments in osmosis?

Interviewer: Which of the three science subjects do you like most?

Pupils (*all together*): Biology is our favourite subject. Reproduction is what we like best. We learn about ourselves.

Rina: The teacher explains and asks questions in class. We do not do a lot of experiments. We never used a microscope at all.

Anusha and Fawzia: In chemistry we like experiments … the colour changes we see are like magic!

(*Devi and Rina agree with Anusha and Fawzia).)*

Devi: Also experiments using acids … they are used in medicines.

Interviewer: For example?

Pupils (*together*): Tablets against indigestion.

Interviewer: How about physics?

Rina and Selvina: Yes, we like physics but the calculations are difficult.

Pupils (*togethe*r): We memorise the notes. The physics teacher gives us notes … he teaches well. We learn the other sciences by heart.

Pupils *all together*: Biology is our favourite subject.

Interviewer: You said you like biology. Could you tell me why you like biology?

Anusha: Reproduction is what we like best … we learn about ourselves.

Interviewer: How about other topics? (*Probes.*)

Fawzia: Yes, we like plants too … they are important. They provide us with oxygen and medicinal plants cure diseases.

Interviewer: Do you do any fieldwork in Biology?

Pupils together: Only some we observe nature outside in the schoolyard.

Interviewer:How about practicals in Biology?

Pupils: We do not do a lot of experiments: never used a microscope at all.

Interviewer: How is it in chemistry? What bits of chemistry do you find interesting?

Pupil A: Yes I like Chemistry especially the experiments. The colour changes we see are like magic.(others agree too)

Pupil B: Also acids- they are used in medicines.

Interviewer: How about Physics? How do you find it?

Pupil C: Yes we like physics but the calculations are difficult.

Interviewer: How do you learn Physics?

Pupils: We memorise the notes. The teacher gives us notes. He teaches well. We learn the other sciences by heart; *par Coeur* . We also use the internet; we have computers at home.

Interviewer: Do you think girls can do science well?

Pupil all together: Yes but our parents do not like science; they say there are no jobs in science-it is difficult…..but Accounts can be difficult too. So we like to do science though it is difficult. Many pupils fail in science; the exams are easy in Accounts.

Interviewer: How do you like to work in science?:In group or individually?

Pupil A: We do group experimentsts. But there are too many pupils in class; we do not et the chance to do experiments on our own, to develop skills. We like to work on our own and try the experiments. (Others agreed)

Interviewer: Apart from school science where do you get information in science?

Pupils: There are clubs: UNESCO Club, Health, Environment---but there are not may activities. We would like to involve more in such activities. In Environment club, we just grow plants.

Interviewer: Don't you think this is important?

Pupils: Yes, but there are other things we would like to learn.

Interviewer: For example?

A: Pollution…this affects our environment.

Interviewer: When you think of a scientist, what comes to your mind? A man or a woman?

Pupils: A man mostly—as science is done mostly by man; woman cannot do it?

Interviewer: Why do you think so?

Pupils: Most discoveries are done by men. Even at place of wok scientists are mostly men.

Interviewer: Who do you prefer to be taught by? A male or a female teacher?

Pupils all together: Biology by a female teacher. There are many delicate questions which we cannot ask a male teacher; we are embarrassed. For other science subjects we do not mind whether it is a man or a woman.

Interviewer: Do you get any homework in science?

Pupils: Not much the ones we are easy.

Interviewer: when you have in science, who helps you?

Pupils: Our teacher; sometimes our elatives such as cousins. Our parents do not know much science.

Interviewer: Who encouraged you to do science?

Pupils: Our parents and ourselves.

Interviewer: You friends?

Pupils: Ourselves.

Interviewer: What career do you have in mind?

Pupils B,C,D,E,: Doctor.

Pupil A: Veterinarian.

The interview had to stop here as it was time for the next lesson. The interview lasted about 45 minutes.

I thanked them for their participation in the interview and wished them all the best in their studies.

INTERVIEW OF CHEMISTRY TEACHERS- SCHOOL A.

TRANSCRIPT

Date;13th October 2004

Time: 9.00 hrs to 9.45 hrs

I had earlier arranged with the Rector and the teachers to carry out this interview. I went to the school at 9.00hrs, greeted the rector in his office as usual had a brief chat with him and then went to the Chemistry lab to interview the teacher whose class I observed earlier. It was a free period and a quiet setting. I showed the semi-structured schedule to the teacher and assured her about anonymity and confidentiality regarding what she or I were going to say during the interview. She agreed to be interviewed .The chemistry teacher is referred as Teacher A in the interview. She is a very young tall teacher barely in her early thirties and she looks very modern in her way of dressing up and hair style. She has a pleasant personality and the children seem to like her. She has a very cheerful personality. With her consent I tape recorded the interview and where possible took some quick notes.

A=Teacher of chemistry

Q=Interviewer

Q: How long have you been teaching?

A: 8 years-2 years in this school

Q: Do you like teaching/

A: Yes, I like teaching; I like to be with children. It makes me feel young.

Q: Which subject do you teach apart from chemistry?

A: Chemistry only.

Q: Have you followed a professional course in teaching science?

A: I am now following a PGCE course at the Mauritius Institute of Education which is interesting and helpful. It is very enriching an makes me think about what I am doing-helps me improve my teaching- makes me more aware about higher and lower ability pupils. I try to help the pupils to be motivated. Usually I used to teach the same way to a whole class; at least ai can do differential teaching now. The children are benefiting from that and are making more effort.

Q: Have you taught both boys and girls?

A: Yes, I like to teach boys more not sensible s girls; girls tend to giggle. Boys ae more open. They say whatever they think.

Q: Can you say more?

A: Girls are more introvert. With boys there is no time to relax as they work more rapidly. We have to keep them busy and working is no problem-class management is not difficult. The boys do more work in a short time while the girls they are more slow at work-one has to explain many times before they can understand.

Q: How are they different?

A: Boys are more alert. I get more response from them especially in practical classes. Boys are more active. What they can do in 10 minutes girls take 20 minutes. They manage their time well- work quickly; girls find the time no enough- they do not finish the experiment; there is no time to discuss and correct work.

Ability is the same but boys are more rapid in their work. They are noisy when doing their work; they are looking at what their friends are doing but they help each other but girls are more personal- not willing to share and tend to compete with each other. Boys like sharing, including their own knowledge.

Q: How do you teach science to the girls?

A: Both the same way, but girls more slowly- I have to repeat a lot. Boys ask more questions in class; girls though they are not clear they do not ak. Girls ask their friends first, then the teacher. They lack confidence. They are afraid to let the teacher know that some concepts are not clear to them. This also depends on pupils; it is always the bright ones who answer

Teaching of science

Q: How do you deal with science lessons?

A: Demonstration as most of the time there is not enough equipment for whole class practical.

Some of the topics are not applicable to everyday life-not relevant. For example gases are interesting. Tests for gases are one as demo; some are interesting, they ask questions, soe are not interesting. Science should be taught according to relevance to everyday life e.g on the cyanide issue : no response. They did not read papers. We ask if they watch TV- only 15 minutes viewing- they will remember that I am going to ask them; then they tel me what happened

Q: Curriculum materials: Which textbook do you use?

A: NCCRD ones. Contents are good but some topics have to be supplemented- more information on pollution is needed. We also use other books, e.g Discovering science which is very colourful, more appealing; the exercises are OK. Additional information are useful.

Q: Have you noticed any gender bias in the books?

A: None whatsoever; they are gender neutral books. Never thought of it.

Q: What are the pupils’ attitude towards science? Are they interested?

A: Not so much; scientific literacy is not so important to them. Parents influence them in their choice of subjects. Their influence is very strong. There is also peer pressure- some parents complained that their daughter should do science- but the child decides by listening o their friends in some cases…….There are cases where girls could not do well in science; parents want them to become a doctor but not a teacher. Science is done by the high flyers; many pupils choose accounts and economics as accounts is easy to pass .Exams results are high in accounts. Here the question do not require much reflection. There is no essay type questions ;economics is difficult though.

Q+How can we bring about a change in their perceptions of science?

A: Organize more visits, e.g the Rajiv Gandhi Science Centre the planetarium gives only a short exposure on the topic. More visits are necessary but it is not so easy. The safety aspect is important. We are willing to take them but the decision rests with the Rector. There is only one visit in the last week of the first term The visit we believe will be more helpful; make them aware about the importance of science.

Q: how else can we increase their interest?

A: MCA programmes are not very helpful; there is no audiovisual room; at home pupils do not watch as they are busy with tuitions.

Talks by outside people- audience is small for a big hall; in class it would be better.

Career talks only to HSC classes. Very few pupils ask teacher for guidance. Teachers however do ask them what career they have in mind.

Bell rings for next lesson .Interview ends here. I thanked them for the precious time they have given for the interview and wished them Good Day. They were willing to volunteer further information.

The interview lasted 45 minutes approximately.