Approaches to Gender Equity in Science Education

Two Initiatives in Sub-Saharan Africa Seen Through a Lens Derived From Feminist Critique of Science

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ABBREVATIONS

ADEA	Association for the Development of Education in Africa
AFCLIST	African Forum for Children's Literacy in Science and Technology
ASTE	African Science and Technology Education (Conference in 1995)
CASE	Cognitive Acceleration through Science Education
CC	Chancellor College (Malawi)
DAE	Donors to African Education
DANIDA	Danish International Development Assistance
EFA	Education for All
FAWE	Forum for African Women Educationalists
FEMSA	Female Education in Mathematics and Science in Africa
GASAT	Gender And Science And Technology
GDP	Gross Domestic Product
GER	Gross Enrolment Rate
HEDCO	Irish Aid
MTR	Mid Term Report
MOE	Ministry Of Education
NER	Net Enrolment Rate
NESIS	National Education Statistical Information Systems
NGO	Non Governmental Organisation
Norad	Norwegian Agency for Development Cooperation
PISA	Program for International Student Assessment
PLA	Participatory Learning Approach
RF	Rockefeller Foundation
SAARMSTE	Southern African Association for Research in Mathematics, Science and Technology Education

SACOST	Centre for School and Community Science and Technology Studies
SAP	Structural Adjustment Programme
SIDA	Swedish International Development Cooperation Agency
SMT	Science, Mathematics and Technology
SMTE	Science, Mathematics and Technology Education
SSA	Sub-Saharan Africa
STVE	Science, Technology and Vocational Education
TC	Technical Committee
TIMSS	Trends in International Mathematics and Science Study
UCE	Uganda Certificate of Education
UDW	University of Durban-Westville
UN	United Nations
UNDP	United Nations Development Program
UNECA	United Nations Economic Commission for Africa
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations Children's Fund
WGFP	Working Group on Female Participation (within ADEA)
WHO	World Health Organisation

CONTENT

1. Setting the scene

1.1 Introduction

1.1.1 Abstract

In this thesis, I explore whether feminist critique of science can shed new light on how gender equity in science education can be achieved. Drawing on feminist theory, I develop a theoretical framework that I use to analyse how two science education initiatives work towards increased gender equity in science education in sub-Saharan Africa.

All studies and initiatives addressing gender issues in science education reflect perceptions of how sex/gender[1] impacts pupils' engagement in scientific inquiry. These perspectives are, however, seldom made explicit. In this thesis I make use of feminist critique of science to explore alternative understandings of how sex/gender can be seen to impact on peoples' engagement in science inquiry. I use this discourse as a point of departure to discuss different understandings of how sex/gender can be seen to impact on pupils' approach to science education.

I suggest that different understandings of what impact sex/gender have on pupils' engagement in science education may imply different approaches for initiatives aiming at increased gender equity in science education. Drawing on feminist theory, I develop an analytical framework that suggests three different approaches to gender equity in science education, each grounded in a distinct understanding of how sex/gender impacts on engagement in science and science education. I use the analytical framework developed from feminist critiques of science to analyse how two science education initiatives work towards increased gender equity in science education in sub-Saharan Africa.

My analysis shows that the two initiatives reflect two distinct understandings of how sex/gender impacts on pupils' engagement in science education and of how gender inequity in science education should best be approached. Although none of the initiatives were influenced by feminist theories and

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[1] I use the term sex/gender to represent biological and/or social sex. For further distinction and explanations on these terms, see chapter 2.3.1.

critiques of science, this study suggests that this discourse can still be used to analyse such initiatives from a new perspective.

1.1.2 Background and overview of the thesis

Working towards increased gender equity in education has gained renewed attention after the Millennium Declaration was signed in September 2000 at the United Nation's Millennium Summit. The Millennium Goals that were formulated on the basis of the Millennium Declaration (UN, 2000a) commits the member countries "to promote gender equality and the empowerment of women, as effective ways to combat poverty, hunger and disease and to stimulate development that is truly sustainable". The target is to "eliminate gender disparity in primary and secondary education by 2005 and in all levels of education no later than 2015" (UN, 2000b).

Science, Mathematics and Technology Education (SMTE) [2] constitute the areas within the educational system where the gender disparity, in several of the poorest countries of the world, is greatest. SMTE is also the area of the educational system where many of the skills expected as a result of an education that stimulates development, naturally should be learned: Securing good health, fighting diseases, protecting the environment, farming and developing agriculture and developing new industries and technologies are all activities that require skills in science and technology. A proper science education is also regarded as crucial to empower pupils and equip them with skills necessary to become active participants in democracies. Science education in several developing countries has however been accused of not being suited to equip pupils with such skills. Despite the documented benefits to economic and social development of granting females education, relatively fewer girls than boys are given the opportunity to participate and perform in science education in several of the poorest countries of the world.

In *Chapter 1*, I present statistics showing that females are underrepresented and underperforming in science education in countries of sub-Saharan Africa. An extensive amount of study and research has been undertaken to explain why females in many parts of the world are underrepresented and underperforming in several of the fields within science education. In this chapter I present a brief overview of some of the findings from these studies.

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[2] It should be noted that I use science and science education as a collective term representing all sciences although differences in girls' and boys' participation and performance vary within the different disciplines in science, mathematics and technology education.

I also present two initiatives that work towards a more inclusive science education in sub-Saharan Africa.

All studies and initiatives addressing gender issues in science education reflect perceptions of how sex/gender impacts pupils' engagement in scientific inquiry. These perspectives are, however, seldom made explicit. Feminist critiques of science offer insight into how researchers' sex/gender can be seen to impact scientific inquiry and practices within the scientific community. In *Chapter 2*, I use insights derived from feminist critiques of science as a point of departure to discuss different understandings of how sex/gender can be seen to impact pupils' engagement in science education. My focus is to distinguish between unlike feminist perspectives and elaborate on how they can be seen to represent different approaches to how gender equity in science education might be achieved. I describe three approaches to gender equity in science education, each building on a distinct understanding of how sex/gender impacts pupils' engagement in science education. The three approaches are labelled "female-friendly", "gender-neutral" and "gender-sensitive" science education. These labels are widely used in literature on gender and science education. Often however, without being explicit about what constitutes these concepts and what action is required to take in order to achieve the different types of education. Making use of feminist critique of science, I suggest that they can actually be seen to represent three different approaches to how gender inequity in science education could be addressed.

The Norwegian Agency for Development Cooperation (Norad) has contributed to the support of two major initiatives that work to transform science education in sub-Saharan Africa: Female Education in Mathematics and Science in Africa (FEMSA) and African Forum for Children's Literacy in Science and Technology (AFCLIST). In *Chapter 3*, I explain my methods for studying these initiatives' work towards increased gender equity in science education. I also explain why I applied a qualitative case study approach and how I have analysed documents, participated and observed at several events organised by FEMSA and AFCLIST and interviewed actors involved in the two initiatives.

In *Chapter 4 and 5*, I make use of the theoretical framework developed in Chapter 2 to analyse how FEMSA and AFCLIST work towards gender equity in science education[3]. The focus has been to study what they regard as

[3] Although FEMSA and AFCLIST also addressed mathematics and technology education (FEMSA had more focus on mathematics then AFCLIST and AFCLIST has more focus on technology than FEMSA (see chapter 7)), the focus of my study has been on their science education dimension.

obstacles to female participation and performance in science education, their arguments for change and their recommendations to how science education should be transformed to increase female participation and performance.

FEMSA was implemented primarily to address gender inequity in science education, while AFCLIST has as a guiding principle that all its activities shall address gender issues. In *Chapter 6*, I compare and discuss this and other aspects of FEMSA's and AFCLIST's distinct approaches to reach gender equity in science education.

Bearing in mind that none of the initiatives analysed as cases have been guided by the theories used to develop the theoretical framework, I have through this study explored whether feminist critique of science can still be utilised to study such initiatives from a new perspective. Applying feminist theories and critique of science to analyse science education initiatives targeting girls has hence been an exploratory task. In *Chapter 7*, I discuss whether my attempt to do so has been successful. I discuss my findings and elaborate over difficulties and challenges I have been faced with along the way. I also provide some recommendations and reflections at the end of my research journey.

1.1.3 Positioning myself and defining my research questions

Much literature is written on gender issues in science education[4]. Besides discussing the importance of recruiting more females to science and science education, this literature also suggest explanations for female underrepresentation in science, mathematics and technology education and recommend what actions are required in order to redress this inequity. The diagnoses of what cause underrepresentation and underperformance in these subjects varies within this literature. So do the recommendations as to what needs to be done to secure change. While some assign female underrepresentation and underperformance to differences in males' and females' interests and argue that science education accommodates mainly the boys' interests, others explain the situation by a science education that tends to apply learning strategies more suitable for boys than girls. Within this

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[4] A search on Google for "gender and science education" resulted in 1.890 000 hits. It is beyond the scope of my dissertation to provide a comprehensive review of this extensive body of literature. A brief review of some main factors discussed in this literature is provided in section 1.3.

literature, one can also identify arguments claiming that there are no such things as girls' and boys' interests and preferred learning strategies, and that difference in attitudes and abilities is determined by factors other than sex[5].

In relation to my master study in science education (Sinnes, 1998) I read a great deal of literature on gender issues in science education. After reading through a fair amount of this literature, I did, however, realise that this reading had not enlightened me regarding some central questions relating to gender equity in science education. The literature that I read did not convince me of what the key to increasing female participation and performance in science really is. I was confused about whether different education initiatives for boys and girls were needed to increase female participation in these subjects. Beyond the obvious benefits to societies of having more scientifically literate women, I was not sure whether I believed that females would actually contribute with something different than men to scientific inquiry.

The first semester of my doctoral programme I signed up for a course in Feminist Philosophy of Science. As the only participant at the course with a background in natural sciences, I was surprised to discover that the whole course was about relations between sex/gender and natural science. The course readings raised questions about the impact of the scientist on science. I read about the masculinity of scientific knowledge and research practice and how the politics and attitudes within the scientific community kept females from being involved in scientific inquiry. I learned about different philosophers of science and their understanding of how the researcher's sex/gender might impact the research object – both in terms of what she or he chose to focus on and also how she or he actually pursued the research. This again gave me new perspectives to how the sex of the researcher could be seen to impact the research output. This was clarifying in terms of reflecting how sex/gender in various ways could be understood to have impact on how people engage in scientific inquiry and thereby provided me with new perspectives as to what we could expect from recruiting more females to science.

I realised that much of my confusion related to literature about gender issues in science education was caused by the fact that this literature was seldom explicit about the understanding of one crucial question: Are males and females considered different? More precisely, this discourse did not formulate openly whether it assumed that males and females were different in

[5] Some of the points emerging from this literature are presented in chapter 1.2.

their engagement in science inquiry and science education. Reflecting over feminist theory in relation to literature on gender equity in science education, I began to think that what understanding one has of how sex/gender impacts people's engagement in science and science education actually implies very different approaches to how gender equity ought to be achieved.

Reading feminist critique of science was for me clarifying because it discussed these issues and provided me with various exploratory models to help me understand how sex/gender can be seen to impact on people's engagement in scientific inquiry. I found feminist philosophy of science fascinating as this discourse demonstrated how scientific knowledge production was influenced by the sex/gender of the researcher. Some theoreticians also used this masculine and western bias as an explanation for the alienation of females from science. I believed that these theories would be relevant to people attempting to increase the participation and performance of girls in science education. I therefore decided to focus my doctoral thesis on how the stakeholders of gender and science education initiatives interpret and use feminist critiques and theories about gender and science in their work, how this theoretical discourse was accounted for in their project design and how it is reflected in the initiatives they carried out.

My initial research question was therefore:

1. How does the academic discourse about feminism, females and science impact science education initiatives targeting girls?

I did not have to carry out much research before I found out that the theories that I, in my enthusiasm believed were core readings, were actually unknown to my interviewees who were all key actors within the main science education initiatives in sub-Saharan Africa. The majority of my interviewees had not heard about feminist critique of science, and not at all made use of this theoretical discourse in their work. I also realised that this situation was not unique to Africa. Most science educators in my own context were also unfamiliar with this discourse.

Since my initial research question was already answered after my first interviews, I thought there was no point in elaborating any further on this question. What now became interesting to me was how feminist critique of science *could* contribute to a deepening of our understanding of gender issues in science education. More precisely I wanted to explore my next research question:

2. Can feminist theories and critiques of science be used to analyse and develop science education initiatives which address gender issues?

This question guides the development of the theoretical part of this thesis. The challenge is to use feminist theory to develop categories which show diverse understandings of how sex/gender can be seen to impact scientific inquiry. This categorisation is thereby used as a basis to reflect on different ways that sex/gender can be seen to impact pupils' engagement in science education. Based on the various perspectives identified, I develop a framework that describes different approaches to gender equity in science education. By doing this I attempt to make use of feminist critiques of science to advance our understanding of how gender equity in science education could be approached.

However, I do not want to approach the question of gender equity only from a theoretical perspective. In order to find out more about some initiatives that work towards gender equity and also to try out whether my theoretical framework can be used to analyse real initiatives, I have added a third research question to guide my thesis:

3. How do two African science education initiatives supported by Norwegian aid address gender issues?

I have chosen to apply the theoretical framework derived from feminist critiques of science to analyse how two major science education initiatives operating in sub-Saharan Africa work towards gender equity. The two initiatives constitute my two cases. My choice to analyse initiatives from Africa, reflects my concern about inequalities in the world. Coming from one of the richest countries of the world (Norway currently scores on top on the United Nations Development Program's (UNDP) Human Development Index (UNDP, 2004)), I had not experienced poverty until I at the age of nineteen travelled to Asia as a backpacker. Since then I have been concerned about the incredible injustice in this world. The fact that 30 000 children die every day from diseases that could easily be prevented is hard to accept. That one third of the world's population does not have access to clean drinking water and the same proportion of the population does not have access to electricity, creates some challenges for science educators that we, in my opinion, can not be ignorant of. I do not believe that my doctoral thesis will change the inequities in the world (!). But I do believe that science education holds a potential for playing an important role in the transformation of these inequities. And I believe that more focus should be directed towards the importance of granting females equal opportunities as males to attend and achieve in science education.

The benefits of securing females equal access to education is now well known among governments, developing agencies and lending institutions. The World Conference on Education for All (EFA) (Jomtien, Thailand, 1990) placed basic education high on the development agenda. In April 2000, more than 1100 delegates from 164 countries reaffirmed their commitment to EFA at the World Education Forum in Dakar, Senegal. They adopted the Dakar Framework for Action – a bold, practical document laying out goals and strategies for achieving Education for All (UNESCO, 2000). The Millennium Declaration was signed in September 2000 (UN, 2000a). Emanating from the Millennium Declaration eight Millennium Goals were formulated. To promote gender equity and the empowerment of women, the Millennium Goals bind rich and poor countries to do more and join forces to "eliminate gender disparity in primary and secondary education by 2005 and in all levels of education no later than 2015" (UN, 2000b).

The areas of the education system where gender disparities in most of the poorest countries of the world are greatest are within the sciences (see chapter 1.2). I have therefore been surprised to discover that few aid agencies and lending institution have focused seriously on redressing gender inequity in science education. In spite of the increased focus on female education, few seem to realise that much of what is expected as outcomes from *Education For All (EFA)*, actually presupposes a high quality *science education for all.* The Norwegian Agency for Development Cooperation (Norad) has supported two of the major initiatives in sub-Saharan Africa working towards a more inclusive science education; FEMSA and AFCLIST. Because of the crucial role such initiatives should play, I have been interested in knowing more about how they work towards gender equity in science education. Both initiatives work for a systemic change of science education in sub-Saharan Africa. Although only one of the initiatives has gender as its main focus, both initiatives work to address the gender disparities in science education.

The focus of my thesis is to study different approaches to gender equity in science education. I have limited my analysis to focusing on how these initiatives approach gender equity and have not studied the impact of the initiatives. I think a clarification and discussion of what approach to gender equity the two initiatives actually represent is needed before evaluating the effect of the different approaches. An evaluation of the impact of FEMSA was completed in 2003 (O-saki & Bunwaree, 2003). A similar evaluation has not been undertaken of the impact of AFCLIST. I have focused mainly on the recipients of aid, the African science educators implementing the initiatives. I have tried to identify their rationale for attempting to increase female participation in science and science education and what they consider as necessary in order to achieve change.

1.2 The African scene

1.2.1 Education in sub-Saharan Africa

To give an account of the context FEMSA and AFCLIST operate within and what situation they are addressing, I will in the following section give a brief introduction to some aspects of the educational situation in sub-Saharan Africa. I will focus on science education. I include a statistical overview of the participation and performance of females in science education in this region. This is based mainly on statistics produced by different institutions within the United Nations and by FEMSA respectively. It is difficult to get hold of updated information and sex segregated educational statistics for this region. Not even Forum for African Women Educationalists (FAWE[6]) had access to this information.

International comparisons like Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) are not available for sub-Saharan Africa except for TIMSS data for South Africa. One reason that data from these studies do not exist from developing countries is the expenses connected to participation in such studies.

Sub-Saharan Africa designates the 46 countries of the African continent south of Sahara. This part of the world is rich in natural resources. According to the United Nations Economic Commission for Africa (UNECA, 2004), it holds 85% of the world's chrome, 85% of its platinum, and produces 50% of its palm oil and 33% of its coffee. In addition, sub-Saharan Africa is rich in oil, gold and diamonds.

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[6] Five African women Ministers of Education in 1993 established the "Forum for African Women Educationalists", FAWE. FAWE established with the purpose of: "Working to ensure that policies and practices would be developed across the continent by governments and NGOs to enable girls to have access to school, complete their studies, and perform well. In particular, FAWE intended to harness the political force for women in policymaking positions to work towards the achievement of these goals." (Namuddu, 2001, p. 2). I was surprised to hear that FAWE did not have updated statistics of the situation in which they are designated to address. In reply to my mail requesting them to tell me where I could get this information, I was told to contact the examination boards of each individual country. My attempt to do so has not succeeded. The leader of the Examination Board in Kenya was not able to get hold of these statistics.

In spite of the large amount of natural resources, Africa's contribution to the world's industrial output is only 2% (UNECA, 2004). The continent consists of the poorest countries of the world. According UNDP, approximately 40% of the sub-Saharan African population lives in absolute poverty (defined as less than 1 US$) per day. Sub-Saharan Africa has the lowest life expectancy rates in the world, with an average life expectancy of 46.5 years (UNDP, 2003, p. 240). The average total fertility rate (per woman) was in 2003, 5.4 (UNDP, 2003, p. 253). 43 % of the population of sub-Saharan Africa does not have access to clean drinking water (UNDP, 2003, p. 257).

In addition to diseases like malaria and tuberculosis, the AIDS/HIV epidemic has affected countries of sub-Saharan Africa particularly badly. AIDS is, according to the World Health Organisation (WHO), currently the leading infectious cause of adult death in the world (WHO, 2004). This epidemic is unlike other epidemics killing people in their most productive age which has severe consequences for development. HIV/AIDS kills almost 5000 men and women and almost 1000 of their children every 24 hours in sub-Saharan Africa. Today approximately 8% of the adults in sub-Saharan Africa have HIV/AIDS, and in 2003 Africa was home to 66% of the people of the world living with HIV and AIDS. WHO claims that as many as 90% of the HIV-positive people in sub-Saharan Africa do not know that they are infected (WHO, 2004).

The situation in sub-Saharan Africa implies great challenges for the education sector. In 2001 this region had an adult illiteracy rate of 62.4% (UNDP, 2003, p. 240). Two thirds of the illiterates are women (UNDP, 2003).

Science education is the area of the sub-Saharan African Education system where the gender disparities are the greatest (see chapter 1.2.2). This area of the education system is crucial when it comes to addressing many of the challenges this continent is faced with. Unfortunately science education in sub-Saharan Africa has been very little suited to addressing such challenges (Naidoo & Savage, 1998). Science education in most sub-Saharan African countries has a long tradition of being influenced by the education systems of its former colonisers. The status of science as a provider of neutral and objective knowledge has legitimised a direct transfer of science curricula, examinations and teaching methods from western countries that have failed to address the current challenges in developing countries. This has resulted in a science education that in most sub-Saharan African countries is characterised by irrelevant, de-contextualised knowledge being transferred by poorly trained teachers in overcrowded and under resourced classrooms

(Rollnick, 1998; Yoloye, 1998). Poor science education is particularly affecting female participation and performance negatively since it often implies discrimination of girls on the basis of their sex (see chapter 1.3).

1.2.2 Gender patterns in science education in sub-Saharan Africa

Participation in science education at primary level

At primary level, science education is in general compulsory in all sub-Saharan African countries (FEMSA, 1997). Low participation in science education at this level is thus only a problem in countries where children are not in school. The World Conference on Education For All in Dakar 2000 noted that despite a notable improvement in gender equality at the primary level over the last decade, 113 million children worldwide, of these 60% girls, still do not have access to primary school. Sub-Saharan Africa was singled out as a region where enrolment is still a serious problem. Most countries in this region have a gender gap that disadvantages girls (UNESCO, 2001). The Education For All assessment (EFA 2000 Assessment) undertaken in year 2000 by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the National Education Statistical Information Systems (NESIS) and the Association for the Development of Education in Africa (ADEA) noted that 42 million children were out of school in sub-Saharan Africa. Approximately 60% of these were also girls (UNESCO, NESIS & ADEA, 2000).

Figure 1.1: Trends in net enrolment ratio (NER) at primary level: sub-Saharan Africa (1990, 1995 and 1998). Source: UNESCO et al. (2000, p. 42).

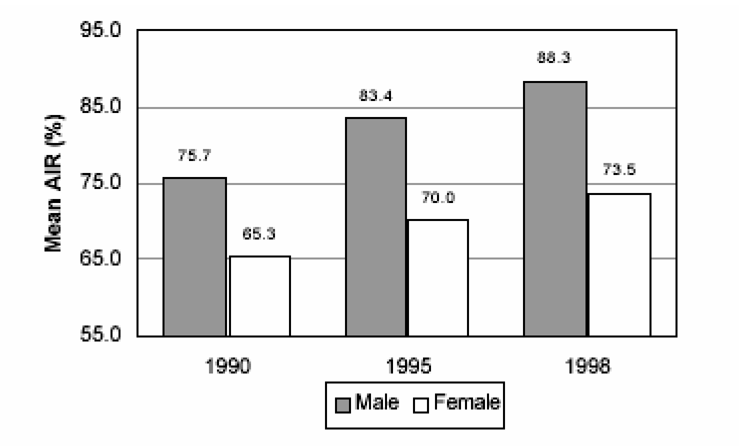
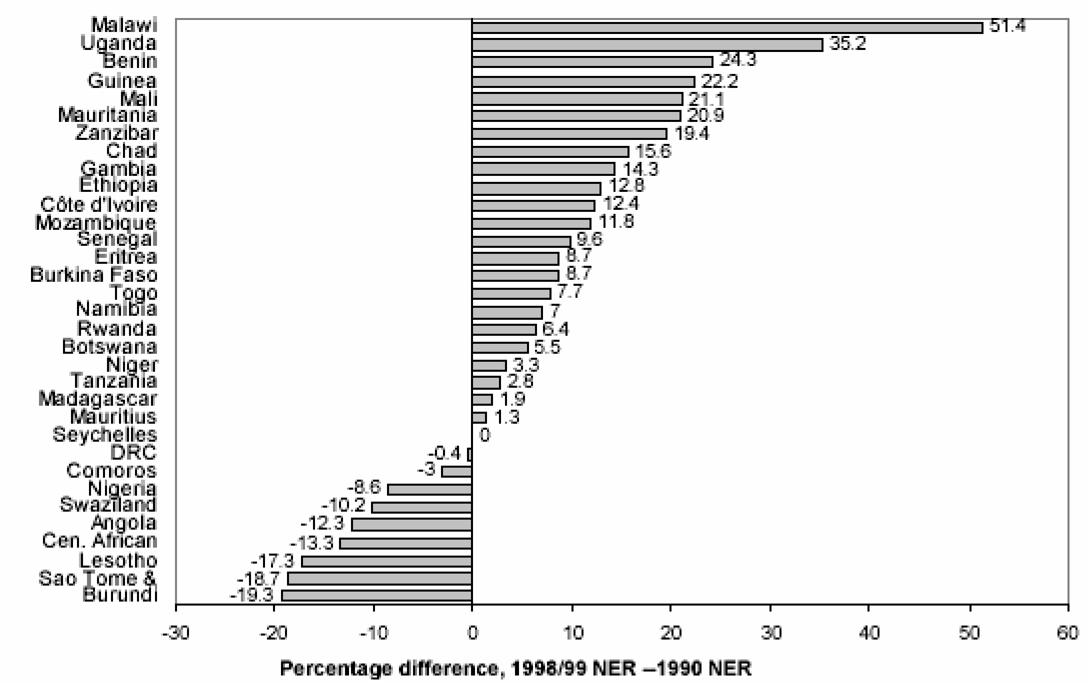


Figure 1.1 shows that although the enrolment ratios have increased since 1990 for both boys and girls, the difference in NER[7] between the sexes has increased.

In 1990 the difference in the net enrolment between boys and girls was about 10%. Since 1990 net enrolment has increased more rapidly for boys than for girls and in recent years the gap between boys and girls is around 13.5% [8] (UNESCO et al., 2000, p. 42). This means that nearly 50% of school aged girls were enrolled in 1990 and 54% in recent years. Boys' enrolment changed from 60% to 68% during the same years (UNESCO et al., 2000, p. 43). From 1990 to 1998/1999 there has been an increase in the NER in several countries in sub-Saharan Africa (see figure 1.2).

Figure 1.2: Percentage increase in net enrolment ratio in primary schools in sub-Saharan Africa from 1990-1998/1999. Source: UNESCO et al. (2000, p. 43).



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7 Net Enrolment Ration (NER) is the number of students enrolled in a level of education who are official school age for that level, as percentage of the population of official school age for that level (UNDP, 2003, p. 352).

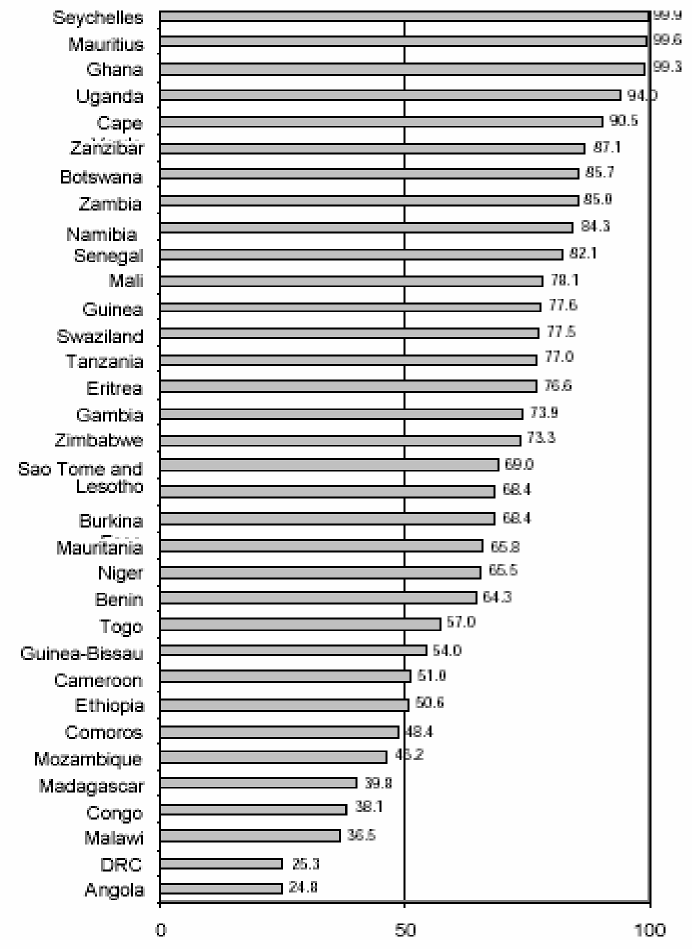
8 There are huge variations in NER across sub-Saharan Africa: In Southern Africa, the Indian Ocean and along the eastern cast south of the Horn of Africa (with the exception of Mozambique), the position of girls relative to boys is very favourable (UNESCO et al., 2000, p. 41). In Malawi, Mauritius Seychelles and Botswana approximately 100% of the girls are in school whereas Ethiopia, Niger, Burkina Faso, Central African Republic and Liberia have NER for girls of less than 30% (UNESCO et al., 2000, p. 43).

The high increase in participation patterns in Uganda and Malawi has to do with change of government policies. Free primary education was introduced in Malawi in 1994. The Gross Enrolment Rate (GER)[9] then doubled from 64% in 1990 to 126% in 1998. A similar pattern has been seen in Uganda since primary education in 1997 was made free for four children per family. At least two of these children have to be girls if there are two or more girls in the family. Since then enrolment in primary schools has more than doubled from 2.6 million to 5.2 million (UNESCO et al., 2000, p. 40). Although the number of pupils attending schools has increased, the funding to go with the policies has been limited. The increase in participation has therefore led to a decrease in quality caused by overcrowded classrooms and limited resources (Naidoo in Zahl, 2004).

Once in school, boys and girls have different chances of remaining in school. Some drop out before they complete the first five years of education, which is considered to be the minimum for acquiring basic literacy. The variations within the different sub-Saharan African (SSA) countries are enormous in terms of the chances for the children to remain in school up until grade 5 (see figure 1.3). While the drop-out rates are higher for girls than for boys in most SSA countries, in Congo, Lesotho, Namibia and Swaziland significantly more girls than boys reach grade 5. One explanation provided to explain this is that boys in these countries leave earlier to work in mines (UNESCO et al., 2000, p. 46).

[9] Gross Enrolment Ratio (GER) is the number of students enrolled in a level of education, regardless of age, as a percentage of the population of official school age for that level. The GER can be greater than 100% as a result of grade repetition and entry at younger or older than the typical age at that grade level (UNDP, 2003, p. 352)

Figure 1.3: Proportion of pupils starting school who complete grade 5. Source: UNESCO et al. (2000, p. 46).



Performance in science at primary school

FEMSA indicated that the performance of girls at primary school final examinations are generally poorer than that of boys in all the four countries that participated in the project's first phase[10], although the differences are not very big (FEMSA, 1997-9, p. 11)[11]. FEMSA did however not have specific data documenting differences in performance in science. In Zanzibar the girls have been found to perform as well as boys, sometimes even outperforming them in science at primary level (Nassor, 2001a, p. 3).

[10] FEMSA was planned to be carried out through three separate phases (see chapter 4). In the first phase, the pilot phase, four countries participated in the project. These four countries were Tanzania, Cameroon, Uganda and Ghana.

[11] The number refers to what number of the Dissemination Reports is referred to. The reference (FEMSA, 1997-9, p. 11) therefore means that the statement is written in Dissemination Report number 9 on page 11.

Participation in science education at secondary level

In developing countries the tendency is for the participation rates to drop significantly from primary to secondary school. In sub-Saharan Africa the gross enrolment rate in secondary education is 29.1% for males and 23.3% for females (UNESCO, 1999a). Also in secondary education the enrolment ratio has increased for both girls and boys over the last decade. The gender gap has however not diminished during this period (UNESCO, 2001).

The participation numbers in science education are not easily available. The results from FEMSA are the most up to date numbers I have had access to. At secondary level the participation rates for girls were significantly lower than those for boys in all science subjects in the FEMSA pilot countries. Table 1.1 shows the percentage of girls enrolled in secondary education who participated in leaving examinations in science. The percentage of boys' participation in leaving examinations in science education is shown in brackets.

	Physics	**Chemistry**	**Biology**
Ghana	35 (65)	35,8 (64,2)	44,2 (55,8)
Tanzania	25	25	Compulsory
Uganda	29,5 (70,5)	36,8 (63,2)	40,3 (59,7)
Cameroon	2-24% of girls choose sciences (district variations)		

Table 1.1: Percentage enrolment of total number of girls and boys (in brackets) enrolled in secondary education who participated at leaving examinations in science. Source: FEMSA (1997-19, pp. 9-10).

Performance in science at secondary school

The FEMSA study showed that girls scored significantly lower than boys in all science subjects in the secondary schools that participated in the first phase of FEMSA (FEMSA, 1997-10, pp. 11-13).

Participation tertiary education

The sub-Saharan average GER in tertiary education was, in 1997, 5.1% for males and 2.8% for females (UNESCO, 1999a). In 2001 FAWE noted that data from ten selected universities in Africa showed that women's enrolment in most universities is below half that of men (FAWE, 2001). Lesotho, Swaziland and Botswana tend to have a higher female participation rate at university level compared to other sub-Saharan African countries. FAWE also observed that women tend to continue to pursue traditional subjects in the areas of education at university level and shy away from the sciences (FAWE, 2001). I have found no data documenting differences in performance in science among males and females at tertiary level.

1.3 Explaining gender inequity in science education

Trying to determine what causes gender inequity in science education has been the focus of much gender research in science education. This research has resulted in an extensive but incoherent body of knowledge suggesting why females are underrepresented and underperforming in some areas of science and science education. This research is considered relevant as a background for my study as it gives insight to one of the main discourses within gender research in science education and an update on different understandings of what causes gender inequity in some areas within science education. It is, however, beyond the scope of this thesis to conduct a detailed review of this massive body of literature[12]. I therefore limit this review to present some of the main factors that are discussed within this discourse as potential explanations to gender inequity in science education.

1.3.1 Biological explanations

Some have attempted to use differences in biology between boys and girls to explain disparities in girls' and boys' participation, interest and performance in some science subjects (Reid, 2003). One such explanation is that that males, due to the physical development of their brain has better developed visual spatial ability than girls (see for instance Child & Smithers, 1971) and that this difference can explain differences in males' and females' interest and abilities in some science subjects (see for instance Gray, 1981). Other studies have found no differences in males' and females' visual spatial abilities and that these abilities depend more on what culture one belongs to than what sex one has (see for instance Jahoda, 1979).

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[12] A review of factors found to impact negatively on females' education in developing countries is provided by UNESCO in the chapter "Why are girls still held back" (UNESCO, 2003a). For a review of the factors affecting girls' science education in particular see for instance Mulemwa (1999) and UNESCO (1999b).

Recent studies have, however, shown that girls in developed countries in many cases are performing just as well in science as boys are, in some cases even better (PISA, 2001; Simon, 2000). A recent trend in some developed countries is in fact that girls outperform boys in most school subjects (Epstein, 1998). Several science educators, after reviewing literature on sex differences, have argued that there is no evidence that biological factors are causing the gender inequity in science education (Kahle & Meece, 1994; Solomon, 1997). When sex differences in performance and participation in science education is still persistent in some areas, this can therefore indicate that the problem of poor performance and participation among girls in science education is more of a pedagogical and cultural problem than a problem caused by sex differences in abilities of learning science.

1.3.2 Poverty

In the context of sub-Saharan Africa poverty is a factor seriously impacting on children's access to education, and therefore also on their access to science education. In a booklet commissioned for UNESCO within the framework of the UNESCO Special project on "Scientific, Technical and Vocational Education (STVE) of Girls in Africa" Jane Mulemwa (1999) discusses what relevance research conducted internationally to identify obstacles facing girls in STVE fields has for Africa. She asserts that many of the major factors identified by international studies are of relevance also in an African context:

> *Many of the major factors that inhibit girls' participation and good performance in the STVE field have been found to be similar across countries and regions. Those that are common include gender biased curriculum and other education materials; poor teaching methods and classroom practices and hence pointing to teacher training; lack of appropriate guidance and counselling of students, particularly girls; and the lack of encouragement and motivation of the girls to pursue studies in these fields (Mulemwa, 1999, p. 3).*

Mulemwa does, however, argue that some factors present in Africa add extra hindrances to girls' access to science in these countries:

> *There are, however, quite a few other problems that have been found to hinder girls' access and continued participation in STVE in developing countries, particularly those of Africa. These range from lack of physical facilities at school such as sanitary facilities, through the loss of opportunities on the "marriage marked" because of the longer duration of STVE courses, to the relative lack of job opportunities for girls compared to boys (Mulemwa, 1999, p. 3).*

The fact that poverty affects girls' access to education is well documented (see for instance UNESCO, 2003a). Poverty both at a societal and a personal level has proven to have a particularly negative effect on girls' education. Direct costs such as school fees, education material and school uniforms make it impossible for many families in developing countries to afford to send their children to school. Loss of child labour is an indirect cost that adds to the price parents have to pay to educate their children. Boys are often given priority if parents can not afford sending all their children to school. This has to do with cultural understandings of boys having higher status than girls, but also because a girl's education is seen as a poor investment since girls are expected to get married and have their husbands provide for them (Mulemwa, 1999; UNESCO, 1999b). Girls also often have more household chores than boys. The introduction of Structural Adjustment Programmes (SAP) in several developing countries in the beginning of the 1990s had a particularly negative effect on girls and women[13]. While the enrolment in education decreased as a result of less public expenditures to education, introduction of school fees etc, the gender gap increased, particularly in primary grades (Brock-Utne, 2000; Heward & Bunwaree, 1999).

UNESCO (2003a) asserts that the AIDS epidemic has further affected girls' education. 13 million children worldwide are now, because of AIDS, left without a mother, a father or both, which makes the children's, workload even heavier than earlier. This applies to girls in particular as they often have to care for members of their family (UNESCO, 2003a, p.127)[14].

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[13] From the beginning of the 1980s, economic and social policies, known as Structural Adjustment Programmes (SAP) were being introduced to and implemented in several developing countries by the World Bank and IMF. The purpose of SAP was to steer economies towards better economic and social performance, to reduce the nations' costs and to enable them to pay back an increasing debt. The means were to open the national economy to imports, reduce the size and role of government, eliminate subsidies to agriculture, encourage privatisation of many economic and social sectors, and to devaluate the local currency (Brock-Utne, 2000; Smukkestad, 1996; Stromquist, 1999). The introductions of SAP have had enormous consequences for the developing countries where they were introduced. The reductions of public expenditures lead to great reductions in the expenditures for health and education (Brock-Utne, 2000).

[14] The AIDS pandemic has also seriously affected schools as a high number of teachers are lost every year due to the pandemic. In Malawi 16% of the teachers die every year due to AIDS related diseases (UNESCO, 2003a).

At a national level, poor economies lead to an insufficient number of school places and low school quality (Colclough et al., 2000; UNESCO, 2003a)[15]. Factors such as long distances to schools and poor sanitary facilities are also factors that have been shown to have a particularly negative impact on girls' school attendance (UNESCO, 2003a). The FEMSA pilot study (1997) showed that poorly equipped schools affected girls more negatively than boys, as girls often lose out in the physical fight for equipment and furniture in overcrowded, under- furnished classrooms (FEMSA, 1997).

1.3.3 Socio-cultural expectations

Formal and informal cultural expectations of the role of females in society add to the obstacles caused by poverty. In patriarchal societies, females are in many cases not protected by the same laws as males. One effect of this legislation is that girls are not given the same legal rights to education (UNESCO, 2003a). Lack of political will to address inequalities in girls' and boys' educational opportunities is hence a contributing factor keeping girls away from school.

Colclough, Rose and Tembon (2000) assert that poverty at household and national levels is associated with an under-enrolment of school-age children, but that the *gendered* outcomes of such under-enrolment are the products of cultural practice, rather than of poverty per see. They show that gender inequalities in schooling, measured in both quantitative and qualitative terms are not necessarily reduced when income rises. Socio-cultural perceptions about the role of females in society hence play a central role in keeping female participation in schools low. In patriarchal societies where girls are seen as less important than males, factors such as gender discrimination and sexual harassment become evident. One factor found to keep girls away from school is the fear of sexual harassment by teachers, male pupils, and people they meet on their way to school (UNESCO, 2003a). Cultural perceptions about what roles females are to play in society also have an impact since education is often not valued as important for girls.

The impact of socio-cultural expectations of females and females' education seems to be particularly evident in science education since science has maintained its image as a special masculine domain (UNESCO, 1999b).

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[15] Some of the poorest countries in sub-Saharan Africa spend more money on military spending than on education. In 2001, Angola spent 3.1% of the countries Gross Domestic Product (GDP) on the military compared to 2.7% on education. Sierra Leone spends 3.6% of GDP on the military and 1.0% on education (UNDP, 2003).

Whereas the perception of science as masculine and hence not suited for girls is still persistent also in many developed countries, the message is not communicated as openly to pupils in most developed countries as what seems to be the case in sub-Saharan Africa (Mulemwa, 1999; UNESCO, 1999b). Girls in these countries are often told by parents, teachers and peers that science is not suitable for girls. Choosing to pursue a career in science is therefore in many sub-Saharan African countries regarded as masculine. Females who choose this career path are often looked upon as less feminine and thus regarded as less attractive on the marriage market (Mulemwa, 1999; UNESCO, 1999b).

Educated women in sub-Saharan Africa are also discriminated against on the labour market (Colclough, 2000; Mulemwa, 1999; UNESCO, 2003a). In countries with high unemployment rates, this makes it even less attractive for parents to pay for an expensive education for the girls.

1.3.4 Lack of confidence in science

One difference among girls and boys in science education that is pointed to by gender researchers in many countries is the difference in self-confidence (Andre, Whigham, Hendrickson & Chambers, 1999; Imsen, 1996; Kenway & Gough, 1998; Mbano, 2001 a). Studies have shown that even when girls tend to perform just as well as boys, their confidence relating to their abilities of learning science is lower than what applies to the boys. It is claimed that the low performing boys have higher self-confidence in their own abilities for learning science than the high-performing girls.

1.3.5 Attitudes and interest

> *Sex is probably the single most important variable related to pupils' attitudes to science (Gardner, 1975, p. 1).*

Studying differences in males' and females' *attitudes* and *interests* in science education is less controversial than studying differences in *abilities*, and constitutes a more popular research praxis among science educators. Small scale studies (see for instance Chambers & Andre, 1997; Greenfield, 1996; Parsons, 1997) as well as large scale studies (see for instance Jones, Howe & Rua, 2000; and Sjøberg, 2000) has documented differences in girls' and boys' attitudes to and interest in science in school. After conducting an analysis of literature on sex differences in children's attitudes to science from 1970 to 1991, Weinburgh (1995) concluded that boys in general were more positive to school science than girls. There were, however, differences in terms of which disciplines within science education girls and boys tended to like. While girls in general seemed to have more positive attitudes than boys to biology, boys in general were found to have more positive attitudes towards physics and chemistry. Similar patterns have also been found in other research projects (Osborne, Driver & Simon, 1998; Simon, 2000; Sjøberg, 2004). Several researchers have argued that differences between girls' and boys' interests in science are linked to the former experiences of the pupils (Johnson, 1987; Jones et al., 2000; Kahle & Lakes, 1983; Smail & Kelly, 1984; Thomas, 1986). While the girls dominate in activities that have to do with the body and health issues, and are interested in activities with an aesthetic dimension, boys tend to show interest in activities connected to cars, weapons, electricity and mechanics (Sjøberg, 2004).

Several studies have shown that girls' and boys' attitudes tend to change as pupils move from primary to secondary education (See for instance Davies & Bremer, 2001; Imsen, 1996; Kahle & Meece, 1994; Lie, Kjærnsli & Brekke, 1997; Mbano, 2001a, 2001b; Nassor, 2001a, 2001b; Osborne et al., 1998; Reid, 2003). While girls generally express positive attitudes towards science at lower levels, they tend to lose interests in science and develop negative attitudes towards the subject as they move to secondary school. In a recent study from Scotland, Reid (2003) showed that by introducing a new type of application-led physics education syllabus at secondary school level, positive attitudes of girls towards physics at this level wee restored. They did, however, see that the actual character of the applications of physics had a different appeal to boys and girls. While girls were drawn to themes that were perceived to have a high social relevance, boys tended to be attracted to those perceived to have a high mechanical or practical relevance (Reid, 2003).

Studies concerning determining factors for girls' choice of future careers has shown that girls more than boys tend to opt for careers that enable them to work with human beings and help other people. Boys on the other hand seem to be more concerned about getting a job that will give them high status and earn high wages (Angell, Henriksen & Isnes, 2003; Baker & Leary, 1995; Myrland, 1997). Earning high wages does not longer seem to be a fruitful explanation to female underrepresentation in several science studies and engineering schools. Even though engineers still earn higher wages than nurses, science subjects have over the past years lost much of its status and becoming an engineer is no longer a guarantee for getting a well paid job. Studies that do lead to well paid jobs, such as law and medicine, are, on the other hand increasingly being applied to by girls.

Research documenting differences in interests and attitudes amongst pupils has recently tended to focus less on documenting differences between boys and girls and more on the differences that exist among pupils of the same sex. It has been argued that research that focuses on documenting differences between pupils on the basis of their sex reinforces and creates stereotypes (Brickhouse, Lowery & Schultz, 2000; Osborne, 2003). When one seeks to detect differences between boys and girls, it is easy to tone down and overlook similarities between the sexes and also differences within pupils of the same sex. While some argue that factors such as ethnicity and age are more important determining factors than sex when it comes to attitudes and interests in science (Greenfield, 1996), others see individual differences within the sex and race groups as relevant for the development of interests and attitudes to science and claim that identity formation is a major factor influencing girls' and boys' choices of future careers (Brickhouse et al., 2000; Scantelbury, 1998).

1.3.6 Identity formation

> *If students are to learn science, they must develop identities compatible with scientific identities (Brickhouse et al., 2000).*

Several science educators have explained gender differences in science education arguing that science and science education has a masculine image that does not fit female identities (see for instance Kahle & Meece, 1994; Kelly, 1985; Sjøberg, 2000).

Much is written to explain how the masculine identity of the natural sciences was developed. Several researchers have written about the development of the Cartesian dualism (Descarte's divide between mind and nature) and how this stock of ideas came to influence the way academics thought about the divide between mind and nature. Much is also written about how science was later developed as a masculine enterprise connected to masculinity and the mind, whereas nature increasingly came to be identified with femininity and women (Bordo, 2001; Code, 2000; Keller, 1985, 2001; Lloyd, 1984; Longino, 1990). In spite of Francis Bacon's proclaimed creation of an objective science, he described the new scientific and philosophical culture of the seventeenth century as "a truly masculine birth of time" (in Bordo, 2001, p. 95). Similarly Henry Oldenberg, secretary of the Royal Society, asserted in 1664 that the business of the Royal Society was to raise a "masculine philosophy" (in Bordo, 2001, p. 95).

Keller (1985) writes that the development of modern science in the 17th century was developed as a masculine enterprise in the sense that culturally defined values associated with masculinity (i.e., objectivity, reason, mind) came to be those values that were closest aligned with science. As such, not only was masculinity culturally defined in opposition to femininity, but scientific was also defined in opposition to femininity (Brickhouse, 2001). Recognising the centrality of such ideas to modern science has led feminist critics of science to characterise modern science in terms of a masculinisation of rational thought (Keller, 1987). Similarly Carl Stern has said that "what we encounter in Cartesian science rationalism is the pure masculinisation of thought" (Stern, 1965, p. 104).

The feminist critique of this enlightment epistemology hence describes how the enlightment gave rise to dualisms (for example masculine /feminine, culture/nature, objectivity/subjectivity, reason/emotion, mind/body), which are related to the male/female dualism in which the former (for example masculine) has been valued over the latter (for example feminine). I discuss feminist critique of science in more detail in chapter 2.

In the article "Sex and the 'body language' of science" Sjøberg (2000) argues that the reasons for girls' underrepresentation in science is not lack of abilities or self confidence, but has to do with the masculine "body language" of science. Building on the work of Merton (1942/1973) he argues, that science through the historical development from Aristotle to Bacon has gained an image that seems incompatible with female values and identities. In addition to characterising the ideals of science, Sjøberg presents the opposite to the characteristics of science and shows how these characteristics are often associated with female traits. He uses the development of these dichotomies as an explanation to why females, particularly females in western industrialised countries, are not attracted to science. Sjøberg asserts that girls, in spite of equal opportunities and encouragement to study science, manage to discover this hidden message within science education saying that science is masculine and thus better suited for the male part of the population (Sjøberg, 2000).

The message of science's immanent masculinity seems to be more openly communicated in non-western than in western contexts. Studies such as FEMSA showed that girls in Africa are often told that science is not suited for females and thus encouraged not to choose science (Mulemwa, 1999, p. 24). Still choosing to study science also in western contexts could be seen to actually weaken a girls' identity as a girl and make her appear less feminine (Kleinman, 1998; Sjøberg & Imsen, 1988).

In the article "What Kind of a Girl does Science? The Construction of School Science Identities" Brickhouse et al. (2000) question the consequences of research that considers girls' identities only in comparison to boys:

We wonder whether this research has exaggerated the differences between girls and boys and not attended to the diversity within these groups (p. 456).

Brichouse et al. claimed that documenting differences in female and masculine identities and how these identities match and/or do not match the scientific identity might pose a danger of creating unintended and unwanted stereotypes and characteristics of science as well as of what it means to be female. Creating dichotomies might be valuable in visualising a continuing masculine image of science and how this can represent a repulsive picture of the scientific body language to pupils who encounter science in school. At the same time, such dichotomies might continue to preserve a stereotypical picture not only of science, but also of female identity, which in turn perhaps can colour both teachers and pupils' view of what constitutes a female identity. I will return to these issues in more detail in chapter 2.

1.3.7 Gender insensitive science education

The last types of explanations provided to explain gender inequity in science education that I will mention here are the ones focusing in particular on how science is presented in schools. The fact that females are underrepresented in several science subjects and tend to lose interest in these subjects as they move up through the grades has led to many attempts to find out what is "wrong" with science education. Such studies have illuminated various aspects of science education that have been suggested to have a negative impact on female participation and performance in science education.

Much research detecting masculine bias in science education was carried out 20 years ago. In many of the countries where this research was carried out, much has been done to address the factors identified through this research. Most African countries seem to lag behind developed countries in terms of addressing these obstacles. Many of the factors identified in "western" studies two decades ago still seem persistent in African schools. But in spite of the fact that many of the factors identified in science education were "discovered" many years ago, and many countries have done much to address these obstacles, girls –and now also boys- still shy away from and lose interest in several areas of science education world wide.

Several studies have documented classroom practices where teachers, because the boys are more active and noisy, tend to give more attention to boys than to girls (Imsen, 1996; Kenway & Gough, 1998; Mulemwa, 1999; Rosser, 1990; Zonneveld, Taole, Nkhwalume & Letsic, 1993). A number of studies have also shown that science teachers often have lower expectations of girls than boys (FEMSA, 1997; Kahle, 1985; Keneway & Gough, 1998; Rosser, 1990).

The underrepresentation of female science teachers and hence lack of female role models, particularly in secondary schools have also been shown to have a negative impact on girls (FEMSA, 1997; Kahle, 1985; Lie et al., 1997).

Much research has also focused on studying learning strategies applied in science classrooms in order to determine any difference in girls' and boys' preferences for particular strategies. Such studies have questioned whether girls prefer and adopt learning strategies that are not widely used in science classrooms, and whether this again can provide explanations to girls' underrepresentation and lack of interest in science (see for instance Harding, 1992; Reid, 2003). Mulemwa (1999) argue that inquiry centred teaching methods have proven more effective than rote learning and "chalk and talk" teaching methods, particularly for girls in Africa. This, she claims, is because girls are often more exhausted coming to school than the boys after doing a lot of home chores before school starts. Inquiry learning methods is therefore, according to Mulemwa, better suited as a teaching method for girls since it enables girls that come tired to school to be more active than rote learning methods allow for. In most sub-Saharan countries emphasis is put on teacher centred learning strategies fostering rote learning and memorisation (Mulemwa, 1999; Rollnick, 1998). There are a number of reasons to why such learning strategies are so widely used in African countries. One factor is economy as most schools have few opportunities to purchase teaching and learning material that foster inquiry learning (FEMSA, 1997). Another factor is the large classroom sizes that make inquiry based learning strategies an extra challenge to pursue (Onwu, 1998).

When it comes to studies of girls' and boys' preferences for working in groups, different studies give different answers. While some studies claim that girls prefer working in groups more than boys (Imsen, 1996; Mulemwa 1999) other studies have shown no difference in girls' and boys' preference for group work (Meece & Jones, 1996). Mulemwa (1999) suggests that girls' preference for working in groups and favouring less competitive learning methods than boys in an African context might be caused by their cultural upbringing and is thus also culturally conditioned:

> *There is some research and anecdotal evidence to suggest that unlike men, women may be more comfortable in and responsive to instructional methods that foster cooperation rather than competition. This might be so because of up-bringing, particularly in Africa, where as home makers and people who provide care for society in general,*

women are often trained and encouraged to tolerate and cooperate with others and share resources. Therefore, involvement in discussions and group work, leading to cooperative rather than competitive learning may encourage girls' participation more (Mulemwa, 1999, p. 24).

The pilot study of FEMSA showed that the science curriculum and syllabus used in the four pilot countries built mainly on boys' interest and experiences (FEMSA, 1997; Mulemwa, 1999). Other research has shown how different types of teaching material discriminate girls. Examples of such discrimination might be science textbooks that reinforce gender stereotypes (Kahle, 1985; Lie & Sjøberg, 1984) and science textbooks that show more pictures of males than of females (Kahle, 1985; Lie & Sjøberg, 1984; Whatley, 1988). Studies of language used in science textbooks revealed overemphasis of the use of the word "he" compared to "she" and use of sexist metaphors (Kahle & Lakes, 1983; Kahle, 1985; Sjøberg & Imsen, 1988). Textbooks have also been found to be uncritical and not challenging the masculine image of science (Eisenhart & Finkel, 2001).

Education in sub-Saharan Africa is often examination-driven. In a review of papers used for the selection for secondary schools in nine African countries, Lewin (2000) showed that science examinations at secondary school entrance level still weighted recall more than the ability to utilise knowledge. Some studies claim to have found that certain assessment practices applied in science education can favour boys (Erinosho, 2002; Rosser, 1990).

1.4 FEMSA and AFCLIST – Two initiatives that address gender inequity in science education

To study how science education initiatives currently work to address gender issues, I have chosen to focus on the Female Education in Mathematics and Science (FEMSA) project and African Forum for Children's Literacy in Science and Technology (AFCLIST). These particular initiatives have been chosen as my cases since they at the time when I started working with my dissertation represented the two major science education initiatives in Africa. FEMSA and AFCLIST were both started by donors. AFCLIST was made independent from their main donor, the Rockefeller Foundation, in 1997 and has later developed into a Non Governmental Organisation (NGO). FEMSA was taken over by FAWE in 2001 who were supposed to carry the project on through their organisational structures. FEMSA and AFCLIST are the only two initiatives supported by Norwegian aid that have science education as their main focus[16]. The initiatives represent two very different ways of addressing gender issues in science education. Only one of the two projects has gender issues as its main focus. By using two projects with different approaches to gender issues, I hope to visualise how gender issues can be addressed in two very different ways.

1.4.1 FEMSA

Female Education in Mathematics and Science in Africa (FEMSA) was launched by the Donors to African Education (DAE), now the Association for the Development of Education in Africa (ADEA)'s Working Group on Female Participation (WGFP) in 1995. By the end of 1995 FEMSA was established as a project under WGFP. The Norwegian Agency for Development Cooperation (Norad) became the leader of a consortium of donors supporting the project.

The central goal of FEMSA has been to improve the participation and performance of girls in Science, Mathematics and Technology subjects at primary and secondary school levels. FEMSA also aimed at invigorating ministers of education and policy-makers to make necessary adjustments in curricula, teacher training and examinations to ensure fuller participation and better achievements by girls in Science, Mathematics and Technology (SMT)-subjects (O'Connor, 2002a).

FEMSA has been carried out in two phases. The first phase of the project lasted for two years and involved four countries. The objective of this first phase was to expose the obstacles that effect girls' performance and participation in science education.

The objective of the second phase of FEMSA project was to change the policies and praxis taking place in the particular countries to combat the obstacles identified through the first phase of the project. Eleven countries participated in FEMSA's second phase. Interventions carried out as parts of the second phase have been multiple and varied. They range from sensitisation and awareness building of teachers, parents and pupils regarding the problems girls face in learning science and mathematics, to motivational activities for the girls, teacher capacity building and instructional material development. The second phase of FEMSA came to an end in December

[16] FEMSA and AFCLIST are the only initiatives in sub-Saharan Africa supported by Norwegian aid that focus solely on science education. Norway does, however, support other initiatives that also address science education such as for example UNESCO.

2001 as the project was handed over to the Forum for African Women Educationalists (FAWE).

1.4.2 AFCLIST

African Forum for Children's literacy in Science and Technology (AFCLIST) started up in 1989 as a Grants Programme under Rockefeller Foundation (RF) giving grants to innovative science education projects and individuals in sub-Saharan Africa. In 1995 AFCLIST was established as an independent initiative, still however financially supported by RF, but also of a number of other donor agencies, amongst these, Norad. AFCLIST is not a gender inititative as it targets both girls and boys equally. Still AFCLIST has since 1995 stated as a guiding principle that all AFCLIST activities should include elements that “Improve the participation and performance of girls” (AFCLIST, 1998c).

AFCLIST is now organised as a joint programme under the University of KwaZulu Natal in South Africa and Chancellor College in Malawi. AFCLIST operates as a network of people working within the field of science education in sub-Saharan Africa. AFCLIST gives professional support and canalises funds from a group of donors to individuals and institutions that are committed to developing interest and skills in science among children throughout sub-Saharan Africa.

AFCLIST organises its activities through four “programmes”. The “Grants Programme” is set up to give grants and support to individual science educators throughout sub-Saharan Africa. Through AFCLIST’s “Network programme” AFCLIST aims to follow up grantees, assist them in further development of their work and have them share their ideas with science educators in other parts of sub-Saharan Africa. Through its “Publication Programme” AFCLIST supports members of AFCLIST in publishing their work. The “Nodes Programme” is organised to institutionalise the developments from AFCLIST. Through establishing nodes, or centres of excellence at selected institutions, AFCLIST seeks to encourage grants holders to use their experiences to impact the educational system on a more permanent basis (write textbooks, engage in educational systems etc). AFCLIST has by now established nodes in seven sub-Saharan African countries (see chapter 5).

In this thesis I will discuss FEMSA’s and AFCLIST’s distinct approaches to gender equity in science education. My purpose is not to evaluate the two initiatives and I have not studied their impact. A comparison of the impact of the two initiatives would have to account for the fact that the two initiatives' funding situation has been of quite a different order during the years both initiatives were operating. According to numbers from to the Donors' Consortium of FEMSA and by the secretariat of AFCLIST, FEMSA's budget was approximately four times the size of that of AFCLIST during these years[17]. Comparing the impact of these initiatives would therefore be problematic. My focus is hence restricted to use the two initiatives as cases to study different approaches to gender equity in science education. In the next chapter, I will present the theoretical framework that I have developed to analyse how these two initiatives work towards increased gender equity.

[17] According to budgets presented to the Donors' Consortium of FEMSA and to the Advisory Board of AFCLIST, the annual budget of FEMSA was approximately 1.2 million US$ while the annual budgets of AFCLIST since it was made independent from the Rockefeller Foundation in 1997 has been approximately 315 000 US$.

2. Feminist theories as an analytical framework

2.1 Introduction

> *I am convinced that feminist theory can inform and possibly even transform science education, but there is a need for work that brings science education and feminist theory together (Howes, 2002, p. 11).*

Several theoretical discourses might be appropriate to advance our understanding of how gender equity in science education can be achieved. I have chosen to explore whether feminist theories and their critiques of science[18] may contribute to a better understanding of possible approaches to gender equity in science education.

Feminist critiques of science offer different perspectives upon how the sex/gender of a researcher impacts on practices within scientific communities. In this chapter, I first map three positions provided by feminist critiques of science on how the sex/gender of scientists affect their engagement in scientific inquiry. Then I use the positions identified to reflect on ways that sex/gender might influence pupils' engagement in science education and what gender initiatives in science education that might follow from each position.

What I see as implications for gender reform programmes grounded in each position are discussed and displayed in two tables (Table 2.1 and 2.2). These tables represent my theoretical framework. The theoretical framework is later used in this thesis to analyse how two initiatives work towards gender equity in science education. The purpose of presenting the different positions is to show how different perspectives on how sex/gender impacts on how people engage in science inquiry may suggest different implications for gender reform programmes aiming at gender equity in science education (see Figures 2.1 and 2.2). The intention in this chapter is not to argue for one position over

[18] I use science as term to represent all natural sciences. Although all feminist critiques may not be applicable to all disciplines within the natural science, it is common within feminist literature to refer to this discourse as feminist critique of science. I question the relevance of the critique to various science disciplines in chapter 7.

the other. My personal opinion about which position I consider to be the best suited to reach gender equity in science education is therefore not considered relevant in this chapter and will be discussed in chapter 7.

Few have attempted to apply feminist theories and critiques of science to analyse gender and science education initiatives[19]. There is a limited amount of literature available that discusses the implications and relevance of this theory for gender and science education reform programmes. The people who have utilised feminist theory as a resource in science education (see for instance Barton, 1998; Brickhouse, 2001; Howes, 2002; Rosser,1990; Scantlebury, 1998; Shulman, 2001; Whatley, 1988; Ødegaard, 2001) have used this theory mainly to position themselves, and to outline the implications of their positions for gender and science education reform. Presenting feminist critiques of science for the purpose of creating an analytical framework to understand various approaches to gender equity in science education is therefore an exploratory task.

2.2 Criticising science from feminist perspectives

Most attempts to explain why females are underrepresented in science tend to end up criticising science and/or science education practices. Within the feminist philosophy of science, natural science and scientific inquiry are criticised for the discrimination and alienation of women. Similarly feminist and postcolonial critiques of science have shown a discrimination of non-western males as well as females (Harding[20], 1998; Shiva[21], 2001).

Feminist critiques of science are in many ways an extension of the critique raised against the status of scientific knowledge as objective and neutral. Creating objective knowledge free from superstition and religious beliefs was

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[19] Eisenhart and Finkel (2001) is the only publication I have come across that attempts to use feminist theory to analyse education reform programmes in science education. Barton (1998) has analysed what gender initiatives in science education have followed historically from the different "waves" of feminist critique of science.

[20] Sandra Harding, a philosopher, is Professor of Education and Women's Studies at UCLA, where she also directs the Centre for the Study of Women. Harding has lectured at over 200 universities and conferences around the world. She currently co-edits *Signs: A Journal of Women in Culture and Society*, one of the most prestigious journals in Women's Studies.

[21] Vandana Shiva is a leading contributor to feminist critique of Third World development, both as a writer and an activist. A physicist by training, she has drawn analogies between the reductionist nature of western science and capitalist development in their combined exploitation of women and nature, particularly in her country, India.

a driving force for the scientists often referred to as the creators of modern science in the 17th century. The ideal was to eliminate the researcher's influence upon the research process for the purpose of creating neutral and objective knowledge. The researcher was to be a neutral observer with no influence on the scientific knowledge being produced. The inductivist method developed as the "scientific method" was based on the notion that scientific inquiry should start with observations carried out by an unprejudiced scientist. Based on these observations (the observations should be repeated under different conditions, several times, and not be in conflict with the derived universal law) the scientist could create general laws describing nature. According to this view of scientific inquiry, the scientist should not at all have any influence on the research results, as the scientists ideally were seen as transcendent neutral observers "reading the book of nature" (Francis Bacon, 1551-1626).

Since the birth of modern science, scientific inquiry's status as a producer of neutral and objective knowledge has been challenged from several stances. Karl Popper (1902-1994) criticised those who adhered to the inductivist method for their claim to be able to provide objective knowledge. He developed a normative theory discussing how scientific research should take place. Imre Lakatos (1922-1974) gave a descriptive critique of science by pointing to the social influences shaping scientific inquiry. Perhaps the most influential critique of the perceived neutrality of scientific knowledge was raised by the historian of science, Thomas Kuhn (1923-1996). In his most influential work "The Structure of Scientific Revolutions" (1962 /1970), Kuhn claimed that scientists always operate within a special context, a paradigm, and that this paradigm will have major impact on scientific inquiry (Kuhn, 1962 /1970). Kuhn demonstrated, with examples from early modern Europe, that "old" theories were often discarded and replaced by "new", not necessarily because the new ones were truer, but because events within society made the new theory more acceptable. Kuhn was only one of several researchers from a variety of disciplines who criticised the objective image of science in the decades following World War II. Their treatment of science as determined by historical, sociological, cultural and political factors, launched a revolution in the philosophy of science (Harding, 1998). This critique against the classical scientific ideal has been an important influence for the development of feminist philosophies of science (Keller, 1987). The developments of critical theory and hermeneutics have been other influencing factors on the development of feminist philosophy (Bondevik & Rustad, 2001). Keller (1987) asserts that the development towards an increased acceptance of the impact of the scientist on knowledge production has been a prerequisite for feminist critique of science.

> *As long as the course of scientific thought was judged to be exclusively determined by its own logical and empirical necessities, there could be no place for any signature, male or otherwise, in that system of knowledge. Furthermore, any suggestion of gender differences in our thinking about the world could argue only too readily for the further exclusion of women from science. But as the philosophical and historical inadequacies of the classical conception of science have become more evident, and as historians and sociologists have begun to identify the ways in which the development of scientific knowledge has been shaped by its particular social and political context, our understanding of science as a social process has grown. This understanding is a necessary prerequisite, both politically and intellectually, for a feminist theory in science (Keller, 1987, p. 236-237).*

The critique of positivism/post positivism in conjunction with critical theory and hermeneutics were important for feminists in providing arguments against the neutrality of scientific knowledge. They did not discuss the particular influence of sex/gender on the production of scientific knowledge. The feminist philosophers of science have thus brought a new dimension into this critique by discussing the role sex/gender might play in knowledge production (Keller, 1987).

Feminist critics of science do not speak in one voice. The critique raised is varied and rich, and reflects different academic perspectives and fields of interest. Much of the feminist critique levelled against the natural sciences has focused on visualising the way the scientific enterprise, under the cover of being neutral and objective, has actually discriminated against females and how this discrimination in turn has alienated women from the field. From the beginning of the 1990s, the critique has been expanded to include parameters other than sex such as race, class and sexual preferences. After being faced with critique for having argued only from the perspective of western, heterosexual women from a middle class background, most feminists now take into consideration how other parameters may play important roles in the creation of knowledge. The feminists have thus acknowledged and incorporated into their critique that not only women but also people with a different background than western males have been discriminated against in science (Harding, 1998; Shiva, 2001).

2.3 Separating positions within feminist critiques of science

2.3.1 Sex versus gender

One dimension that can be used to separate the different positions within feminist theory is the different understandings amongst feminists of the connection between biological sex (sex) and social sex (gender). Gender, in the definition provided by UNESCO (2003 b) refers to the social relations between men and women, which are learned, vary widely among societies and cultures and change over time:

> *Gender refers to the roles and responsibilities of men and women that are created in our families, our societies and our cultures. The concept of gender also includes the expectations held about the characteristics, aptitudes and likely behaviours of both women and men (femininity and masculinity). Gender roles and expectations are learned. They change over time and they vary within and between cultures. Systems of social differentiation such as political status, class, ethnicity, physical and mental disability, age and more, modify gender roles (UNESCO, 2003b, p. 15).*

Sex is in the same document defined as:

> *Sex describes the biological differences between men and women, which are universal and determined at birth (UNESCO, 2003b, p. 15).*

According to the Encyclopedia of feminist theories (Code, 2000) the distinction between “sex” referring to biological sex and “gender” referring to social sex was first formulated explicitly by feminists in the middle of the 20th century. Although Simone de Beauvoir did not herself use the term gender, her famous assertion that “One is not born, but rather becomes a woman” (Beauvoir, 1949/1953) inspired feminists’ arguments against sex as destiny (Owen, 2000, p. 221).

Currently it seems like the term gender may often be used as a euphemism in the English language as a replacement for the word sex, in order to avoid sexual connotations. The distinct meaning of gender as compared to sex currently does not seem widely understood by people who are not explicitly dealing theoretically with issues of gender (Rennie, 1998). Although UNESCO’s definitions of the distinct meanings of sex and gender seem straight forward and fairly easy to separate from each other, they are continuously being debated within feminist literature[22] (Acker, 1992; Butler, 1999; Haraway, 1988/2003; Moi, 1998). Poststructuralist[23] feminists like Donna Haraway and Judit Butler have criticized the notion of biological sex as something stable and hence unquestionable, and have argued that what is regarded as biological sex also changes over time[24]. Other feminists have concentrated on discussing different understandings of the term gender. A central question within these discussions is how closely gender is linked to sex and hence to what degree gender roles[25] are determined by other than biological factors. Moi (1998, p. 25) asserts that feminist theoreticians today use so much energy to argue against biologically based essentialism[26], that they forget that generalisations about social sex can be just as oppressive as generalisations about biological sex. This tendency to generalise about social sex has been criticised by black feminists arguing that social sex has been defined by an understanding of what it means to be a white middle class woman (hooks, 1984). The understanding within feminism of what it means to be a woman has also been criticised by proponents of queer (lesbian / gay) theory (Stacy & Thorne, 1985).

My point of view is that feminist theories that discuss the distinction between sex and gender can be relevant for gender and science studies since they can contribute to a broadening of the understanding of how sex/gender impacts

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[22] The reason for using the definitions from UNESCO's publications rather than others found in feminist literature is that most definitions in feminist literature tend to see this distinction as problematic and hence do not provide clear definitions of what constitutes each concept. Entire books have been written about this distinction. See for instance "Theorizing gender" (Alsop, Fitzimons & Lennon, 2002).

[23] Poststructuralism and postmodernism are two distinct but related terms. Poststructuralism refers to a body of diverse theories (Derrida, Lacan, Focault, Kristeva) which take as their initial point of reference the structural linguistics of the Swiss linguist Ferdinan de Saussure. The term postmodernism was first used in architecture to describe the ways in which architects were breaking with the conventions of international modernism. Like poststructuralism, postmodernism questions some of the fundamental assumptions of the Enlightment tradition in the west. These include the belief in rational, human progress, universal standards and values, and singular truths (Weedon, 2000).

[24] Poststructuralist feminists use transvestites and hermaphrodites to exemplify how sex is not absolute. Moi (1998) argues against this by claiming that the existence of exceptional cases does not undermine the fact that regularities do exist.

[25] The Encyclopedia of Feminist Theories (Code, 2000, p. 223) explains "Gender roles" as social practices associated with masculinity or femininity and unlike the term "sex-roles" not necessarily linked to sex.

[26] Biological essentialism refers to a metaphysical position claiming for instance that women's nature is determined by biology. Several feminist critics have challenged biological essentialism as an explanation of women's nature.

upon females' engagement in science. Different perspectives on the relationship between sex and gender can be used to discuss different understandings of how much of the underrepresentation and underperformance of females in science can be explained by nature and nurture respectively. As I showed in chapter one, there are good reasons to be sceptical of any evidence claiming that there is a correlation between biological sex and the ability to engage in science. In this chapter, I do not discuss theories that consider biological determinism as an explanatory model for sex differences in female participation and performance in science. But even if one accepts that an ability to engage in science and become a scientist is not determined by sex, sex can still be an influencing factor affecting females' participation and performance in science. This is because we live in a gendered society where sex is a main organising principle and hence a major determining factor of how males and females are raised.

2.3.2 How does sex/gender impact upon peoples' engagement in scientific inquiry?

> *What is it about science –or about women- or about feminists- that explains the virtual absence of a feminist voice in the natural sciences, as an integral part of the sciences, with the single exception of primatology? And what would such a voice sound like? How would science be different? How would our perceptions of the natural world, of women and men be transformed? (Bleier, 1988, p.1).*

These questions were raised by the feminist critic of science, Ruth Bleier[27] in 1988. Similar questions are still being raised by feminist critics of science – and various attempts are also still being made to try to answer them. For the purpose of developing an analytical framework, I explore various answers to these questions provided within feminist critiques of science. I separate the different feminist positions from each other based on their interpretation of how sex/gender can be seen to impact on males' and females' approaches to scientific inquiry.

Much of modern science has been developed by white, western males. Depending on what impact one believes the masculine influence has had on scientific inquiry, different feminists propose different solutions to how this situation might be changed. A central distinction pointed to by Sandra Harding (1986) separates those who believe the task of feminist analysis is to

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[27] Ruth Bleier (1923-88), an American medical doctor and specialist in neuroanatomy, is one of the major feminist critics of science who have developed critiques of sexist assumptions in biology.

object to bad practice in science (Harding's "bad science") from those who think that the whole scientific enterprise, its purpose, practice and functions (Harding's "science as usual") –should be the target of feminist criticism (Harding, 1992, p. 57). Harding asserts that the critics of "bad science" think that insufficient care and rigor in following existing scientific norms is the cause of sexist and androcentric[28] results of research. They therefore believe that androcentricm in science inquiry can be removed and objectivity can be re-established provided that sufficient rigour in research praxis is taken care of. According to Harding the critics of "science as usual" on the other hand do not believe that rigor in research praxis is sufficient to acquire a non-sexist science. While some critics of "science as usual" dismiss the possibility of objective scientific knowledge, other critics provide suggestions to how a more objective scientific inquiry could be developed.

Harding points out the importance for feminists concerned with science to keep this distinction in mind when producing arguments and initiatives to increase female participation in science:

> *Of course, not all feminists concerned about science adopt only one of these agendas. A few are concerned to explore the relationship between them, many others simply draw on whichever agenda seems appropriate at the moment and do not worry about the way these projects conflict. But many- perhaps even most- of the feminists concerned with science find compelling only one or the other of these two general approaches. I find this situation troubling for a number of reasons. For one thing, if it is science-as-usual that is the problem, then it appears that feminists should not encourage more women to become part of this problem (Harding, 1992, p. 58).*

Harding points to the fact that the implications of these two types of feminist critiques of science for gender reform in science education would be different. While adherents to the first type of critique would see it as a sufficient to address factors external to science in order to have more females involved, adherents of the second type of criticism would find it necessary to challenge androcentrism implicit in scientific epistemologies. Harding positions herself as a critic of "science as usual" and argues that unless androcentrism and discriminatory practices implicit in science are addressed, there is no point in recruiting more females to this enterprise (Harding, 1992).

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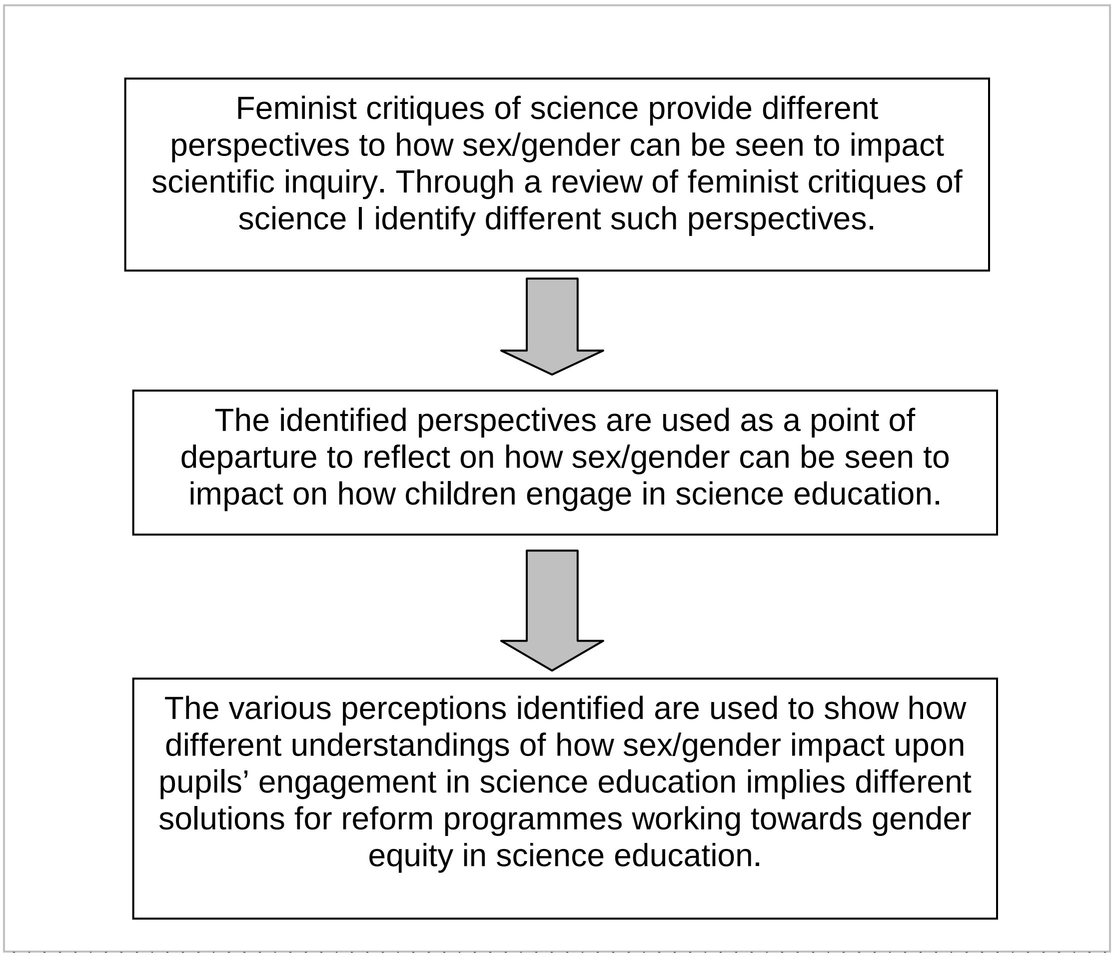
[28] Encyclopaedia of Feminist Theories (Code, 2000, p. 20) define androcentricm as: "Androcentricm (Greek, andro/male) refers to entrenched practices that base theory and practice on men's experiences masquerading as 'human' experiences and counting as unquestioned sources of knowledge 'in general'."

In my reading of feminist critiques of science I have searched for different perspectives regarding the impact of sex/gender on how scientists engage in science inquiry. The purpose is to use feminist critiques of science as a point of departure to reflect on how sex/gender impacts on how male and female pupils engage in science education and what initiatives would have to be taken to secure gender equity according to the various understandings. The framework showing different approaches to gender equity in science education resulting from each of the identified positions constitutes my analytical framework.

Figure 2.1: Developing a theoretical framework by applying feminist critique of science to detect and discuss various approaches to gender equity in science education.

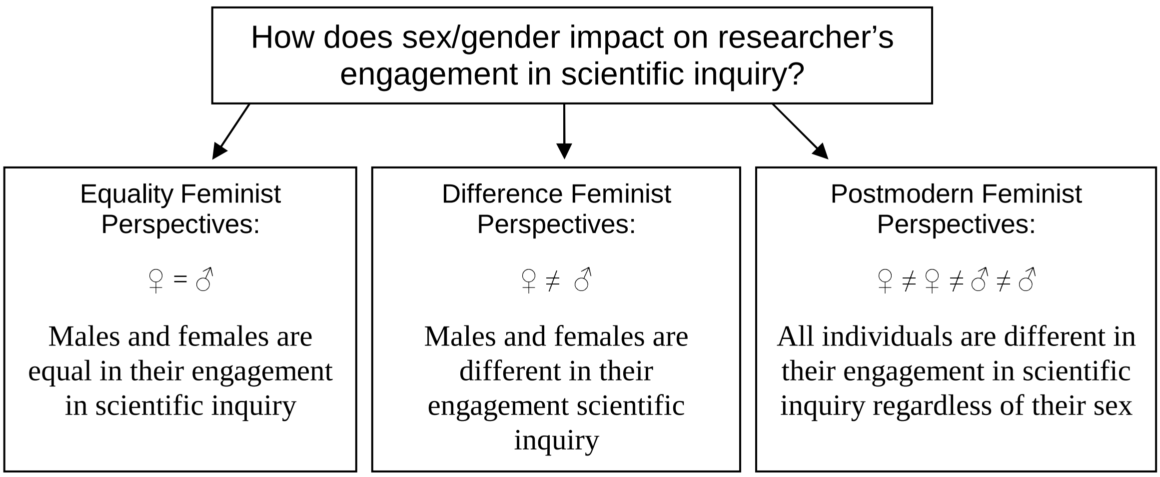


2.4 Positions represented in the analytical framework

> *This intends only to be a mapping of a terrain that has interested me and some others – not the mapping of it (Harding 1998, p X).*

Within feminist critiques of science, several perspectives can be detected, each providing a distinct understanding of how sex/gender is seen to impact scientific inquiry. Different labels represent different positions, and the same labels are sometimes also used to represent what I see as dissimilar understandings. Although building on perspectives described by others, I have found it necessary to develop labels that represent what I see as some main distinctions between the different feminist positions. I have separated the different positions according to whether they focus on similarities in males' and females' approaches to science (here labelled equality feminist perspectives), whether they describe differences in males' and females' approaches (here labelled difference feminist perspectives), or whether they are more concerned about the differences within each sex group than about the differences between people of different sex (here labelled feminist postmodernist perspectives).

Figure 2.2: Perspectives represented in my analytical framework.



There are many equality feminist, difference feminist and postmodern feminist critiques of science. As my focus is to explore different perspectives to how sex/gender impacts scientific knowledge production, I provide herein an overview of each of these perspectives.

2.4.1 Equality feminist perspectives

What I describe as equality feminist perspectives includes understandings of males and females as, in principle, equal in their approach to science. Positions focusing on the similarities between males' and females' approaches to scientific inquiry has in feminist literature often been referred to as "feminist empiricism" (Harding, 1986), "liberal feminist critique" (Howes, 2002; Keller, 1987) and "first wave feminism" (Barton, 1998). Such positions are, according to Sandra Harding, described mainly by feminists who have not positioned themselves according to this understanding of how sex/gender impacts scientific inquiry. Harding asserts that the reason for this is that implicit in such a perspective is that a distinct social theory of how science is carried out is not needed to conduct scientific research of high quality: "They do not give their implicitly held theory of science a name – I, not they, have called it feminist empiricism" (Harding, 1992, p. 66).

What I see as common to perspectives that have been described as "feminist empiricism", "liberal feminism" and "first wave feminism" is an understanding that females in principle will produce exactly the same scientific knowledge as males provided that sufficient rigour is undertaken in scientific inquiry. This type of critique is thus mainly a critique of what Harding (1986) has labelled "bad science". Science is seen as bad because sufficient rigour is not undertaken in scientific inquiry and this allows the identities of the researcher to influence the research process. Therefore science has tended to focus around issues that mainly men were concerned with. Another example of such "bad science" is the anticipation that results, particularly within medicine, of research conducted on men can be generalised to apply to women. Such research is according to Harding's presentation of this position considered bad since it fails to live up to the standards of good, objective knowledge (Harding, 1991).

Equality feminists recognise that females have been kept away from science because of political and social forces external to science (Howes, 2002). Thus, the key to improving female participation in science is to address and change the political, educational and social factors that keep females away from science.

The critique of science pursued by equality feminists was developed mainly as a critique of unfair employment practices within sciences without accusing scientific knowledge of being inherently masculine (Harding, 1986; Keller, 1985, 1987). The basic assumption within this critique is that men and women are equal and should therefore have equal opportunities in the research society. This would benefit women as they would have their possibilities and equity rights extended. It would also benefit the society in general as there would be more women contributing to the development of scientific knowledge. The ability of creating good and objective science is, according to this position, not determined by gender but by one's scientific training. Women and men are thus equally capable of contributing to scientific development. If any sexual bias can be detected in science this is, according to the feminist empiricist, a consequence of insufficient rigour in the scientific methods employed, not because the scientists are males (Harding, 1992). Scientific knowledge is not regarded as discriminating against females since any competent observer in scientifically controlled observations will understand phenomena in precisely the same way as another:

> *To put this point another way, it is not supposed to make any difference to the "goodness" of the research if the researcher is Chinese or British, black or white, a woman or a man. Scientific methods are supposed to be powerful enough to eliminate any social biases that might find their way into scientific hypothesis because of the social identity of the scientist (Harding, 1992, p. 60).*

According to Barton (1998) and Harding (1986) feminist voices here referred to as equality feminists have played a major role in eliminating the formal barriers against women's equality in science, mathematics and engineering by advocating females' abilities to advance science inquiry on equal terms as males.

Harding defines this position by asserting that feminist empiricists believe in the possibility of objective scientific knowledge production and therefore do not consider scientific knowledge itself to be changed through recruiting more women into the practice of science itself. From this perspective there would appear to be no political or conceptual space to argue that women scientists have a special contribution, as women, to a further development and improvement of science:

> *Whatever maternity leaves, child care or other accommodations to women's reproductive and family roles they might think it appropriate to ask for, feminist empiricism tells them that the way they do science and the content of their work is not, and should not be, affected by the fact that they are women (Harding, 1992, p. 63).*

Women would, according to this perspective, not contribute to science in any other way than by adding to the pool of scientists. The benefit of having more females engaged in science would simply be that there would be more people enrolled in scientific inquiry and hence more competition amongst scientists. This would eventually lead to a better science, irrespectively of the researcher's sex:

> *Maybe physicists would have to speak up on equity issues and watch their language a little more carefully to avoid offensive sexist metaphors. But nothing fundamental to how description and explanation of the natural world are produced will be done differently from the ways in which sciences are practiced when women's movement is around (Harding, 1992, p. 65).*

Some people adhering to this type of feminism would also acknowledge the impact of the researcher's sex/gender on the research priorities, while the actual science inquiry would not be affected by the sex/gender of the researcher.

Irrespectively of how one looks at why science might benefit from having more females involved, what I consider to be the key idea implicit in the position here labelled equality feminism is that the sex of the researcher should not impact on the production of scientific knowledge. Stringent rules guiding high quality scientific inquiry would remove possible biases caused by males having a different focus. Males and females would hence not engage differently in science inquiry. Scientific knowledge is considered to be objective and value free, and there is consequently nothing masculine about high quality scientific knowledge that would discriminate against females. Although this theoretical position is said to have been the dominating feminist philosophy of science in the 1960s and 70s, several people engaged in questions of females and science still adhere to this understanding of the role of females in science. Howes (2002) asserts that most initiatives currently addressing gender issues in science education operates under the premises of equality feminism. Such initiatives would seek to recruit more females to science without challenging possible masculinities implicit in scientific knowledge.

2.4.2 Difference feminist perspectives

> *Having more women scientists is not enough if they have been trained to think about science and practice science within the same authoritarian, deterministic framework that prevails today (Bleier, 1988, p. 12).*

Granting women equal rights with men has always been an aim for feminists. Since the nineteenth century, feminist writers have, however, also taken the view that women and men are different. They claim that either by nature and/or through nurture, women have developed what society refers to as “feminine” or “female” characteristics and that women’s particular skills should be recognised and acknowledged for their own values (Nash, 2000, p. 174).

Some feminist voices emphasising the differences between males and females have claimed that the qualities of females are better than those of males. Carol Gilligan (1982) described women’s moral reasoning to be dominated by an “ethic of care” as compared to men's “ethic of rights”. While some feminist critics of science, like Harding (1986) argue that females, due to their underprivileged position in many societies, are capable of undertaking more objective observations of the world, others like Shiva (2001) claim that a feminine science would be more socially responsible and more capable of advancing a more democratic and environmentally responsible science.

In this thesis, voices claiming that males and females have different approaches to science are defined as “difference feminists”. They see the notion of “equality” as problematic because it is seen to reproduce a male norm (Nash, 2000, p. 174). Difference feminists have criticized feminists claiming that males and females are equal in their approach to science for producing a “patriarchal masquerade of neutrality” (Franklin, 2000, p. 434) and for valuing characteristics associated with masculinity higher than feminine or female characteristics (Tong, 2000, p. 113).

Difference feminists argue that scientific knowledge, its processes and priorities are influenced by the identity of the researcher and that whether the researcher is a male or a female is of seminal importance. They claim that science has been developed historically without the contribution of women and people from non-western cultures. This has made scientific knowledge and knowledge production “masculine”, “western” and hence unwelcoming and discriminating to women (Bleier, 1988; Harding, 1998; Rosser, 1990). Since science has been developed mainly by western males, it lacks certain “feminine” attributes that would widen and improve the practices and effects of science, particularly its social impact. The assumption is made that scientific inquiry is still very influenced by the positivist tradition of the 17th century. Even though the scientific ideology, its values, goals and assumptions has expanded after the 17th century, the assumptions of the essential nature of science; that scientific facts are grounded in sound scientific theory largely free of personal, social and cultural values, has persisted (Harding, 1991; Keller, 1985).

Science has, according to such feminist thinkers gained a special status because of its claim to be objective. They argue that it is dangerous when something is claimed to be objective when it is in reality closely connected to special interests:

> *The ideological ingredients of particular concern to feminists are found when objectivity is linked with autonomy and masculinity, and in turn, the goals of science with power and domination (Keller, 1987, p. 238).*

Several feminist critics of science have shown how science, previously regarded as objective, is actually androcentric and coloured by its developers who have most often been (white) men. Ruth Bleier is one of the major feminist critics of science who have developed critiques of sexist assumptions in biology. In her book “Science and Gender: A Critique of Biology and its Theories on Women” (1984), the American medical doctor and specialist in neuroanatomy identified androcentricm implicit in evolutionary theories of human origins, assumptions about hormones and behaviour, and research into brain functions. Bleier has criticised biological essentialism, which she claimed contributed to reinforcing the status quo. Ruth Hubbard is another feminist critic of science who has raised her voice against masculine bias in biology. Her main issue of concern has been reductionism in biology, particularly within genetics and biotechnology. She claims that much research within such fields ignores the complexity both inside an organism (for example genes affecting each other) and between inside and outside (for example environments affecting, say, how hormones work (Hubbard & Wald, 1993)).

Sandra Harding (1986) has shown how androcentricm in scientific inquiry has been developed due to the fact that mainly western men have been in charge of scientific research. She asserts that, particularly in behavioural biology, the behaviour of animals and humans have been compared and that animal models have been used to legitimise male dominance. These studies, according to Harding, “Show a high tendency to project onto ape nature and social relations both racist and sexist projects of the observer’s own society” (p. 96) and “have been used to justify and perpetuate masculine dominance and restrictions of women’s opportunities” (p. 83). She asserts that “androcentric assumptions appear in the collection, interpretation and use of the data” (p. 96). She claims that there most likely exist many more examples of this than we are aware of because the masculine value system is so deeply embedded in our daily lives.

While most of the above mentioned critique has been levelled against the biological sciences, Sandra Harding (1998) has shown how the developments also of physics, chemistry and technology were followed by, and dependent upon, the exploitation of colonies in non-western countries. Keller (2003), at a seminar in Oslo in 2003, argued that more work was needed to uncover sexist metaphors in sciences other than biology.

While several feminist critics have identified masculine biases in scientific inquiry, some have also proposed alternatives to how science could be developed to accommodate androcentric bias. Evelyn Fox Keller (1983) in her famous biography “A Feeling for the Organism: The Life and Works of Barbara McClintock” showed how the Nobel Prize winning geneticist Barbara McClintock was able to pursue research that was less hierarchical and distanced from the objects she studied. McClintock’s approach to scientific inquiry has been seen by some feminists to represent a feminine way of engaging in scientific inquiry (Code, 2000, p. 172). Ruth Bleier (1986), in her book “Feminist Approaches to Science”, attempts to summarise some characteristics of what might characterise what she calls a feminist science:

> *Feminist science, being a better science, recognises the true complexity of nature and of each individual human nature. It constantly resists efforts to reduce explanations of complex phenomena to single causes and to strip human behaviours and characteristics of the social and political contexts within and from which they developed (Bleier, 1986, p. 16).*

Sue Rosser (1990) claims that females apply different research methods in their approach to science and would therefore advance a more socially responsible science. Using examples from research carried out from a number of female scientists, she has created a set of descriptions she believes characterises women’s ways of engaging in science. I will not comment on the empirical foundations for Rosser’s claims. As I will later show, the perspectives she is a proponent for have gained substantial critique from other feminist critics of science.

Rosser describes how the sex of the researcher will impact on the different phases of the research process. She claims that a female researcher will expand observations beyond those traditionally carried out in scientific research to include observations that are not considered worthy of observation by traditional scientists operating from an androcentric perspective. Female researchers, according to Rosser, also tend to increase the numbers of observations and to remain longer in the observational stage of the scientific method. They accept the personal experiences of women as valid components of experimental observations and are, according to Rosser, unwilling to undertake research likely to have applications of direct benefit to the military. Instead, women are more likely to pose hypothesis to explore problems of social concern. According to Rosser, females formulate hypotheses that focus on gender as a crucial part of the question being asked and undertake investigations of problems which are more holistic and global in scope than the more reduced and limited scale problems traditionally considered. Rosser claims that female researchers will be more likely to use a combination of qualitative and quantitative methods. They will be more interdisciplinary in their approach and make sure to include females as experimental subjects in research design. According to Rosser, females tend to use more interactive methods, thereby shortening the distance between observer and the object being observed. Female scientists according to her analysis tend to be less competitive and more aware of the role of the scientist as only one facet which must be smoothly integrated with other aspects of their lives. They will place increased emphasis on strategies such as teaching and communicating with non-scientists to break down the barriers between science and the lay person and exert, whenever possible, a positive control over the practical uses of scientific discoveries to place science in its social context.

Although Harding (1986) does not claim the existence of a universal feminine perspective, she argues that all *oppressed* have common experiences[29]. By virtue of being oppressed, women have common experiences and a common way of viewing the world that will tell more about the world than by hearing the story of the oppressors. Building on Marxist theory she claims that the knowledge and culture of a class society reflects the interests of its ruling class. A more objective and transformative knowledge can only be found through the perspective of the oppressed and that they will always be epistemologically privileged compared to the oppressors:

> *The problem is that knowledge has been generated from the lives of a small proportion of the society (and, at that, the most powerful one) is not useful for most people's projects. It's only useful for the projects of that group, just as Western sciences, for example, have been extremely helpful for helping European expansion but not too helpful to the people who got expanded into by Europe (Harding in Hirsh & Olson, 1995, p. 16).*

In her writings, she criticises feminist who believes that sex/gender does not impact scientific inquiry (feminist empiricists). Harding asserts that in order

[29] I interpret Sandra Harding's focus on the common experience of females as oppressed as one type of difference feminism. Although she does acknowledge that other oppressed groups can share similar understandings without being females, much of her writings show how females as an oppressed group share similar perspectives.

to address inequalities in science, there is a need to create a new feminist science that uses as a starting point the lives of the marginalised and acknowledge how all knowledge production is shaped by society.

Through her “standpoint methodology” Harding develops a way for the researcher to become conscious of her/his own role as a researcher. She argues that if science is ever to increase its level of objectivity, scientists must recognise and acknowledge the social forces that shape their beliefs (Harding, 1991). The standpoint methodology starts out by including and reflecting on the situatedness of the researcher in order to make visible the genderedness of the knowledge (Harding, 1993; Rustad, 1996, p. 22). This, according to Harding, is called “strong objectivity”.

Harding argues that the standpoint of the researcher will always impact upon knowledge production. Initiatives aiming to increase female participation in science hence need to be based on the assumption that female scientists would contribute to science in different and better ways than male scientists, and challenge the androcentricm inherent in science:

> *Should feminism want women to have equality with the men of their respective races and classes without challenging race and class exploitation within science? Should feminism want women, too, to do research that it is only reasonable to predict that will be used by the military or to increase profit? What is progressive about mounting heroic campaigns to “add women and gender” to the social structure and subject matters of the sciences without questioning the legitimacy of science’s social hierarchy and politically agendas more generally? (Harding, 1992, p. 59).*

Although the understandings of what causes these gender differences in males’ and females’ approach to science varies a great deal between difference feminists, they all tend to put an emphasis on the importance of acknowledging and valuing gender differences between males and females.

2.4.3 Postmodern feminist perspectives

The third main feminist position I focus on is postmodern feminism. Postmodernist thinkers reject universal, simplified definitions of social and natural phenomena. They call for the recognition and celebration of differences and the importance of encouraging the recovery of previously silenced voices. They also argue for an acceptance of the partial nature of all knowledge claims and thus the limits of knowing. Feminist thinkers informed by postmodernism have challenged the belief that women are united by biological sex and have asserted that the “category of women” is neither natural, nor essential, but socially constructed (McPherson, 2000, p. 209).

Postmodernist thinkers have also questioned the authority of traditional guarantees of meaning such as religion, science and nature for their patriarchal androcentricm. I understand several science educators who currently write on the topic of feminist science education (Barton, 1998; Brickhouse et al., 2000; Brickhouse, 2001; Howes, 2002) to be inspired by postmodern feminism. An influential contributor to feminist critique of science within a postmodern position is the north- American biologist and historian of science, Donna Haraway. Haraway (1988/2003) argues against the view that there are some positions that are more epistemologically privileged than others. Her alternative to Harding’s “standpoint methodology” is the theory of “situated knowledge”. According to the theory of situated knowledge all knowledge is situated and no position is more privileged than others when it comes to viewing the world. Haraway argues that nobody, no matter of being oppressed or oppressors, men or women, can see the world more clearly than others. We can only see the world from our personal perspective, and hence all knowledge is situated.

Haraway argues that neither men nor women are in a position to describe the world on any other’s behalf than on their own. She argues that researchers claiming to be able to conduct universal and objective knowledge conduct what she labels the “God-trick”. By this she means that they try to exclude their own position and thereby biased basis for research, in order to be able to conduct neutral observations. This “view from nowhere” is, according to Haraway, methodologically impossible (Haraway, 1991, p. 195).

Difference feminists have been criticised by postmodern feminists for treating all women alike. They argue that by treating women as one single group, all the different voices will not be heard. Women, according to Haraway, are not one identical group. They do not have one identical story to tell. Within the group of women there are huge differences. All women do not view the world in the same way:

> *There is a premium in establishing the capacity to see from peripheries and the depths. But here lies a serious danger of romanticising and/or appropriating the vision of the less powerful while claiming to see from their positions (Haraway, 1991, p. 191).*

According to postmodern theories and Haraway, the standpoint of the researcher as a subject and all other subjects differ from each other. The knowledge that can be achieved about the world is therefore of an individual character and contains no universal truths (Rustad, 1996).

Haraway does however; warn against a total relativist view of science:

> *Relativism and totalization are both "god tricks" promising visions from everywhere and nowhere equally and fully (….) But the alternative to relativism is not totalization and single vision, which is always finally the unmarked category whose power depends on systematic narrowing and obscuring. The alternative to relativism is partial, locatable, critical knowledges sustaining the possibility of webs of connections called solidarity in politics and shared conversations in epistemologies (Haraway, 2003, p. 395).*

According to Haraway, all stories about the world are not equally valuable. Scientific research thus has a powerful potential to tell good stories about the natural world. There are however no stories that represent the only truth. All stories, including scientific stories, are functions of politics and the situatedness of the researcher. Haraway argues that although not all stories about the world are equally valuable, several stories are better than one (Haraway, 1989). In her major work "Primate Visions. Gender, Race and Nature in the World of Modern Science" (1989) Haraway exemplifies this by presenting four female primatologists each challenging the androcentricm implicit in research conducted on primates. By telling the stories of four researchers, with sometimes conflicting argumentation, Haraway shows that several perspectives can be equally valuable although they are not always coherent.

In spite of Haraway's critique of natural science, she argues for the importance of "critique from within". She criticises feminists for being critical of science without knowing the field from the inside. Haraway wants change and she wants more stories to be heard. She therefore promotes a higher representation of females within fields such as science and technology as this will bring new and varied perspectives to the field (Haraway, 1989).

Because women are not epistemologically privileged compared to men, the reason for recruiting more girls to science would not, according to Haraway, be that they would produce better knowledge than men would. The reason for more women to be involved in science would be that many stories would not be heard if women did not have the possibility of telling their scientific story. Gaining access to the world, the natural as well as the social world, is according to Haraway, about "the power to see" (Haraway, 1991, p. 188). By excluding women from science the power to see would be in the hands of men. This power to see should not be reserved men.

2.5 Constructing an analytical framework

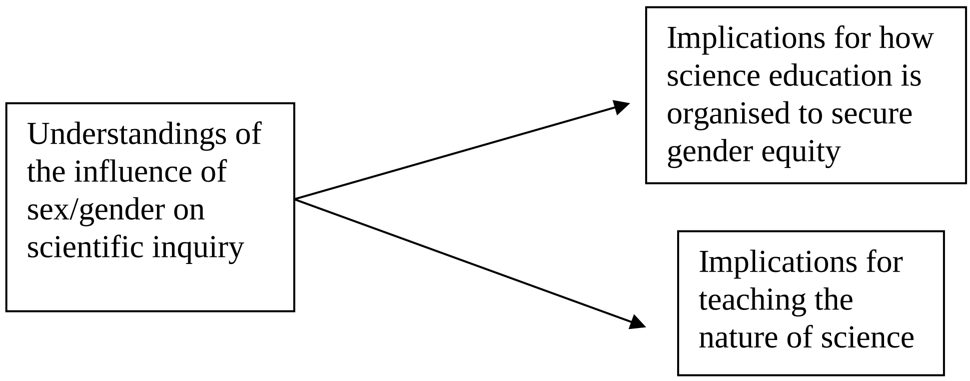
I have now outlined what I see as the main distinctions in the way feminist critics of science regard sex/gender as impacting on scientific inquiry. Feminist critiques of science have discussed science education only to a very little extent. Therefore they do not discuss how sex/gender impacts the *learning* of science. In constructing this analytical framework I therefore use the same perspectives found on the impact of sex/gender regarding scientists' engagement in science inquiry to reflect upon how children engage with science in school.

My analysis of what type of science education initiatives would follow from different positions identified has been based on the assumption that the same theories that I have now presented can be used to understand how people engage in scientific inquiry and how pupils are engaged in the learning of science.

These mechanisms are, however, not necessarily the same. The understandings of how sex/gender impacts on a scientists approach to science can in other words not necessarily be directly transmitted to the understanding of how sex/gender impacts pupils' engagement in science in schools.

If one makes use of feminist theory solely to determine alternative ways of perceiving how male and female pupils differ in their approach to science education, one will deduce one set of consequences for science education reform programmes. Such consequences would be designed to accommodate our analysis of how sex/gender is seen to impact on one's approach to science education. If, on the other hand, science education initiatives should be planned according to the understanding that male and female researchers would advance different kinds of scientific knowledge, this would also challenge what image of the nature of science should be reflected through science education.

Figure 2.3: Implications for science education of different understandings of the relationship between sex/gender and scientific inquiry.



In my presentation of what I see as consequences for science education reform programmes of the various feminist positions, I have incorporated the consequences of each position for the organisation and planning of science education and also for the image it reflects of the nature of science. As I will later show in my analysis of AFCLIST and FEMSA, several science educators do in fact see these two factors as separate.

2.6 Suggested implications for science education

2.6.1 Introduction

I will now turn to reflect upon the implications of the various feminist perspectives for thinking about gender equity in science education. In doing this, I use the understandings of the impact of sex/gender on scientific inquiry implicit in the three positions described previously.

Before presenting what I regard as possible implications for science education programmes operating within equality-, different- or postmodern feminist positions, I will summarise what I see as the main characteristics of each feminist position.

2.6.2 Suggested implications for science education of equality feminism

Equality feminism in a nutshell:

- Scientific inquiry influenced by the researcher's identity is considered "bad science".
- Sex is not relevant for scientific knowledge production. Males and females are equal in their approach to science.
- If sufficiently scientific rigor is provided, scientific knowledge production, both in its priorities, process and interpretation of results, has the potential of being objective.
- More females should be recruited to science to have equal opportunities with males. Because more people are engaged in scientific inquiry there would be competition for scientific positions and thus higher quality scientific knowledge production.

Initiatives that build on the assumption that females and males are equal in their approach to science, and that inequality in science and science education is caused by political, educational and social factors external to science, would be expected to focus on removing these external obstacles. In a gender and science reform program operating under the premises of equality feminism, I would expect to find interventions that would aim to change the image of females' abilities to succeed in science. In such programmes, one should seek to sensitise the girls about their equal abilities to engage in scientific thinking and inquiry and become scientists. One should also try to diminish the development of different interests and attitudes amongst girls and boys. One way of doing this could be to focus on giving girls' and boys' similar experiences as they grow up. Giving girls (and boys) toys that are traditionally given to the other sex would be one way of trying to break down traditional gender barriers. It would also be important to avoid discrimination caused by placing girls and boys in traditional gendered roles. Girls and boys should be encouraged to develop similarly without emphasising their sex.

In order to avoid discriminatory practices of males and females, society should, particularly in traditional and patriarchal societies, be sensitised to understanding the equal ability of males and females to becoming a scientist and engage in science. This could be done through campaigns where female role models in scientific positions were used to visualise the equal ability of females to pursue scientific careers. Role models who had succeeded in science on equal terms as men could be used. Society could develop policies that would make it impossible to discriminate against girls' opportunity for schooling. Society in general could also avoid conveying stereotyped images of women in newspapers, commercials etc.

Universities and other institutions and companies that employ scientists could, in response to an equality feminist reform programme, remove discriminatory employment practices. A gender reform program in science education operating under the premises of equality feminism would be expected to focus on removing all gender biases and practices discriminating against females. In this regard, it would be important to develop gender-neutral education material. This could be done either by removing all references to sex, refer equally to the two sexes, or challenge traditional gender roles in texts and illustrations. It would also be important to avoid pictures that foe example portray males in active and females in passive positions. Curricula and teaching materials should accommodate girls' and boys' experiences and interests equally without emphasising one sex over the other. Great care should, however, be taken in curriculum and teaching material development not to convey stereotyped images of males and females. Hence one should strive to produce gender- neutral education material.

In a science education inspired by equality feminism, science teachers should play an active role in the avoidance of treating males and females differently. Teachers should give equal attention to boys and girls in class. They should also not say anything that could be understood as discriminatory to girls, in the sense of giving the impression that males and females are different. Based on research showing that males and females often adopt different roles in science laboratories and classrooms, the teachers would have to pay extra attention to the girls in such situations in order to make sure that girls do not adopt such passive roles. Ideally, there should be an equal number of male and female science teachers to underline the point that males and females are equally capable of pursuing a career in science.

Science curricula and examinations should be developed to be gender-neutral and equally relevant to boys and girls. It would not be regarded central to spend much time in science education to question the objectivity of scientific knowledge. Science education operating under the premises of equality feminism would tend to be a science education that could be described as "gender-neutral science education".

2.6.3 Suggested implications for science education of difference feminism

Difference feminism in a nutshell:

- Males and females are gendered differently.
- This difference impacts on how males and females engage in scientific inquiry.
- Since all knowledge is influenced by its developers and their societies, no knowledge can be absolutely objective.
- Several difference feminists claim that scientific knowledge developed by females would be qualitatively better than scientific knowledge developed my males.

In a science education reform programme operating under the premises that males and females are different and that females might even be able to contribute in a special way to science, it would be important to encourage and acknowledge the differences between the sexes. Within such initiatives girls should be encouraged to value and appreciate their own experiences and interests, and be sensitised to uncover the androcentricm implicit in scientific inquiry where it has been developed mainly by men.

Teachers operating within this position should pay extra attention and be aware of research documenting differences in girls' and boys' approaches to and interest in science education. To accommodate research showing differences in males' and females' preferred learning strategies (see chapter one), they should organise science education in small group settings and try to develop a non-competitive environment in science classes. They should also, according to research showing differences in girls' and boys' interests relate the teaching to issues of health / body and personal development whenever possible. Generally such initiatives should try to link the education to girls' out of school experiences and interests and encourage them to acknowledge, appreciate and develop further their feminine interest and traits. Teachers should try to visualise the societal and environmental dimensions of science and how such factors have impacted on knowledge production. It would be important in this regard to show how scientific inquiry can be biased since it has mainly been developed by men.

In a "difference feminist" science classroom the teacher would be expected to pay extra attention to females and make sure that their special interests and needs are followed up on the girls' own premises. Organising strategies such as groups divided by sex, single sex schools etc could be applied to further acknowledge girls' special way of learning.

It would also be important to sensitise the broader society as regards to the special contributions of females to science and the importance of recruiting more females to science. If one approves Harding's understanding of this position, it would be important to visualise for the broader public how females in most contexts are oppressed and how this again has contributed to broaden their perspectives as knowledge producers.

Reform programmes operating under the premises of difference feminism would be expected to pay close attention to scientific research communities. Emphasis should be given to making explicit for scientists the androcentric biases within scientific knowledge. It would be crucial to build bridges between feminist theoreticians and the scientific society. One way of doing this could be to offer courses in feminist theory and critique of science at institutions educating students to assume different scientific positions in order to give the students an opportunity to become aware of assumptions underpinning scientific research. Another useful effort could be to popularise feminist theory and make it understandable for people with a science background. Scientists should be introduced to standpoint methodologies and learn to be explicit and open about how external factors, such as sex/gender, might impact upon their research. In a gender reform program that acknowledges differences between sexes, initiatives should be taken to make room for further developments within what has been described as the characteristics of how females gain knowledge about the world. This has been described for instance by Bleier (1986), Rosser (1990) and Shiva (2001). Perhaps scientific research institutions could be developed that would adapt such feminist methodologies. Reform programs acknowledging females' special contribution to science would be expected to be particularly concerned about also recruiting more females into science related positions.

A science education based on the assumption that females and males have a different approach to science, and hence contributes differently to the development of scientific knowledge, would be expected to pay extra attention to girls' common interests. It would also be expected that such a science education would incorporate scientific knowledge developed by women. In such science education initiatives, it would also be important to show examples of how scientific knowledge is influenced by its developers. Science education operating under an understanding of males and females as different would therefore be political in the sense that it would focus on visualising how the oppression of, and discrimination against, women have hampered their opportunities to contribute to the development of scientific knowledge. Science curricula should be developed to acknowledge the special contribution of females in science. They should also build heavily on research on girls' special ways of learning. I would label a science education that acknowledges the differences between males and females and is designed mainly in order to accommodate females, a "female-friendly science education".

2.6.4 Suggested implications for science education of postmodern feminism

Postmodern feminism in a nutshell:

- Gender is constructed and not necessarily linked to sex. Differences between individuals of the same sex can be equally significant as differences between people of a different sex.
- Not one position is more privileged than any other in terms of objective understandings of the world.
- All knowledge is situated / contextualized.
- Describing the world is about the power to see. More females should be recruited to science in order not to be deprived the power to see.

Science education reform programs inspired by postmodern feminist ideas would be expected to challenge the idea that female pupils are united by biological sex. Science education initiatives acknowledging the difference between all individuals would be expected to encourage all pupils, regardless of their sex, to value their own experiences and interests and make them relevant to the learning of science. Gender reform programmes, operating under a postmodern feminist understanding, would be expected to enforce an increased awareness of marginalised groups irrespective of their sex. It should not be taken for granted that pupils have the same preferences and needs because they have the same sex. Single sex school settings would therefore not be adapted in schools inspired by postmodern feminism. Believing in the importance of all voices being heard, it would be crucial for such initiatives to bring the marginalised to the centre of all interventions.

Science education reform programmes operating under this understanding of gender and science would be expected to explore differences in interest found between pupils of the same sex and develop teaching materials to accommodate such a broad variety of interests. It would also be expected in such science education to have teaching material that visualise the relations between science and society and hence how all knowledge is situated. A science education that values other understandings of the natural world equally with the understandings developed by modern science would also be expected to explore other knowledge systems (traditional, indigenous etc.) in science teaching.

A teacher operating in a postmodern feminist classroom would be expected to be cautious about the varieties in interests and abilities that exist among pupils in the classroom without separating them into categories based on their sex. Groups should rather be developed based on the pupils' interests. Constructivist teaching/learning methods would be expected in such a classroom.

A science curriculum based on this understanding would be expected to put much emphasis on visualizing the social, political, cultural and psychological dimensions of science. Science should not be presented as a fixed body of knowledge, but as knowledge that is continuously developed, challenged and changed. Teachers should visualize how all scientific knowledge is constructed and contextualized and how researchers are all influenced by the time in which they live. Pupils and the rest of the public society should be informed about the social, political and gendered assumptions that underpin knowledge production and how social context shapes all knowledge. Pupils should be encouraged to look for hidden assumptions in scientific knowledge and make them explicit. Pupils in a postmodern science classroom should also be encouraged to be explicit about what assumptions they make when making their own statements. Science reform programs based on an understanding that all knowledge is contextualised, should be committed to helping pupils to see various approaches to the same problem and have them realise that there is often more than one single correct answer, also within science.

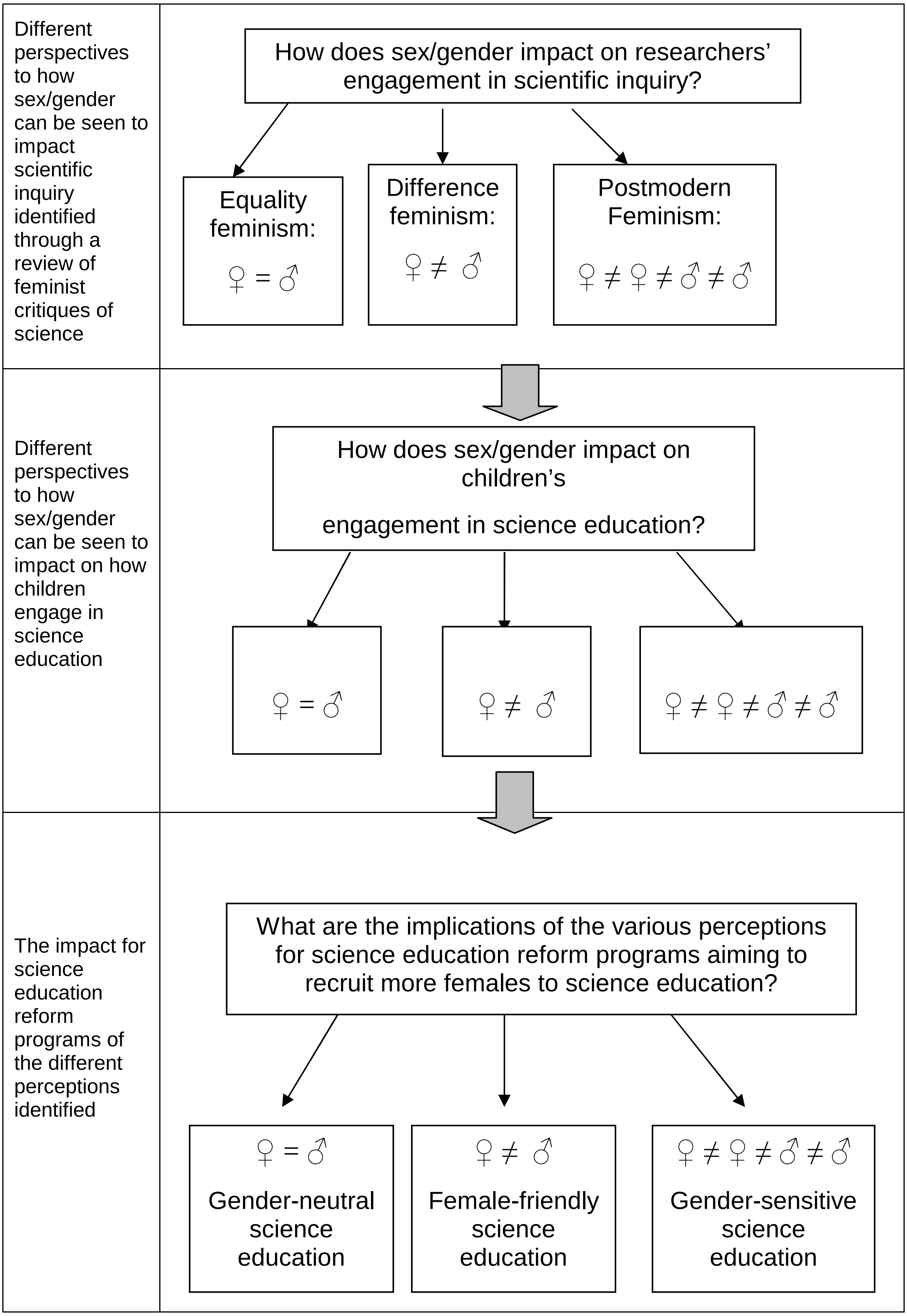
Within a feminist reform position operating under a postmodernist understanding of gender it would also be important to build bridges between feminist (and other social /philosophical sciences) research and natural science research communities. People practicing natural science should be sensitised to how all research is situated, and to how multiple perspectives may enrich knowledge production. Scientists should be educated in how they can avoid playing “the God trick” by learning to situate their knowledge.

A science education that is designed in order to accommodate various interests and abilities without assuming that such varieties are a result of having different sex, I would label a “gender-sensitive” science education.

2.6.5 Summing up

Based on my review of feminist literature and an analysis of how sex/gender can bee seen to impact on scientific inquiry, three main understandings have emerged. Based on these three understandings I have suggested three corresponding organising principles for planning gender and science education initiatives:

Figure 2.4: How feminist critique of science is used as a point of departure to separate different approaches to reach gender equity in science education.



In Table 2.1, I outline my suggestions for science education of reform programmes grounded in different understandings of how sex/gender impacts scientific inquiry. The tables show what I consider to be the implications of each of the above described positions. As I have described previously, I would expect gender initiatives opting for gender equity in science education not only to address science education explicitly, but also try to influence communities of scientists and the broader public.

	The girl	**Science Education**	**The science community**	**The public**
Equality feminism	- Sensitise the girl about her abilities for doing science - Provide girls with toys that have proven to provide experiences necessary for doing science - Avoid discriminating against the girl in a way that places her in traditional gendered female roles	-Gender-neutral science curriculum equally relevant to boys and girls - Gender-neutral education material - Teachers sensitised not to discriminate against girls - Equal number of female and male science teachers	- Address employment practices that discriminate against women	- Sensitise parents on the equal ability of girls to do science - Arrange campaigns to visualise female role models that succeed on equal terms as males in scientific positions - Avoid discriminating images of females that reinforce a stereotyped image of women - Address discriminating education practices that keep girls from entering school

Difference feminism	- Empower girls to value / appreciate their interests - Sensitise girls on their special abilities and hence potential in science	- Curriculum should be developed to accommodat e girls' interests and ways of learning/kno wing - Female-friendly teaching material - Teachers should be responsive to girls' special interests, and sensitised on how girls learn	- Sensitise on the importance and special contributions of women in science - Actively recruit more female scientists through special recruitment programmes, positive discrimination etc - Build bridges between feminist theory and scientific society. Visualise andocentric bias in science - Make room for special female research institutions that would enable females to explore and develop research based on a female way of knowing - Apply feminist research methods such as those described by Rosser on scientific inquiry - Visualise how all knowledge and research is situated through standpoint methodologies	- Sensitise on the oppression of women / females and how this has impacted on their abilities to engage in science inquiry - Sensitise on the special contribution of females in science and society
Postmodern feminism	- Empower girls and boys to value their stories regardless of sex, race, and class	- Curriculum developed to accommodat e a broad variety of interests - Gender-sensitive teaching material - Teachers responsive to the different perspectives of all pupils irrespective of their sex	- Sensitise on the situatedness of all knowledge - Visualise the impacts of the researcher on scientific research - Bridge the gap between feminist research and the scientific society - Sensitise researchers on the value of having multiple perspectives in science - Sensitise on how researchers can avoid playing "the god trick" and show the possibilities of situating research	- Increased awareness on marginalised groups irrespective of their sex - Gender mainstreaming initiatives. Bring the marginalised to the centre of interventions - Sensitise on the biases implicit in scientific knowledge

Table 2.1: Suggested implications for gender initiatives grounded in understandings of how sex/gender impacts science inquiry formulated through equality, difference and postmodern feminist perspectives.

In table 2.2 I focus on the implications for the science education system in particular. The consequences I see of the different positions for the teaching of the nature of science are in this table written in italics.

	Curriculum	**Educational material**	**Teacher development**
Equality feminism ↓ **Gender-neutral science education**	- Curriculum should be gender-neutral and hence be equally relevant to both boys and girls	- Develop gender-neutral education materials either through: - Equal number of the words “he” and “she”, and equal number of illustrations showing males and females, or - Remove all references to sex, or - Portray males and females in untraditional gender roles	- Teachers should be sensitised not to discriminate against girls - Teachers should give equal attention to girls and boys in class - Teachers must avoid saying anything that could be understood as discriminatory to girls - Preferably there should be an equal number of female and male science teachers - Teachers must make sure that girls are given equal responsibilities in the lab
Difference feminism ↓ **Female-friendly science education**	- Curriculum should be developed to accommodate girls - Build on research regarding how girls learn in science education *- Be responsive to feminist critique of science and incorporate the contributions of women and other oppressed groups*	- Teaching materials should be female-friendly: -Build on girls’ special interests and experiences *- Incorporate scientific knowledge developed by females and oppressed* *- Show examples of how scientific knowledge is biased by its developers* *- Be political in terms of visualising the oppression of females and non western people*	- Teachers should be responsive to girls special interests, and sensitised on how girls learn: - Teach in small groups - Develop a non-competitive environment in science class - Focus on health / body and personal development whenever possible - Link science education to girls’ out of school experiences - Link science education to societal / environmental issues *- Visualise the masculine bias in scientific knowledge and priorities* *- Visualise the special contributions of females to science* - Pay extra attention to females in class - Separate into girls / boys groups - Separate schools for girls /boys

Post modern feminism ↓ **Gender - sensitive science education**	-Curriculum should be developed to accommodate a broad variety of interests - *Curriculum should visualise the social, political and psychological dimensions of science* - *Curriculum should incorporate other knowledge systems*	- Teaching materials should be gender-sensitive: - Teaching material should reflect differences in interest in science - *Teaching materials should visualise the relations between science and society and how social and political factors impact science* - *Teaching materials should include science developed by minorities and other cultures and visualise the differences between different types of scientific inquiry*	- Teachers should be responsive to the different perspectives of all pupils irrespectively of their sex - Teachers should build on pupils' experiences irrespectively of their sex/apply constructivist teaching methods - *Teachers should visualise that scientific knowledge is constructed by human beings and hence influenced by its creators* - Teachers should acknowledge that all pupils are different and that great differences in interests exist also within groups of pupils of the same sex - Teachers should introduce questions of sex, race and class when it is relevant - Teachers should not divide pupils into groups based on sex, but rather on interests

Table 2.2: Suggested implications of equality feminism, difference feminism and postmodern feminism on science education.

I have labelled the three approaches to gender equity in science education "gender-neutral", "female-friendly" and "gender-sensitive" science education. In literature which discusses gender and science education initiatives, these labels are often used without any further explanation or consistent meaning. In this chapter, I have tried to visualise that they can in fact be seen to represent very different understandings of why females are underrepresented in science and thus represent different approaches to secure gender equity in science education.

All the above understandings of how science education might be changed to accommodate gender differences in science have been criticised within science education literature. What I have labelled "gender-neutral" science education has been criticized for building on the assumption that it is possible to produce objective knowledge through scientific inquiry (Kenway & Gough, 1998). It has also been criticised for not challenging the oppressive and discriminatory practices within scientific inquiry (Harding, 1992). Eisenhart & Finkel (2001) claim that the types of initiatives following from a gender-neutral science education, what they call "compensatory strategies" treat disadvantaged persons according to their special needs, but only with the aim of enabling them to measure up to a standard already set by the advantaged. As Howes (2002, p. 23) puts it:

> *This approach assumes that if women were to think, behave, learn, and work more like male scientists, the problem of women in science would be solved.*

Another problem with a gender-neutral science education could be that it can easily represent a false picture of reality. Most societies are not gender-neutral. Particularly in traditional societies, males and females do have very distinct roles to play. It is therefore difficult to understand how the key to increased gender equity in science could be to reflect a gender- neutral situation when most societies are in reality strongly gendered.

Gender and science education reform programs which build on an understanding of males and females as different in their engagement in science would be expected to pay close attention to research trying to document such sex differences. A female-friendly science education would then be expected to be designed with the purpose of appreciating and accommodating these differences. There is, however, limited evidence for the existence of such differences (see chapter 1). Brickhouse et al. (2000) accuse female-friendly science education of reinforcing stereotyped images of females.

An additional drawback to a female-friendly science education could be the effect such an education might have on boys. It is possible to imagine and even show evidence for classroom situations where girls have dominated boys both in terms of interest and abilities in science. A science education designed to accommodate pupils on the basis of their sex could easily fail to stimulate and assist boys who experience problems in their learning of science.

Gender-sensitive science education is based on the assumption that the variations between pupils of the same sex might be more important than differences between people with opposite sex. Such an education would acknowledge the existence of masculine and feminine pupils, but not take for granted that masculinity and femininity necessarily are determined by a person’s biological sex.

The implications outlined here for what image of the nature of science that would follow from a postmodern science education might be problematic for science educators to accept. The assumption that all knowledge is contextualised and marked by the fingerprint of the scientists, contests the status of scientific inquiry as a suitable method to obtain objective knowledge about the natural world. Science education initiatives grounded in such postmodern assumptions would therefore require major changes to how science is currently being taught in most science classrooms around the globe. Several science educators might even argue that a postmodern science education is a contradiction in terms.

Accepting the importance of other knowledge systems in science education could be important in order to value other ways of knowing. Such knowledge systems could however prove to imply a conservation of inequalities for instance by representing conservative understandings of the role of females in societies. Scientists and science educators could also argue that scientific knowledge and its methods, in spite of perhaps being androcentric and biased has proved extremely effective in advancing technological and economic development. Why then, should this knowledge not be delivered to future generations without questioning its underlying assumptions?

I am not going to respond to the critique raised against gender-neutral, female-friendly and postmodern science education. The purpose of outlining the different positions has not been to judge which approach is best suited to secure gender equity in science and science education, but to make explicit what I see as distinct approaches to reach this goal.

Although the three positions and my appraisal of their implications for science education can be seen to represent some distinct ways to approach gender equity in science education, other approaches are clearly possible. For the purpose of using this feminist theory to better understand different paths to gender equity in science education, I have seen it as necessary to simplify the positions. I acknowledge that important nuances may have been lost along the way.

My interpretations and analysis of what type of initiatives would logically follow from each of these positions are my own judgements. Other science educators would very likely analyse this differently. My reason for showing these different approaches has hence not been to provide *the* map to this rugged terrain but to provide *a* map. By providing this map I hope to contribute to an ongoing discourse around these issues.

In the next sections of this thesis, I apply this map to analyse how two science education initiatives work towards gender equity.

3. Methodology

3.1 Introduction

In the introductory chapter, I explained which ideas and questions shaped the formulation of my research questions. These ideas were my point of departure for my research journey. Finding reliable, valid and ethical sound answers to my research questions was my goal.

The word “methods” stems from the Greek word “methodos” which means “following a certain path towards a goal”. In this methodology chapter I explain my pathway. To reach my goal I followed a path that brought me to various types of unfamiliar terrain. The journey has been exiting and informative, but also frustrating, steep and exhausting. I have explored new literature, travelled to new countries and met a lot of new people. But most of all I have had to learn how to follow the rules set for scientific research journeys. Since different rules should be followed for different journeys I have had to decide on which rules to follow.

In this methodological chapter I will explain what rules I followed and which I had to break. I will also present how a number of “guide books” assisted me in finding my way.

I open this chapter by giving a presentation of my research design. I briefly discuss why and how I constructed a theoretical framework based on feminist theories to be used in the analysis. I then give an account of my collection of data about FEMSA and AFCLIST. I present how I analysed the data. I end this chapter with a discussion of how I have dealt with issues of objectivity, validity and reliability in this study.

3.2 Research Design

3.2.1 Why case studies?

In the Handbook of Qualitative Research, Stake (2000, p. 435) claims that choosing a case study is not a choice of method, but a choice of subject to be studied. As a form of research, he claims case studies are defined by an interest in individual cases, not by the methods of inquiry used. Since I want to study how two particular initiatives approach gender equity, it was natural for me to define these two initiatives as two separate cases and hence define the empirical part of my study as a case study.

3.2.2 What type of case study approach?

> *A new case without commonality cannot be understood. Yet a new case without distinction will not be noticed (Stake, 2000, p. 443).*

In the Handbook of Qualitative Research, Stake (2000, p. 437) identifies three types of case studies distinguished by the researcher's interest in the cases and the purpose for doing a case study:

1. *Intrinsic case study*: When a case is studied because one wants better understanding of the case in itself. The intrinsic case study is not undertaken primarily because it represents other cases but because the case in itself is interesting. The purpose is not theory building.

2. *Instrumental case studies*: A particular case is examined to provide insight into an issue or refinement of theory. The case is of secondary interest.

3. *Collective case study*: Is an instrumental case study extended to several cases. The cases are chosen because it is believed that understanding them will lead to better understanding, perhaps better theorizing, about still a larger collection of cases.

According to this way of categorising different approaches to case study research, my study would fit into the collective case study category. I have chosen the AFCLIST and FEMSA as cases because they represent two distinct ways of addressing gender issues in science education. By analysing these distinctions through the light of a theoretical framework derived from feminist theory, I have hoped to make explicit different paths to gender equity in science education. My reason to choose AFCLIST and FEMSA as cases does, however, also reflect a particular interest in studying how two initiatives supported by Norwegian aid address gender inequity in science education. In that sense my case study also has an intrinsic case study dimension.

3.2.3 *Why a qualitative research approach?*

Stake (2000, p. 435) asserts that a case study might use quantitative as well as qualitative research methods. In order to answer my research questions I needed a research methodology that would give me more information about the particular cases than what would be possible to obtain through the use of a predefined questionnaire. For this purpose I found a qualitative research design to be more appropriate than a quantitative.

All types of methodologies have their strengths and weaknesses. The challenge in selecting an appropriate methodology is according to Yin (2003) to find a methodology that enables you to maximise the strength and minimise the weaknesses of your study. In this study I chose a qualitative research paradigm using case studies as my main approach. In the following section I will elaborate why I found a qualitative approach to be the most appropriate to answer my questions. In order to conduct this study I realised that I needed a research design that:

1. was not in conflict with my choice of theoretical framework,

2. was exploratory and flexible,

3. enabled me to understand complex initiatives,

4. enabled me to explore the perspectives of the actors,

5. enabled me to experience how the initiatives worked,

6. acknowledged the interaction between the researcher and the object of study, and

7. enabled me to maximise my strengths as a researcher…and minimise my weaknesses…

1. Was not in conflict with my choice of theoretical framework

In my study I make use of feminist critique of science to analyse how two initiatives go about addressing gender inequity in science education. I do not consider the choice to build my analytical framework on feminist theories to demand any particular set of feminist methods. In fact, feminist researchers now adopt a range of different research approaches and do not longer tend to search for one particular feminist method (Code, 2000; Olesen, 2000). In spite the fact that I do not consider it necessary to adopt a particular feminist methodology, my choice of a qualitative interpretative research design harmonises with the methodologies most often adopted by feminist researchers and is hence not in conflict with my choice of theoretical framework.

2. Was exploratory and flexible

The research questions raised for this thesis are exploratory in nature. I wanted to develop a new set of lenses in order to try to understand initiatives working to address a well known issue: Why and how address gender issues in science education. As the preceding chapters have shown, much work has previously been carried out to understand and explain why females are underrepresented in science and science education in most parts of the world. I found much of this work confusing, as it rarely explained explicitly why gender inequality in scientific inquiry was regarded a problem and what one expected from addressing such issues. In addition, I often found some of the recommendations contradictory and confusing. Through the reading of feminist critique of science I found new perspectives that could be of help to clarify some of these issues. Qualitative research is, according to Merriam (1998), characterised by an inductive approach. According to Goetz & LeCompte (1984, p. 4) inductive researchers "hope to find a theory that explains their data". In my study I have searched within feminist critique of science for theories that have enabled me to explain AFCLIST and FEMSA in a new and different way. The possibility of a study to emerge gradually and respond to the changing conditions of the study in progress is a benefit of qualitative research designs (Merriam 1998, p. 8). The flexibility of a qualitative study has made it possible for me to develop my study according to changes in the conditions for the cases and also to account for an ongoing development and refinement of my theoretical framework.

3. Enabled me to understand complex initiatives

A major concern of mine prior to my work with this study was that I would not be able to grasp the complexity of the initiatives I studied. Since qualitative research is multimethod in focus (Denzin & Lincoln, 2000), a qualitative research design enabled me to use different methods to gain information about the two initiatives. Qualitative research enables the researcher to gain a deeper understanding of the research objects than what is possible through quantitative data (Silverman, 2000). To gain information about the two initiatives, I studied documents, read background information about what shaped the initiatives as well as literature written by actors engaged in the two initiatives. I interviewed actors associated with the initiatives. I also interacted and participated at events organised by FEMSA and AFCLIST. Having the possibility of talking and getting to know the actors involved enabled me to gain a deeper understanding of the various perspectives implicit in each initiative.

4. Enabled me to explore the perspectives of the actors

In qualitative research, the researcher aims at capturing the individual’s point of view and tries to interpret phenomena in terms of meanings people bring to them (Denzin & Lincoln, 2000). Qualitative researchers are thus interested in understanding the meaning people have constructed and how they make sense of the world (Merriam, 1998). I was interested in how FEMSA and AFCLIST addressed gender issues in their work. Since both initiatives consist of individuals very much involved in shaping the two initiatives, it therefore became important for me to understand the perspectives of the various actors within the two initiatives. I wanted to find out what they regarded as the main obstacles to female participation and how they argued for the importance of having more females engaged in science education and scientific inquiry. Moreover, I wanted to learn about their ideas of what changes were needed in order to increase the participation and performance of females in science education. It is my understanding that information about people’s opinions and ideas can more easily be obtained by talking and engaging with the individuals instead of having them filling out a predefined questionnaire.

5. Enabled me to experience how the initiatives worked

Denzin & Lincoln 's (2000) definition of qualitative research says that qualitative research is naturalistic. This means that the researcher frequents the places where the event she is interested in naturally occurs (Bogdan & Biklen, 1998). This should be done in order to study individuals in their natural setting (Creswell, 1998). Merriam (1998) writes that the investigator in qualitative research spends a substantial amount of time in the natural settings of the study, often in intense contact with the participants. The focus of my study has been to understand the ideas developed and implemented in FEMSA and AFCLIST. “Natural settings” in this study would hence be settings where these ideas were developed and discussed. I have had several opportunities to frequent such settings in order to understand how AFCLIST works (see chapter 3.4). Since FEMSA ceased to exist as a project in 2001, it became impossible for me to engage actively in meetings and visit the various countries where the project operated in the same way that was possible with AFCLIST. I had to base my description and analysis on FEMSA primarily on the documents produced by the project while it existed and the interviews carried out with the actors during the FEMSA/AFCLIST workshop in December 2001 (See chapter 3.4). I also had some prior information about FEMSA since I had included data from FEMSA in my master study submitted in 1998 (Sinnes, 1998). Although Merriam (1998) writes that fieldwork is not a prerequisite for qualitative studies, I am aware of the limitations of my study that are a result of my limited ability to interact with the actors of FEMSA. When I still decided to include FEMSA in my study, I based it on an understanding that it would be of more value to my study to include FEMSA than to exclude it. Since FEMSA has been a major initiative carried out in order to address gender issues in science education in sub-Saharan Africa, I reckoned that including FEMSA would contribute to the understanding of how gender issues are analysed and addressed within this context. I also estimated that by being open about the limitations of my data material and trying to maximise the strengths and minimise the weaknesses of the material I did have access to, I had sufficient data available to be able to give a qualified analysis of how FEMSA addressed gender issues.

6. That acknowledges the interaction between the researcher and the object of study

While all research strives to develop research designs that eliminate bias, qualitative research acknowledge that research designs and results will always be inevitably permeated by values, those of the researcher, the research participants and the research audience (Denzin & Lincoln, 2000, p. 367). Although qualitative research acknowledges that research cannot be totally objective and value free, several methods have been developed within qualitative inquiry to minimise the bias of the research. I will discuss in chapter 3.6 how I have tried to minimise the bias of my research, however, I realise that a research design such as the one I have developed will never be totally neutral. The theoretical framework that I have developed to analyse the cases have coloured my findings. The meetings with people upon which I have based much of my research have also impacted on my interpretation of data. The fact that the interviews with FEMSA people were carried out at a point of time where they experienced much frustration and uncertainty regarding the future of FEMSA, most likely also impacted on their answers.

The fact that I came from a foreign culture most likely had an impact on our meetings and also on my interpretation of their work. Merriam (1998, p. 6) asserts that:

> *Key philosophical assumption, as I noted earlier, upon which all types of qualitative research are based is the view that reality is constructed by individuals interacting with the social worlds. Qualitative researchers are interested in understanding the meaning people have constructed, that is, how they make sense of their world and the experiences they have in the world.*

I once discussed my role as a researcher with one of the actors in AFCLIST. I was frustrated and afraid that I would not be able to fully understand the two initiatives. He said that the fact that I came from the outside enabled me to see other aspects than a person with a different cultural background than mine. Even though a science educator that had grown up in sub-Saharan Africa would most likely have seen different things when studying AFCLIST and FEMSA their picture would not be truer than mine, although it might be different.

I have chosen an interpretative approach to qualitative inquiry (Cohen, Manion & Morrison, 2001). Throughout the text I do not attempt to hide my voice as a researcher and how I as a researcher have gone about to interpret my findings. Allowing for the researcher to be present in the text are by several research traditions, particularly within natural sciences regarded as being too subjective and hence not meeting scientific standards. On the contrary, Denzin & Lincoln (2000) assert that qualitative researchers acknowledge that there is no such thing as value free inquiry and permits the value commitments of the researchers to be transparent. I build on Moi (2001) arguing that I do not believe that scientific inquiry will become any more objective by replacing personal pronouns such as “I” and “me” with “this study”. Qualitative research “is a situated activity that locates the observer in the world” (Denzin & Lincoln, 2000, p. 3). I try to position myself by allowing my impact and my interpretations of my findings to be transparent throughout the text. In that way it is left open to the reader to judge the reliability and validity of my interpretations.

7. That enabled me to maximise my strengths as a researcher… and minimise my weaknesses…

By acknowledging the influence of the researcher on the research process, the qualities of the researcher become crucial in a qualitative study.

In a qualitative study the investigator is the primary instrument for gathering and analysing data and, as such, can respond to the situation by maximising opportunities for collecting and producing meaningful information. Conversely, the investigator as a human instrument is limited by being human – that is, mistakes are made, opportunities are missed, personal biases interfere. Human instruments are as failable as any other research instrument. The extent to which a researcher has certain personal characteristics and skills necessary for this research needs to be assessed, just as a rating scale or survey would be assessed in other types of research (Merriam, 1998, p. 20).

A prerequisite for a qualitative researcher is to earn the trust of the people she wants to research. Qualitative research methods put strong demands on the researcher's ability to get in contact with the people she wants to study (Bogdan & Biklen 1998). The fact that I like meeting new people and feel that I can easily get in contact with other individuals, was one of the reasons why I thought that a qualitative research methodology might suit my study. The use of methods such as interviews and participatory observations seemed suitable to my personality as a researcher.

A qualitative researcher needs to tolerate ambiguity (Merriam, 1998). I started this section describing why I chose a qualitative research approach by claiming that I needed a research approach that was flexible and exploratory. I wanted this study to be exploratory. I wanted to explore the relevance of feminist critique of science to the thinking about gender equity in science education. The fact that qualitative research inquiry does not have firm guidelines or specific procedures and is evolving and changing constantly (Creswell, 1998) made it a difficult but also a creative process to carry out this study. This has been very challenging but also extremely exiting for me.

3.3 Constructing a theoretical framework

Early in my study I came up with three theoretical "discourses" that I believed would be relevant as background reading for studying science education initiatives in Africa. The three theoretical discourses I identified as relevant were:

1. literature about gender issues in science and science education,
2. literature about the teaching of science in non-western contexts, and
3. literature about the role of education for development.

I presented a draft of this theoretical framework at the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE) conference in Durban in 2001 to have African science educators comment on my choice of analytical framework. The response I got after making it very clear to my audience of about 30 renowned African science educators, encouraged me to continue my study using this framework. After carrying out my interviews and working further with the material and literature I did, however, decide to eliminate the literature about the teaching of science in non-western contexts from my analytical framework. Although I am fully aware of the importance of these issues for teaching science in an African context, I found these issues somewhat drawing my attention away from my actual focus – gender issues.

The cases I have chosen to focus on in this study are both supported by aid. All aid supported initiatives in some way or another need to have a relationship with the institutions that grant the aid, the donors. Donors have their own agendas. Therefore it becomes crucial in order to understand how the projects work, also to understand the agenda of some donors. My first approach to understanding the politics of aid to education was to join two one-week courses about the politics of education and development arranged by the international summer school for PhD students at the University of Oslo. The courses focused on the changing politics of aid to education and offered basic introductory readings in the field, which for me were unknown. I wrote an essay for the last of these courses called "Science Education for Girls in Developing Countries – Why, Who and How?" (Sinnes, 2001) The course lecturer, an African professor in education, commented this essay. His comments were useful in orienting me in the field and to where I should seek further information about the theoretical foundations for the politics of education and aid. I also studied policy documents form various donor and lending institutions as well as conducted interviews of some representatives' from the donor agency in my country, Norad. Although these readings were valuable to better understand the conditions under which my cases worked, my choice to cultivate the gender perspective, made me decide to eliminate this literature from my theoretical framework.

As I started reading more about feminist theory and critique of science I decided to cultivate the gender perspective in my theoretical framework. I wanted do see whether the perspectives within feminist theory and critique of science could be of relevance to better understand different ways of addressing gender issues in science education. Barton (1998) had used feminist theory in a similar way in her description of how science education initiatives targeting girls had developed and changed over time in accordance with the changes in feminist directions or “waves”. I decided to use conceptions found in feminist critique of science of what impact sex/gender may have on the construction of scientific knowledge as a basis to reflect over different paths to gender equity in science education. With the basis in feminist theory I developed a theoretical framework that I have used in my analysis of the two cases.

The theoretical framework, and hence my interpretations of the implications for gender initiatives of the different feminist positions identified, has developed and been adjusted to account for several different types of inputs and comments. Academics with a background in feminism as well as science education have acted as critical readers. I have also presented the theoretical framework at several international meetings and conferences. The theoretical description of approaches to gender equity in science education has also developed in meeting with the empirical study of how FEMSA and AFCLIST approach gender equity. In that way the theoretical framework has been developed in a way that has allowed for empirical and theoretical positions to meet and inform each other.

In my mapping of the different feminist perspectives and their possible implications for science education initiatives aiming at gender equity as outlined in chapter 2, I have not positioned myself within any of the positions described. I realise that by not locating my own preferences and standpoints within the theories described, I might break with the interpretative ideals that I have positioned my study within. The reason for me not to communicate more frankly my own theoretical perspective when developing my analytical framework, is that my study of these positions has been exploratory. Hence, I have not until later in my research journey developed a view about which of the identified positions I would personally adhere to.

3.4 Collecting data

3.4.1 Introduction

Getting access to the field is crucial in qualitative research (Denzin & Lincoln, 2000). This applies in particular when doing research projects in cultures different from your own. Prior to my study, I did worry about getting access to the cases. I worried about how I would be met by the different actors within the two initiatives. I had read a lot of critique against researchers coming from rich countries seeking for research topics that enabled them to visit exotic countries, preferably warm and sunny. What made my project different? Was it any different? Would my respondents see me as yet another fortunate rich student choosing to do research in an exotic context? Would I be able to understand the situation in which the cases operate coming from such a different cultural background? Would they look at me as a representative for the donors and be nice to me because if they didn't it could have a negative effect on their economic support? Although I do not represent the aid agencies, my supervisor has close links to Norad, and has on several occasions represented Norad on events within the two initiatives. Would they, because of this link, not be honest about their agenda? A female colleague from home had warned me that African women sometimes acted hostile towards white women coming to "research them". How should I handle this if it happened to me? Although for me it was clear from the start that the purpose of my study was to learn from the cases and not have the cases learning from me, would I be able to communicate this to my interviewees?

In doing case studies, establishing trust with the people involved in the cases is of crucial importance in order to gain access to the cases (Nisbet & Watt, 1978). I realised prior to my empirical work that my only chance to establish trust with the respondents and thereby get access to the cases would be to be open and honest with them about what I did during my fieldwork as well as in the writing up of my research. I was in a learning situation. Everybody knew that. Most of my interviewees were older than me and had high academic positions. The fact that I was there to learn from them was therefore evident from the start, and I experienced no problems in having people wanting to talk to me and share their views.

3.4.2 Negotiating access to FEMSA and AFCLIST

Lincoln & Guba (1990) write in the article "Judging the quality of case study reports" that:

> *Some part of the methodological treatment ought to comprise reflections on the investigator's own personal experience of the fieldwork. Any case study is a construction in it self, a product of the interaction between respondents, site and researcher. As such, the construction is rooted in the person, character, experience, context and philosophy of the constructor. That constructor, the inquirer, has an obligation to be self-examining, self-challenging, self-critical, and self-correcting. Any case study should reflect these intensely personal processes on the part of the researcher.*

In the following description of how I got access to the cases and collected my data I will include descriptions of how these personal relationships were established and how they impacted on my work.

FEMSA and AFCLIST were chosen as cases since they at the point when I started working on this thesis represented the two major science education initiatives in sub-Saharan Africa. They were also chosen since they are the only two initiatives Norway supports that aim in particular at improving science education in developing countries. Previous to my studies, my knowledge about the two initiatives differed considerably. In my master's thesis I used results from the first phase of FEMSA to shed light on the different obstacles girls face choosing science in Norway and Uganda. Through my masters study I had got to know some of the central actors within FEMSA and was also familiar with the documentation produced by the project at that time. I had some knowledge about AFCLIST prior to my studies due to my supervisor's representation on the AFCLIST board. My supervisor was also a member of the "Consultative Group" of FEMSA. The fact that my supervisor played a central role in both initiatives eased my access to documents as well as to the actors. He introduced me to the different actors within the projects and also on several occasions travelled together with me to meetings within the two projects. Due to his close relationship to many of the actors within the two projects, I also got to know them more on a personal level, which gave me access to more in depth knowledge about the two initiatives.

My access to the two cases throughout my study has been very different since I started the collection of data at the time when FEMSA was in a period of transition. FEMSA was handed over to FAWE at a gathering in Nairobi in December 2001 (see chapter 3.4.5). I had to collect all my interviews from FEMSA at this one gathering. Since there has been a lot of uncertainty connected to what happened to FEMSA after it was handed over to FAWE I had very little opportunity to keep up my communication with the informants and to actually visit the places where FEMSA operated. It also proved difficult to get access to documents from FEMSA kept at the FAWE office prior to the handover. Most of the recommendations from FEMSA were, however, developed in the first phase of the project. This is also the phase of the project that is best documented. I have gained access to these documents through Norad, some from Svein Sjøberg and some documents have been e-mailed from the FAWE Regional office. The majority of these documents are however minutes of meetings, correspondence between donors and Regional Coordinator and correspondence among the donors. Although many of these documents offer interesting reading about FEMSA, the information given about the actual *outcome* of the project, the professional ideas developed and the interventions carried out are scarce. My effort to gain access to the documents offering information of this sort has not been as successful that I had hoped for. Norad, as the leading donor agency does not have a complete overview of which documents have been produced as a result of FEMSA. My approach to FAWE asking them to send me all documents that were produced as a result of FEMSA and to verify which documents were actually produced has not resulted in much. For half a year they wrote that they would send me the documents as soon as they found them. Since most of the documents I requested were never sent, I assume that they were never found. The lack of information, dissemination and publications that has come out as a result of FEMSA did complicate the writing of this case. The Regional Coordinator produced much of what has been written about FEMSA. These documents are by and large without many references. It has therefore been difficult to evaluate on which basis he has made his claims.

In this thesis, I focus on the contributions of FEMSA to the understanding of what causes underrepresentation and underperformance of females in science, and their contributions and recommendations to how this situation might be changed. The focus of this study is hence not to study the impact of the initiatives. Since most of these ideas were developed in FEMSA's first phase, and since this is the phase that is best documented, I judged that my information about FEMSA was sufficient to conduct an analysis of FEMSA according to my focus.

Getting access to information from AFCLIST has been totally different. Since this initiative is still operating I have had the possibility to keep in contact with the actors over a long period of time. I have had the opportunity to participate at several of their arrangements and thereby gradually get to know both the initiative and the individuals engaged in the initiative better than the case has been for FEMSA. I have also had the opportunity to spend three months as a visiting scholar at the University of Durban-Westville (now University of KwaZulu Natal) where AFCLIST's offices are situated. During this period I had free access to all materials present at AFCLIST's office.

3.4.3 Types of data collected

Table 3.1 shows the sources of data collection for the two cases. The table also shows the conceptual organisation of levels, sources and techniques for data collection.

Sources of data collection	Levels and data collection techniques				
	Written Material		Persons		Records
	Policies	Other written material	Secretariat	Local / National stakeholders	
CASE 1: FEMSA	Policy documents Minutes of meetings from the development of FEMSA Written correspondence discussing policy issues	Dissemination Reports Documents written by National Coordinators Documents written by the secretariat Letters between donors and secretariat, boards etc Reports written by Svein Sjoberg	Semi-structured interviews E-mails	Semi- and unstructured interviews E-mails Casual conversations	Minutes of meetings Informal E-mails Corre spon dence
CASE 2: AFCLIST	Policy documents/ Guiding principles	Articles written by stake holders/ grant receivers Newsletters Information folders	Semi- and un-structured interviews E-mails Casual conversations	Semi and un structured interviews E-mails Casual conversations	Minutes of meetings Personal notes

Table 3.1: The conceptual organisation of levels, sources and techniques for data collection.

The various data collected were used as a basis to answer research questions 1 and 3. Table 3.2 shows how the various sources of data contributed as sources to answer these questions.

Questions	Documents	Interviews	Events
How does the academic discourse about feminism, females and science impact science education initiatives targeting girls?	Do they refer to distinct theories in their documentation?	Do they say that they subscribe to/ are informed by certain theories?	Do they discuss theories in their meetings?
How do two African science education initiatives supported by Norwegian aid address gender issues?	How do they address gender issues in their written documentation?	How to they talk about girls and science education?	How do they address gender issues in their meetings/events?

Table 3.2: The relationship between research questions and questions addressed through the case study.

To answer research question number 2, I developed a theoretical framework showing different approaches to gender equity in science education (see chapter 2). Although data from the cases contributed to modify and develop my analytical framework, research question 2 was answered mainly by building on theoretical data from the literature reviewed.

3.4.4 Interviews

What types of interviews?

The majority of the interviews undertaken were semi-structured interviews (Kvale, 1996). Some unstructured interviews were carried out with some actors to get a deeper understanding of some aspects of the cases. The semi-structured interviews followed the same structure, but were developed individually when talking to different people. Emphasis was also put on different questions depending on each individual's role in the two initiatives. More emphasis would for instance be placed on the part of the interviews dealing with policy aspects of the organisation in interviews with the director of AFCLIST then when interviewing grants receivers. One interview normally lasted about one hour, but there were interviews lasting 30 minutes and some lasting for two hours. All the interviews except the two interviews with Norwegian donors were carried out in English. One interview was carried out with the aid of a translator that translated from French to English. For me and most of my interviewees English is not our mother tongue. Since all my interviewees were highly educated and all but one spoke English, this did however not create any problems. The semi-structured interviews were tape recorded and transcribed in full length. Interviews with the donors and also the unstructured interviews were used mainly as background information and were not all transcribed in full length.

When and who were interviewed?

Due to the geographical spread in the location of my interviewees and the cost connected to see each of them, I had to carry out most of my interviews at times where the actors where gathered for meetings.

The interviews were carried out over the duration of approximately a year from December 2001 until January 2003. Table 3.3 shows when and where the interviews were carried out. The table also shows what type of interviews that were carried out and how the interviews were used in the case study.

Place and date for interview	What type of interview	Who were interviewed?	TU/URO*
Nairobi, Kenya, December, 2001	Semi-structured	National Coordinator for FEMSA in Swaziland	TU
		National Coordinator for FEMSA in Zambia	TU
		National Coordinator for FEMSA in Tanzania	TU
		National Coordinator for FEMSA in Uganda (old)	TU
		National Coordinator for FEMSA in Uganda (new)	TU
		National Coordinator for FEMSA in Senegal	TU
		National Coordinator for FEMSA in Cameroon	TU
		National Coordinator for FEMSA in Burkina Faso	URO
		Regional Coordinator for FEMSA	URO
		Representative from FAWE Malawi	URO
Venda, South Africa, May, 2002	Semi-structured	Node director, AFCLIST node on large classes	TU
		Grantee, AFCLIST node on large classes	URO
		Grantee, AFCLIST node on large classes	URO
Zomba, Malawi, May, 2002	Semi-structured	Deputy Director AFCLIST	TU
		Technical advisor AFCLIST	TU
		Node director (environment) AFCLIST	TU
		AFCLIST Grantee 1, Malawi	TU
		AFCLIST Grantee 2, Malawi	TU
		AFCLIST Grantee 3, Malawi	URO
Manzini, Swaziland, May, 2002	Semi-structured	Node director (relevance) AFCLIST	TU
		Node associate 1 (relevance) AFCLIST	TU
		Node associate 2 (relevance) AFCLIST	TU
	Un structured	National Coordinator for FEMSA in Swaziland (second interview)	TU
		FAWE representative Swaziland	URO

Pretoria, South Africa, May, 2002	Semi-structured	Director AFCLIST	TU
		Former node director (large classes)	URO
		NORAD's representative at the Norwegian Embassy in South Africa	URO
Oslo, Norway, October, 2002	Un structured	Director AFCLIST (second interview)	TU
Oslo, Norway, December, 2002	Semi-structured	Head of Department for education and research in Norad	TU
Mbabane, Swaziland, January, 2003	Un structured	Node director (Science education and industry) Ghana	URO
		National Coordinator for FEMSA in Zambia (second interview)	URO
		FAWE representative in Uganda	URO

Table 3.3: Interviews undertaken as part of the case study of AFCLIST and FEMSA. The table shows when and where the interviews were carried out, type of interviews, who was interviewed and how the interviews were used in the case study.

****TU= Transcribed and Used, URO= Used for Reference Only***

Interviews with FEMSA actors

I conducted interviews of nine FEMSA actors. Two actors from FEMSA were interviewed twice. Six interviews were transcribed in full and used in the analysis. Most of the FEMSA interviews used here were carried out during the meeting in Nairobi in December 2001. After and in-between these meetings I interviewed the Country Coordinators and the Regional Coordinator of FEMSA. They all responded very positively to my request to interview them although time was short between the meetings and they had to spend parts of their limited spare time to be interviewed. It was however important for me to carry out as many interviews as possible at this meeting due to the uncertainty connected to the future status of the FEMSA Coordinators after the handing over of the project to FAWE.

The interviews were carried out in between other meetings and in the afternoons. I made appointments with the Coordinators, during the breaks of the meetings they attended. Most of the interviews were carried out in my hotel room. The interviews carried out in my room turned out to be the best and most focused interviews. Due to the interviewees' busy schedule, some of the interviews were carried out over lunch. The noise and disturbances at some of these interviews hampered the technical quality of the interviews to such a degree that they could not be transcribed.

One of the interviews was carried out in one of my interviewees' room. She was sharing room with a Coordinator from a different country. As I was interviewing one of them the other one was showering. As she finished the shower she came into the room where the interview was being carried out. She got engaged in the interview that was carried out in her hotel room and started commenting on it. The interview was already coming to an end so I did not interrupt her but invited her to engage in the conversation. This interaction ended up in an informal chat about gender roles in our respective countries. The conversation was amusing, we laughed and chatted as she towelled herself and got dressed. This is one of several incidents where I felt that I got extra access to informal information because of my sex. Several times I felt that I got into a “woman to woman talk” with my female interviewees. These chats were useful as they gave me a deeper understanding of my interviewees as well as their background than I would have gained only through the interviews.

I made additional interviews of two of the Coordinators. The Country Coordinator of Swaziland was interviewed again in Manzini, Swaziland in May 2002. The Country Coordinator of Zambia was interviewed for the second time in Mbabane, Swaziland in January 2003. The second interviews were brief and focused on what had happened to FEMSA after the being handed over to FAWE.

Interviews with representatives from FAWE and NORAD

I had brief unstructured interviews with three local representatives from FAWE from Malawi, Uganda and Swaziland. The FAWE interviews all focused on the organisational structures of FEMSA after December 2001. These interviews were used for reference only. I interviewed two representatives from Norad. These interviews dealt mainly with the organisational issues of FEMSA and AFCLIST and were used to deepen my understanding of Norad’s engagement in the two initiatives.

Interviews with AFCLIST actors

I conducted interviews with fifteen AFCLIST actors. I could not use three of the interviews due to low technical quality of the recording. I interviewed the director of AFCLIST two times with six months’ interval.

The twelve remaining interviews are of representatives with the following connections to AFCLIST:

- The director of AFCLIST.
- The deputy director.
- The technical advisor

- The node directors of three of AFCLIST's six nodes (Venda, Swaziland, and Malawi)[30]
- Six other actors either connected to AFCLIST through the nodes or receivers of AFCLIST grants.

Of the twelve interviewees, five were women.

Most of the interviews of the AFCLIST actors were carried out in May 2002. Over the duration of a two week period, I visited three of AFCLIST's nodes; in Venda, Swaziland and Malawi. In Venda, South Africa I interviewed the node director of the "large classes node" as well as two other people engaged in the node. In Swaziland I interviewed the node director of the "relevance in science" node as well as two other people engaged in the node's work. I spent four days in Malawi where I interviewed the node director and three other people engaged in the "environmental science" node. I interviewed the deputy director of AFCLIST as well as the technical advisor. In Malawi I also interviewed a teacher who has received several grants from AFCLIST.

In Pretoria, South Africa, I carried out interviews with the director of AFCLIST and also of the former node director of the Venda node on large classes. I also interviewed the Norad representative in South Africa, who is now in charge of Norad's funding to AFCLIST. I carried out a second interview with the director of AFCLIST when he visited Norway in October 2002. The head of the education and research department in Norad was interviewed in December 2002. In January 2003 I interviewed the node director of the AFCLIST node in Ghana. This interview was carried out in Swaziland where we were gathered for AFCLIST meetings and a conference (see chapter 3.4.5).

The original plan was to carry out most of the interviews in connection with a board meeting where a number of the stakeholders would participate. Due to a delay in the funding for AFCLIST this meeting was not carried out until January 2003. This would be too late for me to carry out the interviews. Although this meant higher travel expenses for me, since I then had to travel a lot more to see my interviewees, this turned up to be a very rewarding solution. I went to visit three nodes and got a much deeper understanding of

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[30] AFCLIST currently has seven nodes, or centres on excellence, that are meant to be resource centres for research and development within key problem areas in science and technology education in sub-Saharan Africa (see chapter 5.2.3 for details).

what was going on there than I would have got by interviewing the stakeholders at a meeting. Actually going to the different nodes also enabled me to meet more people. I interviewed more people than I had originally planned. This way I got an understanding of the multiple perspectives that also exist between the stakeholders within each node. I also got a deeper understanding of the facilities and constrains that are caused for example by limited space at the universities. Visiting the nodes also provided opportunities to engage at a more personal level with the people involved in the projects. I was met with warmth and an impressive hospitality. The AFCLIST actors would pick me up at the airport, invite me home for dinner and take me for drinks in the afternoon. This of course, besides being very pleasant, enabled us to interact more freely. Often we would continue talking about the issues that were raised during the interview. In these more informal settings other issues would be raised that deepened my understanding of the situation.

I used Pretoria as a base for my May 2002 travels and always returned there between the excursions. Here I had the possibility to meet regularly with the director of AFCLIST. We discussed my experiences from the interviews and I had the possibility of asking him questions and filling in gaps in my understanding. All these discussions were very helpful in gaining a broader understanding of the initiative.

Reports from my interview journeys

Venda, South Africa.

The University of Venda for science and technology is situated in the northern province of South Africa, close to the border of Zimbabwe. It is a former black university. Even though it is now open for all racial groups, the university recruits mainly black students from the district. The node on teaching of large classes was opened in November 2001. The node is now run by a female lecturer at the University. Three other persons at the University were involved in the node activities.

I travelled by plane to Pietersburg and was picked up by a university driver and taken the two hours' drive to Venda where the node director met me. She arranged for the other AFCLIST people to meet in the science education department immediately after my arrival at the university. We then made a schedule for my interviews. I carried out two interviews each day. All interviews were carried out on campus in the offices of the people I was interviewing. Between the interviews I spent time with the node director. She bought me lunch, showed me around campus, and took me for drinks at the hotel in the evening. During the informal time we spent together, she showed me the research she undertakes within the node. This research focuses on detecting characteristics of effective science teachers in large science classrooms. She expressed a high degree of enthusiasm for her research and gave a great deal of honour to AFCLIST for giving her the opportunity to carry out this research. “AFCLIST has given me a life”, she said.

She also told me about the problems she experienced working with the node. She felt that she had problems in engaging people at the university to work for the node and also found it difficult not to have a room at the University for the node. AFCLIST was promised a room for the node activities. This room was however taken away from them a few months later without any further explanations or warning from the university. When I left Venda after two days, I felt that I in spite of the short duration of my stay had gained much information about the Venda node, much thanks to the node director's open communication with me. After my visit to Venda we have kept in regular contact via e-mail and telephone calls.

Manzini, Swaziland

The University of Swaziland in Manzini hosts the AFCLIST node on “Bridging School, Science and Society”. I visited the node for two days and interviewed three of the people involved in the node.

I arrived Manzini in the morning and was picked up at the airport by the node director. She had already made arrangements for me with people to see and interview. Besides three central actors within the node, she had made arrangements for me to see the FAWE representative in Swaziland, the former FEMSA Coordinator from Swaziland, and also a representative for the United Nations Children's Fund (UNICEF) who was dealing with gender issues within UNICEF. I had not requested to see the UNICEF representative, but the node director had made arrangements for me to see him as she thought it would be of interest for me to learn about what UNICEF was doing to address girls’ needs. To meet the UNICEF representative she drove me from Manzini to Mbabane.

All interviews, except the one with the node director were carried out on campus. The interview with her was carried out in her home as we waited for dinner to be prepared. She invited me home for “real Swazi food” the night I spent in Manzini.

Also after leaving Swaziland I was very pleased with all the information I had gained. The informal chats with the node director and her family over dinner, lunch and the drive back and forth to Mbabane gave me deeper insights to some of the issues we discussed during the interviews.

Zomba, Malawi

The interviews in Malawi were carried out in connection with a planning meeting for the secretariat. I spent four days in Malawi interviewing people. I also got the opportunity to participate at parts of the secretariats' planning meeting.

I travelled to Zomba from South Africa together with the director of AFCLIST. The meetings were to take place in Zomba where AFCLIST's joint secretariat is situated at the Chancellor College. The drive from Blantyre to Zomba takes a little more than one hour. The road is bumpy without any lights except for the light coming out from the small houses and the fires used for cooking along the road. We arrived in Zomba well after dark and were met by the technical advisor of AFCLIST and a teacher from Malawi who is actively involved in AFCLIST's work in Malawi. The four of us were going to share a guesthouse by the hills of the Zomba Plateau during our stay.

The first night in Zomba all the people involved in AFCLIST's activities in Malawi were gathered at a restaurant close to our guesthouse for dinner. The atmosphere was pleasant and people seemed happy to see each other. They chatted about the meetings that were to come, and more personal issues. The director of AFCLIST gave a short speech and thanked all of the people in "the AFCLIST family" for their contributions to AFCLIST. At this gathering I took the opportunity to make arrangements for interviews in the days to come.

The following days were packed with meetings and interviews. Everything took place at Chancellor College, which was within half an hour's walk from the guesthouse. The secretary from the office in Malawi assisted me in getting in contact with my interviewees and in finding places to carry out the interviews. Some interviews took place outside on campus, but most of them were carried out in the interviewees' offices.

It turned out to be difficult to get time to interview the deputy director of AFCLIST as well as the technical advisor. They were busy in meetings from early morning to late night. I carried out these interviews at the guesthouse late at night at the last day of our stay in Malawi.

3.4.5 *Participation at events*

Most of the interviews were carried out in connection with meetings within and between AFCLIST and FEMSA. Besides carrying out interviews I participated in several of these meetings. Participating at these events gave me valuable information about the two initiatives, and a deeper insight to how they work.

Winneba, Ghana: Launch of SACOST centre

The first AFCLIST gathering I participated in was the launch of the Centre for School and Community Science and Technology Studies (SACOST) Centre in Winneba, Ghana in June 2001. The centre constitutes AFCLIST's node in Ghana.

At this time in my PhD process (three months after I started) I had not yet decided to include AFCLIST in my study. I travelled to Ghana together with my supervisor mainly to gain some knowledge about what was happening within science education in sub-Saharan Africa. The workshop gathered representatives from all levels of the education sector in Ghana from primary school children to vice-chancellors at universities in Ghana, representatives from the ministries, and examination councils. The workshop also gathered numerous representatives from industries in Ghana. Several aid and lending institutions were also represented at the workshop. The objectives of the workshop were to:

- assess the impact of AFCLIST supported projects in Ghana,
- develop strategies to take innovative projects to scale,
- increase awareness of stakeholders of the need to perceive science education as a cultural enterprise in and an inquiry process,
- highlight SACOST as a focal point to catalyse the popularisation of science in Ghana and Africa in general, and
- establish networking activities between AFCLIST and other stakeholders that lead to fundable proposals (Anamuah-Mensah, Savage & Asabere-Ameyaw, 2000).

This workshop was my first experience with AFCLIST. I struggled a bit to grasp what things were about. I found the different accents difficult to understand and sometimes I felt that I missed some of the discussions due to language problems. I therefore used the opportunity of participating at this workshop mainly to talk to people. I spoke to the pupils and also to some of the student teachers at the university. Two of the female student teachers invited me to their residence at campus. I also had the opportunity to talk to some of the central actors from AFCLIST. The experiences at this workshop made me aware of the work AFCLIST does and sparked my curiosity in the initiative. I believe that the contacts I made at this workshop were also determining factors for the further development of my study. I kept in contact with some of the AFCLIST actors after the workshop via e-mail and also contact via letters with some of the primary school pupils who participated at the workshop. One year later I was invited by AFCLIST to present a paper at a joint FEMSA/AFCLIST workshop in Nairobi.

Nairobi, Kenya: FEMSA/AFCLIST joint workshop

The joint AFCLIST / FEMSA workshop lasted for three days (December 6th - 8th 2001). The workshop was sponsored jointly by FEMSA, FAWE and AFCLIST. The purpose of the workshop was for FEMSA and AFCLIST to share experiences on gender issues with each other. The first day of the workshop was allocated for FEMSA to share their findings from the two phases of the project. The second day, AFCLIST presented their experiences through three papers on gender issues. I was invited to this workshop by AFCLIST to present a paper on the relevance of feminist theories for science education initiatives targeting girls. For me this task was a fantastic opportunity to engage and have comments to my ideas from the people whom it really concerned. At the same time, it scared me immensely. I was worried about how the audience would response to my reflections regarding the relevance of such theories for their work. I was nervous about how it would impact on the rest of my study if they thought my ideas did not make sense. I was also anxious as to whether this presentation would impact on my later interviews, since several of my interviewees were among the audience. As it turned out I had no reason to worry. I got fruitful comments to my paper that I used in my later development of a theory chapter and an analytical framework. I also realised that the presentation actually strengthened my later interviews since it gave my interviewees an introduction to my way of thinking and also offered an introduction to feminist critique of science for those who were not familiar with this discourse. Participating at this meeting also gave me opportunity to discuss my ideas with relevant people at an early phase of my research.

Zomba, Malawi: Planning meeting for the AFCLIST secretariat

In connection to the interviews carried out in Malawi in May 2002, I had the opportunity to participate at one of the secretariat's planning meetings. Participating at this meeting gave me a better understanding of how AFCLIST works and also gave me an update on the activities they planned for the year to come. The fact that they included me in this meeting was typical of the open attitude within the AFCLIST events. I never felt that I was unwanted in any of the events. On the contrary the members of the secretariat requested my participation and were open and willing to share their ideas openly with me.

Manzini, Swaziland: AFCLIST meetings and workshop

In connection to the 11th annual SAARMSTE conference in January 2003, AFCLIST arranged several meetings and two workshops. In cooperation with SAARMSTE, AFCLIST arranged a two days workshop on how to write journal articles for publication. A one-day workshop focused on developing programmes for master's studies in "African studies in science education". The AFCLIST advisory board had a whole day meeting. The grants committee also met for several days to discuss grants proposals. In addition one day was set aside for the nodes to report on their work in their respective countries. I was invited to report on my findings regarding how AFCLIST addresses gender issues.

I participated in all the AFCLIST meetings during these ten days except the board meeting and the meetings of the grants committee. I did however get access to all the documents from the board meeting, and had the opportunity to speak to several of the members both from the board and the grants committee.

I used the opportunity of being at SAARMSTE to go to as many presentations as possible by AFCLIST as well as previous FEMSA actors. In this way I got to learn more about the initiatives and how they work and also got an insight as to how other people responded to their projects.

During the SAARMSTE conference and also during the meetings after the conference, all AFCLIST delegates stayed at the same guesthouse. I stayed together with them for all ten days. Staying together all this time made it possible for me to get to know several of the actors better. We would eat all meals together, drive together to the different venues and take walks together at night. Even though I was the only person there who was not representing AFCLIST, I did not feel as an outsider. I got the feeling that everybody looked at me as one of them, and I was never under the impression that they acted differently to me than towards the others. I knew most of the AFCLIST delegates from previous meetings and from my fieldtrips and seeing them again I felt I was seeing old friends. Since I was among the few who held an international driver's licence, I was appointed to be the minibus driver and drove the delegates to and from meetings. I also drove the minibus from Johannesburg to Swaziland and back. Driving back to Johannesburg, we had to start of early in the morning. One of the delegates had to catch a plane to Uganda quite early, so we started of at 0530. The passengers in the bus I was driving were three men all holding central positions within AFCLIST in two different African countries. They were all engaged in keeping me awake during the four-hour drive from Mbabane to Johannesburg. We had a wonderful time talking about different issues in our countries. We all ended up singing our national anthems for each other. When we left each other at the airport one of my passengers, an elderly professor, whom I found quite formal the first time we met, said to me: "Good bye Astrid, we are going to miss you!" This is one of the several moments I will not forget and that makes me believe that my attempts in gaining access to the cases by establishing trust to my respondents were successful.

Maputo, Mozambique: AFCLIST workshop on developing a master's course in science education

The last event I participated at organised by AFCLIST was a workshop in Mozambique organised for the purpose of developing the framework for a master's study in science education. The workshop gathered AFCLIST actors from throughout Africa. They sat together for a week to develop the first drafts for the different modules of the master's study (see chapter 5). At this meeting I was invited by AFCLIST to contribute to the development of a module on "Equity and Development". Together with the former FEMSA Coordinator from Uganda and two other women engaged in AFCLIST work we tried to work out relevant content for this module. When being asked to contribute to develop this module I had to reflect on the implications for my research of being involved in such a way in one of the initiatives I write about. Since the assignment came after I had collected my data and done most of the analysis I decided that it would not impact on my study in any way apart from giving me an extra opportunity to further experience how FEMSA works.

I have had different roles as a researcher throughout this study. I started out at my first AFCLIST event in June 2000 as an *observer as participant*. This means that:

> *The researcher's observer activities are known to the group; participation in the group is definitely secondary to the role of information gatherer (Merriam, 1998, p. 101).*

At that point of time I had not yet decided to include AFCLIST in my study. I participated to gain information about science education initiatives in sub-Saharan Africa. I interacted with the participants, and used every opportunity to talk and learn from them, but I did not play any role in the gathering other than as a researcher or a student.

Since I at the next event was invited to present a paper, my role, according to Merriam (1998), changed from an *observer as participant* to become a *participant as observer*. This according to Merriam (1998, p. 101) implies that:

> *The researcher's observer activities, which are known to the group, are subordinate to the researcher's role as participant.*

My own interpretation of my role as a researcher is that I moved gradually more and more towards a role as a *participant as observer* in my study of AFCLIST. Since FEMSA stopped existing as a project so early in my research, I did not have the opportunity to become involved in that project in the same way. For me it would have been difficult to keep a role as strictly as an observer in AFCLIST after participating in several of their events. The fact that the members of the group were open and including and also eager for my participation, would make my role as a researcher more complex because I needed to keep a certain distance to the group. Merriam (1998) writes that the trade-off between the depth of the information revealed to the researcher and the level of confidentiality promised to the group is crucial when taking an active part as a participant in a group. The trade of between gaining access and "going native" is central to obtain confidentiality. I believe this confidentially has been secured by me having an open dialogue with my interviewees and by making sure to separate personal reflections shared with me from information relevant for this study.

3.4.6 Documents

The documents reviewed for this thesis include:

- documents produced by the initiatives through which they present themselves,
- policy documents,
- documents produced by the different actors within the inititatives (publications, presentations, teaching material),
- reports to donors and boards,
- letters between donors and initiatives,
- letters between different donors,
- letters between supervisor and donors,
- minutes of meetings,
- evaluation reports, and
- web-sites.

My main source to documentation from FEMSA has been my supervisor, Svein Sjøberg. Due to the central role he has played in the project, he had access to much documentation. This included the Dissemination Reports produced through FEMSA's first phase, minutes of meetings from various FEMSA meetings, reports written by the various FEMSA actors, reports written by him to Norad etc. My supervisor also shared with me his e-mail correspondence with various actors from FEMSA. I also got access to the archives of Norad. In Norad's files I found documents and reports from the project, communication between the Regional Coordinator and the donors, as well as other documents describing the development of FEMSA. Through these files I also got access to the three external evaluation reports carried out of FEMSA. Some material was also collected at the joint FEMSA/AFCLIST meeting in Nairobi.

What I did have problems detecting, were documents actually presenting the findings and recommendations form the second phase of FEMSA. According to the reports written about the outcome of FEMSA, several documents should have been produced that it has neither been possible for me to get hold of them neither from Norad, my supervisor, nor from requesting them at the FAWE office in Nairobi. After several attempts to get hold of the various documents at the FAWE office, I gave up and concluded that whether or not these documents have actually been produced, the fact was that the findings from the second phase of FEMSA were impossible to get hold of. I hence based most of my analyses of FEMSA on the documents from the project's first phase. I believe this can be legitimised due to the severe difficulties in getting hold of other documents and also because this was the phase that was used to study obstacles and recommendations to how female participation and performance in SMT education could be obtained[31].

Also for the case of AFCLIST, I got some documents through the assistance of my supervisor. Most of the documents I needed from AFCLIST were however brought to me directly from the AFCLIST office in Durban. Some were sent over e-mail, some were brought when people from AFCLIST visited Norway, and much I have collected myself during my visits. I wrote a first draft to the chapter on AFCLIST during my stay at the University of Durban-Westville in the spring semester of 2003. This was convenient since I then had access to the archives of AFCLIST because their office is located in the university building. This made my access to AFCLIST documents very easy.

For both initiatives I also used internet pages to fill in gaps in the documentation and to gain extra information about the two cases.

3.4.7 Informal communication, e-mails, phone calls etc

During my research process, I have gained information from both initiatives through informal communication channels like e-mail, phone calls and more personal communication. This information has been used to gain more insight to the two projects, clarify uncertainties and to verify information. I have also used e-mail actively to stay in contacts with various actors within the two initiatives. This has enabled me to stay updated on issues of relevance for my study even though the initiatives I have studied are situated all over Africa. Many of my interviewees have kept in contact over e-mail asking me how things are going with my research and, sharing their thoughts with me about their work. Several of my interviewees have even written e-mails to encourage me to keep going with my own work.

My worries prior to my study that the actors in FEMSA and AFCLIST would not be willing to share with me their ideas have been put to shame. Except for

[31] I have been informed that a PhD student who wanted to write a PhD about the impact of FEMSA in one of the FEMSA countries experienced so much difficulties in collecting data even coming from the same country that she had to give up writing about FEMSA and change the topic of her thesis.

the few problems gaining access to documentation form FEMSA and participating at the FEMSA meeting in Nairobi, I have met only positive attitudes by the actors from both initiatives. They have been willing to share their views with me, assisted me in getting hold of information, helped me organise my field trips, given me feedback and positive encouragement, and willingly included me in their groups. This has made data collection for this study a very stimulating and rewarding experience for me.

3.5 Data analysis

According to Stake (2000), the methods of qualitative case study are largely the methods of disciplining personal and particularised experience. In my study I have used interviews, document analysis, informal communication and participation at events and meetings as information channels to gain knowledge about the cases.

I have made use of an analytical framework developed in Chapter 2 to analyse the two cases. In writing the cases, I have first treated the cases as independent units, before analysing the commonalties and differences between them. The emphasis has been to visualise and sort out different perspectives and arguments as to why and how gender issues are addressed within the two cases.

3.5.1 Transcribing, managing data and coding

I used six interviews from FEMSA and twelve from AFCLIST in my main analysis. These interviews were transcribed in full. The full pages of transcribed interviews constituted 210 pages of text[32]. I found some of my interviews hard to transcribe due to difficulties in understanding the various African English accents. I had to replay some sequences over and over again, which was a very time consuming process. Merriam (1998) rightly states that transcribing interviews is time consuming. Still I felt that I gained much from transcribing the interviews since I became familiar with the content of the various interviews by transcribing them in full text.

I read all the documents available for the two initiatives and made notes along the way. After reading all the documents available I sorted out what documents I needed for the different parts of the analysis. Some documents were relevant in the presentation of the cases. Other documents were relevant

[32] Times New Roman 12 pt, single space.

to conduct the actual analysis regarding how the two initiatives understood what obstacles had a negative impact on female participation and performance in SMT and SMTE, how they argued for change, and what recommendations they had developed for change to happen.

Although I have tried to portray the two initiatives in an accurate way, I still regard the description of the cases as part of my analysis. This is because in spite of having several of the actors within the two projects verifying my description, I regard it as likely that a different researcher would portray the two cases in a dissimilar way. My presentation of the two cases represents my understanding of how the two initiatives work, and is hence a result of my understanding and analysis.

I used the computer programme ATLAS.ti[33] first and foremost to handle and sort information from the interviews. The computer program ATLAS.ti makes it possible to handle and get an overview of large amounts of qualitative data. Since the interviews were quite extensive and semi-structured, I needed to go through the transcripts and sort out the different themes handled in the interviews. Miles & Huberman (1994) describe this first part of analysis as “data reduction”. This implies selecting, focusing, simplifying, abstracting and transforming the information collected into manageable data. Miles & Huberman (1994) claim that data reduction is an important part of the analysis, since this is the point when the researcher decides on which data should be included in the analysis and what should be eliminated. They assert that this cannot be seen as an activity separated from the analysis, since these are all analytical choices. Patton (1990) suggests that since in semi-structured interviews the topics tend to occur in different parts of the interview, the interview questions might be used as a coding guide guiding the different topics. I did not follow the interview questions slavishly in my coding, but used them as a basis to sort out the chunks of the interviews that I would use in my analysis. The parts I decided to leave out were parts focusing on other aspects of the projects than their gender focus. Since I had to conduct the interviews of FEMSA actors at an early stage of my research, I had not yet decided to focus only on gender aspects of the project. I therefore included in my interviews also questions about their perceptions about cultural critique of science, issues of donor aid to education and so on. Some of these aspects were also dealt with in the AFCLIST interviews. As I decided to cultivate the focus on gender, I decided not to use the parts of the interviews focusing on these issues in my analysis.

[33] ATLAS.ti: see Web site: http://www.atlasti.de/

Due to the different character of the interviews, I decided to use different sorting categories to sort the interviews of the secretariat and the other stakeholders.

The chunks of interviews were sorted in order to give information about the following aspects:

- About the importance of working towards gender equity in science education.
- About the impact of sex/gender on science inquiry.
- About required actions needed to increase participation and performance of females in science education.
- About how the initiative each interviewee represents address gender issues.
- About causes for female underrepresentation and underperformance in science and science education.
- About theories about feminism, gender and science education.

This thematic coding facilitated a data display (Miles & Huberman, 1994). After carrying out the thematic coding through the use of ATLAS, I printed all the transcripts over again. I then had all the sequences of data about the same theme displayed together on paper. This eased my further analysis of the cases.

3.5.2 Analysis within cases

FEMSA and AFCLIST differ on several aspects that make the two projects difficult to compare on equal terms. First and foremost only one of the initiatives, FEMSA, was planned to address gender issues in particular, while AFCLIST has this as only one of several focuses. The fact that my possibility to collect data and participate in the two initiatives' activities have varied to such a degree would also make it difficult to compare the two initiatives following a set of predefined variables. Miles & Huberman (1994, pp. 205-206) warn that:

> *Cross-case analysis is tricky. Simply summarizing superficially across some themes or main variables by itself tells us little. We have to look carefully at the complex configuration of processed within each case, understand the local dynamics, before we can begin to see patterns of variables that transcend particular cases.*

I have treated both my cases as individual cases before seeing them in relation to each other. This is partly done to avoid “simply superficial summaries”. But mostly because I have been interested in understanding the different ways of addressing gender issues the two initiatives represent. The two cases are therefore first presented and analysed individually.

After the thematic coding of interviews I started coding the interviews with the focus of trying to grasp the variety of perceptions in the data about the different themes. I chose to do this manually without the use of ATLAS.ti. The reason for this choice is that I felt I got a better overview of the different interviews being able to go back and forth in the interviews when they were printed than if I had them on a computer.

For every theme I draw a mind map. The main question for each theme formed the centre of the mind map, while the different responses to the questions formed the branches of the map. The first maps were sorted after the statement made by each person interviewed. After working with this model, I changed it to have each statement form different branches of the mind map. In this way the focus of the map was on the different ideas, and not on the different actors. Next to each idea I wrote the name of the actor that pushed the idea forward and the page of the transcripts where I could trace the statement. In cases where the statement formulated the basic idea in a particularly clarifying way I marked the name with a * so that I knew I could go back and use the reference in my writing up of the case. This way of coding and mapping the arguments enabled me to keep track of how many actors approved to each idea and the sex of each actor. In this way I also made sure to include all perceptions from every actor in my analysis, also the perceptions that were not included in the writing of the cases as quotes.

After mapping the ideas I clustered them into different broader categories. This clustering became very useful in both the writing of the description as well as the analysis of the cases.

The documents collected were used for the analysis in different ways. The types of documents describing the development of the two initiatives were used to present the cases. Field notes and unstructured interviews were used mainly to verify information from the semi-structured interviews and documents.

Some documents were chosen for a more in-depth analysis. These documents were documents where the questions that constitute my research focus were discussed. The selected documents were analysed according to:

1. how they analysed what obstacles caused female underrepresentation and underperformance in science and science education,

2. which arguments they raised for why the situation should change, and

3. which recommendations they developed as to how the situation could be changed.

I extracted the various perspectives represented in these documents and used them in the analysis together with the information obtained through the interviews.

3.5.3 Analyses using a theoretical framework

The analytical framework developed in Chapter 2 suggests that different perceptions about how sex/gender might impact on pupils' engagement in science education might imply different intervention strategies for initiatives aiming at gender equity in science education.

By treating AFCLIST and FEMSA as individual cases, I have teased out what strategies the two initiatives suggest to how gender equity in science education should be achieved. These strategies have then been analysed and sorted according to what perception about sex/gender's impact on science education initiatives they reflect.

The different recommendations and strategies have thereby been analysed in relation to the recommendation and strategies suggested for each approach described in the analytical framework. Through this analysis, contradictory recommendations within the two cases have been detected and typical patterns have been described.

3.5.4 Analysis across cases

The central point in my analysis of how FEMSA and AFCLIST work towards increased gender equity in science education has not been to compare the two initiatives but to study the different ideas they represent. Some of the distinct features in the two initiatives do however become more evident when looking at the two cases in relation to each other. I have therefore conducted an analysis where I see the FEMSA and AFCLIST in relation to each other in order to visualise some of the similarities and differences in how the two initiatives address gender issues. By doing this I have also been able to clarify and discuss in more detail the distinctions between the two approaches to gender equity that FEMSA and AFCLIST represent. In the part of my analysis where I see the two cases in relation to each other, (chapter 6) I also include a discussion of some of the issues that have appeared through the analysis of the individual cases.

3.6 Objectivity, validity and reliability

3.6.1 Objectivity

It is my understanding that in all research, quantitative as well as qualitative, there is an element of subjectivity. This is acknowledged also in methodological literature (see for instance Patton, 1990; Strauss & Corbin, 1998). Accordingly no research findings can be absolutely objective. Since all research activities are initiated by people, all research activities will to a certain extent be marked by people. This subjectivity can be visible either through politics of research funding, design of research methods, choices of theoretical lens, collection of data or through what interpretations are made on the basis of the research findings. Still all researchers strive towards having the highest level of objectivity possible. As shown in chapter 2 the conception of objectivity varies within different research traditions.

Realising that no research can be 100% objective, methods are developed to increase the level of *validity* and *reliability* of research findings. While validity refers to whether an account accurately represents the phenomena to which it refers, the degree of reliability refers to whether the research instruments are consistent and dependable (Hammersley, 1990).

3.6.2 Validity

For my own study the question of validity did concern whether I would be able to represent the two cases in a “true” way. In methodological literature, two common responses to secure validity of a study are *triangulation* and *respondent validitation* (Merriam, 1998; Silverman, 2000; Yin, 2003). Several methods might be used to triangulate data (Miles & Huberman, 1994). The idea behind triangulation of data is that using multiple sources and perceptions to clarify meaning and verify repeatability will increase the validity of a study (Creswell, 1998). The idea behind *respondent validitation* is that the research objects should be able to read the interpretations made by the researcher and give comments to the degree to which they perceive the researcher to have portrayed their reality in a valid way (Silverman, 2000). Both these methods to secure validity have been criticised. Silverman (2000) argues that using multiple sources does not give a guarantee for the “whole picture” to be accurate. Neither does respondent validitation give a guarantee for valid analysis (Fielding & Fielding, 1986).

Silverman (2000, pp. 178-185) proposes some alternative ways to secure the validity of a study. He suggests that a researcher should seek to secure the validity of a research project by trying to falsify the findings by coming up with refutable evidence (the refutability principle) and compare different sets of the data material to look for controversies (the constant comparative method as well as deviant case analysis).

In spite of the limitations of triangulation and respondent validitation pointed to by Silverman (2000) and Fielding & Fielding (1986), I have found it useful to adopt these methods to increase the validity of my study. Trying to accommodate some of Silverman’s alternative ways of increasing validity, I have applied three different strategies:

1. Triangulation

By using these different approaches to compare information from different sources of data, use different methods and look for contradictions I tried to accommodate Silverman’s constant comparative , refutability and deviant principles. The use of different methods (semi-structured and unstructured interviews, participation and observation and field notes) to collect data provided me access to various types of data. The written documents analysed were written by different actors in the two initiatives. Documents presenting what the initiatives ought to do were compared to descriptions of what the projects actually had done (papers written by actors in AFCLIST, Dissemination Reports from FEMSA etc) and external evaluation reports. The interviews of the secretariat in AFCLIST were compared to the interviews of the other actors, papers written by the secretariat of FEMSA were compared to statements in interviews and evaluation reports. The possibility of participating at events and talking freely to participants engaged in the two initiatives also enabled me to draw a picture of the two cases. I do, however, assert that although emphasise is placed on drawing a consistent picture, the picture can never represent anything else but *my* picture of *their* reality.

2. Comprehensive data treatment

Another principle I have emphasised in my treatment and analysis of data has been what Silverman labelled comprehensive data treatment. This was done to avoid becoming a victim of what Silverman (2000, p. 176) has labelled anecdotialism:

> *How are they (qualitative researchers) to convince themselves (and their audience) that their "findings" are genuinely based on critical investigations of all their data and do not depend on a few, well chosen "examples" (Silverman 2000, p 176).*

To leave out examples that contradict with the main findings and generalisations of the study, can be tempting, but constitutes a serious damage to the validity of a study. Silverman, in his description of comprehensive data treatment, asserts that no generalisations should be made about the cases unless they apply to all sets of the data material.

In this study I wanted to visualise and detect tensions implicit within each case. I still assert that the fact that the various actors within each case have different and sometimes contradictory understandings to the "official" policies of the initiatives should not be of hindrance as to draw some generalisations in portraying the cases. For my own analysis I have portrayed and displayed in my presentation and analysis of data also contradictions and tensions that exist within each case. Since both of the cases analysed through this study consist of various individuals that all have impact on the initiative, I have attempted to show both what typical patterns within each cases are and which perceptions that break with these distinct characteristics. To visualise the varieties within each case I start each presentation of the cases by presenting a profile of each individual interviewed. These profiles are developed on the basis of each respondent's answers to the central questions of the interviews. By doing this I have attempted to include the individual differences between each interview before analysing the various perceptions more generally. The different responses to the central questions raised are also displayed in the text.

3. Respondent validitation

A third action undertaken to increase the validity of the study has been to let various actors involved in the two studies read and comment on my presentation of the cases. The transcribed interviews were sent to all members of AFCLIST. Transcribed interviews were not sent to the interviewees from FEMSA since the project at that time was ended and I had difficulties in getting hold of the former Coordinators. After the analysis of the cases were written, some representatives involved in FEMSA and AFCLIST read and comment on the accuracy of my description of the cases. These comments were accounted for in my rewriting of the chapters. My own analyses were however left unchanged. In addition to having representatives from FEMSA and AFCLIST read and comment on these chapters, a representative from Norad also read and commented on the accuracies in my descriptions.

3.6.3 Reliability

Reliability refers to whether the research instruments are consistent (Silverman, 2000, p. 188). A central question in order to secure the reliability of a study is hence to ask whether a research instrument would measure the same when used in other occasions (Descombe, 1998).

For my own study my main “instrument” besides the collection of data, was an analytical framework that I had developed on the basis of an analysis of feminist theories and critique of science. By having experts in the field of science education commenting on my suggested implications for science education of each position identified, I tried to increase the reliability of my analytical framework. I believe that the analytical framework I developed could be used to analyse initiatives similar to FEMSA and AFCLIST and get comparable results. On the other hand it is not likely that the exact same analytical framework would have been developed by other researchers.

In order to visualise the development and connotations associated with each position constituting the theoretical framework, I have made these explicit in the text. In this way I present not only my conclusions, but also how I reached these conclusions. Whether or not my instruments are reliable can therefore be judged by the reader.

Patton (1990) asserts that creativity is a human quality that is of crucial importance in a research process. I believe that the fact that creativity is used by qualitative researchers both in the design, collection and analysis of data, makes total reliability in the sense that different researchers arrive at the exact same conclusions impossible. Hence every qualitative study is unique. I believe that for every researcher to be open about this uniqueness is a central issue to increase the credibility of any research project. I will now turn to present the cases and my analysis of them.

4. FEMSA

4.1 Introduction

The Female Education in Mathematics and Science in Africa (FEMSA) project is one of the most extensive initiatives that has taken place in order to improve the participation and performance of girls in science, mathematics and technology education (SMTE[34]) at primary and secondary school level in sub-Saharan Africa.

FEMSA collected knowledge about which factors contributed to the low female participation and performance in SMTE and developed intervention strategies to address gender inequality in SMTE in this region. These intervention strategies were in turn planned to be implemented and mainstreamed throughout sub-Saharan Africa.

FEMSA began as an initiative under the Association for the Development of Education in Africa, ADEA's[35] Working Group for Female Participation (WGFP). It was supported by an international consortium of donors in which Norway played a particularly important role. As a leader of the Donors' Consortium, actors from Norway were actively involved both in the design, planning and funding of FEMSA.

FEMSA has been chosen as a case for this thesis because of its position as a major female and science education initiative on the African continent. It is also chosen because of its close link to Norwegian aid.

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[34] FEMSA in its documents claim that they focused on science, mathematics and technology education (SMTE) (see for instance FEMSA, 1997-1). My impression is that little emphasis was made on technology compared to science and mathematics education in FEMSA. The "T" for technology was not included in the projects' name, FEMSA. Still in most of the FEMSA documents they use "SMT education" to represent their focus. I therefore in this chapter also use SMTE. In my analysis of FEMSA I have, however, focused on their findings and recommendations for science education only.

[35] The Association for the Development of Education in Africa (ADEA) was established through an initiative of the World Bank in 1988. Then called "Donors to African Education" (DAE), its objective was to foster collaboration and coordination between development agencies in support of education in Africa. ADEA now focuses on developing partnerships between Ministers of Education and funding agencies in order to promote effective education policies based on African leadership and ownership (www.adeanet.org).

This chapter is opened by a presentation of FEMSA and the development of the project. I then give an overview of FEMSA's findings regarding what causes female underrepresentation and underperformance in SMTE and what recommendations FEMSA developed to address these obstacles. FEMSA was, in each of the twelve sub-Saharan countries in which the project operated, carried out under the leadership of a female Country Coordinator. In the next section of this chapter, some of the Country Coordinators' perspectives to the issues FEMSA addressed are presented. I end the chapter by analysing how FEMSA addressed gender issues through the lens of the theoretical framework developed in chapter 2.

In this study I focus on FEMSA's analysis of what causes female underrepresentation in science education, and what strategies were developed to address this inequality. I have not studied the impact of FEMSA. My focus has been to understand and interpret how FEMSA addressed gender issues in science education, rather than evaluating whether FEMSA reached the initial goal of the project. The description of FEMSA as a project is developed as a backdrop to understand the interpretative analysis of the ideas permeating the project[36].

By analysing FEMSA through an analytical framework derived from feminist theories, I try to show a different way to understand the ideas permeating FEMSA. I use this framework to analyse the obstacles FEMSA identified to have a negative affect on girls' participation and performance, their argumentation for change and their recommendations to how change could occur. Through this I explore whether feminist theories can be of value to increase the understanding of how a project like FEMSA did and did not address gender issues.

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[36] Three evaluations were conducted of FEMSA in the course of the project (Lexow & Kainja, 1998; O'Bura, Ng'andu, Etta & Khatete, 2000; O-saki & Bunwaree, 2003). These evaluations have all focused on organisational structures of the project and to a lesser extent given attention to the subject specific developments of FEMSA. An external evaluation of FEMSA submitted in 2003 had focused on what impact FEMSA had in the various countries (O-saki & Bunwaree, 2003).

4.2 The development of FEMSA

4.2.1 A project is born

In 1988, The World Bank initiated Donors to African Education (DAE) to provide all African Ministers of Education, multilateral, bilateral and private donors with a forum for revitalising education in Africa.

The Rockefeller Foundation became the convener of a 23-member DAE Working Group on Female Participation (WGFP) which should seek effective means for catalyzing sound national educational policies to increase enrolment of women and enrich school curricula.

In 1992 three sub-committees were suggested formed within the WGFP of which one was focusing on female education in mathematics and science. The Norwegian Agency for Development Cooperation (Norad) agreed to lead this sub-committee. Sissel Volan, who was Norad's representative in the WGFP, describes how Norad became involved in FEMSA in the following way:

> *It wasn't Norad that initially found science education for girls in Africa important. It started with DAE, the Donors to Education in Africa. One of the working groups under DAE focused on girls and education. It was Rockefeller Foundation that was in charge of this working group for the first 10 years of DAE's life. And then Rockefeller in collaboration with leading African education-women had identified three or four areas that these African women regarded as crucial in the work to improving girls' education in Africa. One of these areas was girls and science education (…) We were a member of this Working Group from the start. And I represented Norad in that working group. And then Rockefeller came to Norad and asked us if we could take the responsibility of leading a sub-group that would focus on girls and science education. So that is how we came in. And we agreed to do that because I thought it was a challenge and very interesting (Volan, 2002).*

A Draft Work Plan for DAE's WGFP was developed as an outcome of a meeting between DAE and Norad in Geneva 1994 (Sjøberg, 1994). According to this work plan the sub-committee's strategy was:

> *It is in the strategy of the Sub-Group* ***not*** *to establish new structures, but to build on existing mechanisms and initiatives. When initiating new activities, the Sub-Group will launch them through the appropriate channels available.*

The initial work plan suggests that the Sub-Group focusing on girls' science and mathematics education should collect and analyse data regarding females' participation and performance in SMTE, and identify gaps in such statistics. They should also analyse and collect information on science education projects with a gender profile. The Sub-Group should collect and analyse research regarding girls and science education in Africa and collect information about donors' support to gender initiatives. It should also collaborate closely with current initiatives such as GASAT[37] (Gender And Science And Technology), AFCLIST and UNESCO's Project 2000+[38].

Norad organised the first meeting of the WGFP's sub-committee on science and mathematics education in Oslo in 1994. Representatives from Forum for African Women Educationalists (FAWE), donors, AFCLIST and other resource people participated in this meeting (FEMSA 1, n.d). A follow up meeting was organised by FAWE in Nairobi in 1995. The purpose of this meeting was to develop a draft to a project outline:

> *The next step was that Svein and I went to Nairobi. We invited Jane who came from Uganda. Katherine Namuddu (Representing Rockefeller Foundation-my remark) and Edda Gachukia also participated. Edda was at that time the leader of FAWE (…). We were in Nairobi for a week and worked very intensely with this (Volan, 2002).*

At this meeting FEMSA was given a name, and an outline was developed giving more detailed plans for the project (Sjøberg, 1995). It was decided to start the work by collecting data about the participation and performance of females in SMTE (FEMSA, 1997-1):

> *FEMSA therefore, begins by supporting national teams of educators and Ministry of Education personnel to assemble an information base on the status of female participation and performance in SMT, that can be used as a basis for national policy action (FEMSA, 1997-1, p. 2).*

Cameroon, Ghana, Tanzania and Uganda were selected to participate in the first part of the project on basis of the following three criteria:

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37 Gender And Science And Technology (GASAT) Association is an international association concerned with issues arising from interactions between gender and science and technology. GASAT promotes networking and capacity building of females engaged in science and science education.

38 The UNESCO/CASE Project 2000+ is a world-wide project aimed at improving the relevance and the teaching and learning of science (UNESCO, 1993, p. 40).

1. They all have relevant information in female participation and performance attributes. These sources will permit the development of criteria and an analytical methodology with can be adopted in other countries.

2. They are countries whose SMT activities are supported by complementary efforts and organisations such as the Forum for African Women Educationalists (FAWE), the African Academy of Sciences (AAS) ; Gender and Science and Technology (GASAT), The African Forum for Children's Literacy in Science and Technology (AFCLIST) ; and the UNESCO /CASE Project 2000+.

3. In each country a key oversight contact has also already been established through consultation with FAWE and the AAS Female Education Research Program. The FAWE contact is especially important because of the ministry of education's role in supporting overall research and policy development activities in SMT; developing future action plans arising out of the Country Profiles' Data; bringing experimental work into mainstream curriculum development and taking demonstrative action to scale (FEMSA, 1997-1 p. 7).

The project draft recommended that the FEMSA activities in each country should be led by a National Coordinator. The National Coordinator should lead a national team to work in cooperation with the ministry of education. It was also recommended that a project consultant should be employed to run the project and be a linkage between the participating countries. In November 1995 a project consultant was hired. According to Norad it was a surprise to them that Rockefeller Foundation decided to give a white man with a European background the job to coordinate a project to recruit African females to science education:

When Katherine called or e-mailed me and said she could hardly believe it, because they had found a very qualified person for this job but he did not fulfil any of the criteria we had set up for the project consultant because he was white and male haha! But he proved to be a lucky decision (Volan, 2002).

After O'Connor was appointed a project consultant, the work began to identify the National Coordinators for the four selected countries (FEMSA, 1996). The National Coordinators were selected by FAWE and RF using the following criteria's for selection:

- *Should be a woman.*
- *Should have an outstanding expertise in the area of SMT education.*

- *Should be aware of the problems encountered by girls in SMT and have a strong interest in strengthening girls' participation and achievement in SMT through improvement in the quality of teaching and learning.*

- *Should be capable of adopting an essentially pragmatic and action-oriented approach to the review of problems and possible solutions in these areas (FEMSA, 1997- 1, p. 5).*

All the National Coordinators were approved by FAWE Executive Director in Nairobi (FEMSA, 1996, p. 2).

4.2.2 Phase 1, January 1996 to December 1997: Research and documentation

The first phase of FEMSA was launched in January 1996. In this phase the country Coordinators were to collect data about female performance and participation in primary and secondary schools in their respective countries. An objective was also to scrutinize the reasons contributing to these disparities to find out more about the difficulties facing girls in their approach to science education and come up with recommendations as to how the situation could be changed. The project draft shows the following expected outcomes of FEMSA's first phase:

> *1. Four countries will have an information base on the status of female participation in SMT arising both out of the data compiled as well as from the national seminars. In addition the four countries will have collated and summarized key ideas and perceptions from a wide range of interested parties on what should be done to improve female performance in SMT.*
>
> *2. Countries will have a data base to assist them develop concrete and realistic action programmes and or interventions in the areas of girls' education in SMT.*
>
> *3. FEMSA will have put together a methodological framework of how to compile country profiles and how to establish a set of progressive benchmarks traceable in each country, which other countries can adopt and use to undertake a similar exercise.*
>
> *4. The individual talent as well as the active institutions identified will be a resource as technical assistance needed to draw up a framework of action for interventions and programs that are appropriate for the for the improvement of girls' performance in SMT. These resources can also be called upon to strengthen technical cooperation between African countries (FEMSA 1, n.d., p. 9).*

In addition to the expected outcome of the first phase, the project outline also indicated some less tangible outcomes, such as to identify and create networks between people working within the field of SMTE in each country and to rejuvenate the commitment and awareness to support girls' science and mathematics education (FEMSA 1, n.d.).

The first phase of FEMSA lasted from January 1996 to December 1997. It was decided to divide this phase into four shorter phases:

1. The preparatory phase.

This phase focused on preparing the project proposal, creating a Donors' Consortium, and establishing contacts with the participating countries and ministries of education. The Donors' Consortium constituted the following donors: Norad, The Rockefeller Foundation, Irish Aid (HEDCO), DANIDA (Denmark), Netherlands Ministry of Foreign Affairs, ADEA secretariat, Carnegie Foundation of New York, SIDA (Sweden), Commonwealth Secretariat and The Norwegian Ministry of Foreign Affairs.

2. The data and information collection phase.

This phase was carried out nationally and led by the four National Coordinators. In this phase, school studies were carried out in some selected primary and secondary schools. Between 11 and 16 primary schools and 10 to 12 secondary school were selected in each of the four countries (FEMSA, 1997-19). To collect the requested information, different research methods were used. Questionnaires were developed to gather information from the pupils and teachers. Focused group discussions using the Participatory Learning Action (PLA)[39] methodology were used with parents, pupils and teachers. Some interviews with individuals were also carried out. Observations in science and mathematics classes were carried out to gain information about teaching strategies. Textbooks, curricula, syllabi and examinations were reviewed (O'Connor, 2002b, p. 3).

The data collected in this phase was used to create country profiles providing data about female participation and performance in SMTE in the four countries. The country profiles also included data about science and

[39] The Participatory Learning Action (PLA) methodology was pioneered by the Ugandan team and used extensively by them in their school studies. It was later adopted also in other countries. It involved group discussions with intense brain-storming, first with male and female only groups, and then in mixed groups of participants. This methodology was used to unravel the reasons for the poor participation of girls in SMTE and to come up with strategies for how the situation could be improved (FEMSA, 1997-1, p. 13).

mathematics teaching and how the various actors within the education systems perceived the underrepresentation of females in SMTE and what solutions they saw to the problem.

3. The seminar phase.

After the country profiles were produced, a national seminar was organised in each of the Phase 1 countries in collaboration with the ministries of education. The purpose of the national seminars was to disseminate the information presented in the country profiles and create an opportunity for different stakeholders to meet to discuss the findings and identify any issues of concern. The country seminars brought together participants from a wide cross-section of the educational and scientific community in each country: pupils, teachers, parents, the universities, FAWE national chapters, gender activists, NGOs concerned with gender issues, funding agencies and Ministry of Education Personnel with an interest in policy making, people working within curriculum development, examination development and teacher training (FEMSA 2, n.d.).

4. The follow up phase

In the follow up phase, the country profiles were used as a basis to formulate national action plans (Lexow & Kainja, 1998). The country profiles were used as a basis to document the findings from the initial phase in the four Phase 1 countries.

4.2.3 Phase 2, January 1998 to December 2001: Interventions

The second phase of FEMSA started in January 1998. In this phase, eight new countries joined the project. The new countries were Mali, Senegal, Burkina Faso, Kenya, Malawi, Zambia, Swaziland and Mozambique. Ghana was dropped from the programme "since it was unable to meet the requirements for phase II" (O'Connor, 2002b, p. 6)[40]. The countries that were selected for the second phase of the project all had strong FAWE chapters and had expressed willingness to participate in the project (FEMSA 2. n.d., p. 25-26). It was intended that the findings from the first phase would be used as a basis for interventions in the newly selected countries (FEMSA 2, n.d., p. 5).

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[40] This situation was according to Sjøberg (personal communication, 2004) caused by internal conflicts in FAWE and FEMSA actors in Ghana.

According to the project proposal for FEMSA's Phase 2 were:

1. *To influence national policy development and decisions regarding girls' education by making a significant input into the work of mainstream ministries of education in areas such as curriculum development, production of books and resource materials, teacher training and examinations. The FEMSA contribution to mainstream developments will ensure that the findings and proposed solutions of Phase 1 are given serious consideration.*

2. *To sensitise students, teachers and parents to a realisation of the difficulties and constraints faced by girls in the study of SMT subjects through small scale interventions at primary and secondary school level.*

3. *To develop innovative girl-friendly approaches to the learning of SMT; to relate the teaching of SMT to the girls' out of school experiences and their needs after school; and to promote girls' interest in mathematics and science based careers.*

4. *To disseminate the findings from Phase 1 throughout Sub-Saharan Africa.*

5. *To extend FEMSA activities to up to eight new countries, which should have a reasonable mix of Anglophone, Francophone and Lusaphone countries.*

6. *To widen the partnership of interested parties at both national and grassroots level among women and gender activists and the general science community to promote the participation and performance of girls in SMT and build a strong network of NGOs , organisations and funding agencies to further FEMSA's objectives.*

7. *To build capacity and develop expertise, especially at the grassroots level and develop a strong corps of committed, imaginative and innovative activists, facilitators and implementers to undertake and sustain meaningful interventions.*

8. *To disseminate SMT related publications and promote the activities of organisations active in the field of gender and SMT (FEMSA 2, n.d., p. 5).*

In the eight Phase 2 countries it was decided to carry out small scale school studies in order to corroborate the findings from Phase 1. Following the school studies, each country held a national seminar similar to those undertaken in the Phase 1 countries. The findings from the school studies and national seminars were incorporated and used to produce national action plans in the respective countries (O'Connor, 2002b, p. 6).

Administrative structure of FEMSA in Phase 2

The project documents from FEMSA indicate a project structure that has varied in the different countries, and also changed over time. The titles of the different actors have changed in the course of the project, so has the compositions and labels of the different boards and their duties. The functions undertaken by the "Project Committee" in Phase 1, was for example in Phase 2 taken over by a "Consultative Group" bearing the responsibility for the professional guidance and developments of FEMSA. According to the Mid Term Review (O'Bura, Dioum, Ng'andu, Etta & Khatete, 2000) the organisation and compositions of the national centres of FEMSA also varied across the different participating countries:

> *Across the eleven FEMSA programmes FEMSA teams are different entities. In one case they may be largely the five FEMSA centre professional staff (Burkina Faso). In other cases they could be described as the Centre together with the Zonal Coordinators and the FEMSA heads and teachers (about 80 in Tanzania) (O'Bura et al., 2000, p. 36).*

Based mainly on the Proposal for FEMSA's Phase II (FEMSA 2, n.d.), The Mid Term Review of Phase II (O'Bura et al., 2000) interviews of the Coordinators, and minutes of a meeting between Norad, FAWE, RF and FEMSA in 1998, I have constructed the following understanding of the different FEMSA bodies and their responsibilities:

Organising bodies	People involved	Responsibilities
Regional secretariat	Regional Coordinator (full time) Programme Assistant (full time)	- Responsible for planning, coordinating and implement all FEMSA work - Disseminate all information on FEMSA activities throughout the region and provide professional support for the national teams
Consultative Group	National Coordinators of FEMSA Member nominated by Norad representing the donors A representative from AFCLIST A representative from GASAT Representatives nominated by FAWE	- Facilitate information and experience sharing between National Coordinators - Discuss the FEMSA annual Work Programme and make recommendations to FAWE for approval - Provide guidance for professional operation of the FEMSA Centres, including interventions to be supported during Phase II - Assess overall progress of FEMSA activities carried out in Member countries and report to the FAWE Executive Committee - Advise on arrangements and modalities for the dissemination of information regarding FEMSA activities throughout the Africa region - Provide an overview of and secure coordination with other initiatives in the SMT area
Technical Committee	FEMSA Regional Coordinator FAWE Programme Manager Member appointed by Donors' Consortium Three additional educationists from outside FEMSA[41]	- Discuss and review FEMSA work programmes - Discuss and review progress reports drawn up by the FEMSA secretariat

[41] In the Project Proposal for FEMSA's Phase 2, the 3 additional educators from outside FEMSA are not included in the TC. The Mid Term Report (MTR) (O'Bura et al., 2000, p. 38) reports that the Technical Committee also consist of three more people without writing more explicitly about who these people are.

Donors' Consortium	Major donors' representatives FEMSA Regional Coordinator	- Approve programmes and financial reports for onward transmission to FAWE - Recommends decisions on all substantial issues
National FEMSA centres	FEMSA National Team (Project Coordinator + additional staff varying in each country how many) National Advisory Committee (Members of FAWE, FEMSA national team, members from Ministry of Education, two prominent members of the women's science community, one member representing the parent institution of the FEMSA centre)	National Coordinator: - Promote ownership of the FEMSA objectives among various groups: (FAWE, MOE, teacher training institutions, teachers and pupils, parents and the larger community) - Target opinion leaders and senior educational staff to address problems that the FEMSA national team cannot address - Create an impact and shaping public opinion using print and electronic media - Make sure that schools become more pupil and parent friendly - Ensure coordination of various educational projects at grassroots level National Advisory Committees: - Make decisions on professional issues relating to the activities of the FEMSA project - Approve the arrangements for the efficient organisation and operation of the FEMSA centre - Approve the national work plan and budget for expenditure and recommend the disbursement of FEMSA funds for the implementation of the National Action Plan and the in-country interventions - Approve arrangements for the dissemination of information regarding FEMSA activities throughout the country - Ensure effective collaboration with local mainstream education system, the FAWE chapter, and agencies working within the field of gender and SMT

Table 4.1: Organisational structure of FEMSA (Based on: FEMSA 2, n.d; O'Bura et al., 2000; O'Connor, 1998a, 1998b, 2000a).

The Consultative Group was to be the overall coordinating body securing the quality of the work done in each country, give professional advice and assess on the interventions carried out to achieve the FEMSA goals:

> *This body will consist of SMT professionals and deal purely with professional matters (FEMSA 2, n.d., p. 9).*

The Consultative Group should act as a body where the different Coordinators could meet and exchange their experience, give guidance to the dissemination of results and findings from FEMSA and contribute to building alliances with other initiatives dealing with science education for females in Africa.

The minutes of meetings from the Consultative Group reflects that professional discussions seldom transpired at these meetings. As the project continued, more and more time seems to have been spent on administrative issues, economy and “reporting” from the projects:

> *In the Consultative Group meetings we used to report on activities of individual countries and many of us did NOT always agree with what others were doing (…) During those meetings people presented individual views of their work, which they may not have even discussed with their Advisory Groups in their countries in some cases. When it came to the Regional Coordinator – well he summarised our reports in the ways he wanted – and he quite often ignored our comments (…) In my opinion there WAS NO FEMSA VIEW (Friday, personal communication, 2003).*

This Country Coordinator expresses that her view is that the planners of the Consultative Group meetings never allowed time for such professional discussions in spite that “some of us – me included- tried hard to get the Consultative Group to do this” (Friday, personal communication, 2003). The representative of the Consultative Group from Norad, who is a professor in Science Education, also on several occasions, commented that the original purpose of the Consultative Group was to provide professional assistance to the project, but he was turned down because of “time constraints” (Sjøberg, 2001).

The Consultative Group met annually. The cost of each meeting was 50000 US$ (O’Bura et al., 2000). Judging from the large amount of money allocated to these meeting one should believe that the coordination and sharing of professional experiences was seen as important for FEMSA. It is therefore difficult to understand why this was not given priority at these meetings.

Relationship between FEMSA and FAWE

In the original Project Proposal for FEMSA (FEMSA 1, n.d.), the relationship between FEMSA and FAWE was described in the following way:

> *FAWE will serve three main roles in FEMSA: (1) It will advise the Project Committee (later Consultative Group- my remark), on the participation of FAWE member countries in the FEMSA study of Country Profiles; (2) It will advice FEMSA on the specific needs of FAWE members with regard to technical assistance in areas related to female education programmes in SMT curricula; and (3) It will through its fiscal agent, Messrs. Price Waterhouse, undertake management of the finances of the FEMSA project (FEMSA 1, n.d., p. 8).*

My readings of the FEMSA documents indicate that the relationship between FEMSA and FAWE has been continuously debated throughout the course of the project. The topics being debated seems to relate mostly to issues of ownership of FEMSA both at Regional and local level. In 1998, FAWE took over after RF as the lead agency for ADEA'S WGFP (Namuddu, Sutherland-Addy, Diop & Sutherland, 2001). Norad at this point of time felt that it was wrong for a project like FEMSA to be driven by donors (ADEA) and wanted the project to be implemented within an already legally registered pan-African NGO (Volan, 2002). It was decided that FEMSA, after its second phase, along with the two other sub-committees under WGFP should be mainstreamed into the overall FAWE work programme and structure (Mlama, 2004, p. 2). The FEMSA Regional secretariat moved from Rockefeller Foundation's (Rockefeller Foundation's) offices to FAWE's offices (located in the same building in Nairobi). The FEMSA Progress Report for the period April to June 1998 indicates that there at this time were discussions in the various FEMSA bodies regarding the relationship between FEMSA and FAWE and that the "relationship between FEMSA and FAWE has been clarified" (FEMSA, 1998, p. 15).

In the Project Proposal for FEMSA's second phase the relationship to FAWE is described in the following way:

> *There will be the closest cooperation and collaboration between FEMSA and FAWE at both regional and national levels. At the regional level, the location of the FEMSA secretariat at the FAWE regional headquarters will ensure that major FEMSA decisions will be easily approved by the FAWE Executive. At national level, the involvement of the FAWE National Chapters in the National Advisory Committees will result in the harmonisation of the FEMSA in-country activities with FAWE's wider programme. Within each country FAWE should be seen as the focal point for all contact and interaction*

between FEMSA and the Ministry of Education. FAWE can be of immense benefit to FEMSA at the higher levels of the Ministries of Education and in terms of their greater ability to access the media and in general sensitisation of the society. FEMSA can, through building a strong network of activists and facilitators at the school and teacher training level make a strong impact at the grassroots level and provide expertise and ideas for prospective FAWE interventions (FEMSA 2, n.d, p. 15).

The Mid Term Review of FEMSA indicates that the cooperation between FEMSA and FAWE did not proceed without tensions in all the FEMSA countries. The cooperation between the FEMSA Coordinators and the FAWE Chapters, also with regard to professional matters, seemed to cause difficulties in some countries:

In some cases FEMSA National Coordinators, being prominent international academics, find it difficult to work as equal partners with FAWE leaders who are less academically qualified than themselves (O'Bura et al., 2000, p. 40).

In 2000, there seems to have been renewed discussions about the FEMSA/FAWE relationships. Two documents are written in January 2000 describing the relationship between FEMSA and FAWE. The document written by the FAWE Executive Director is called: "The Relationship between FEMSA and FAWE: The FAWE view" (Mlama, 2000) while the one written by the Regional Coordinator of FEMSA is called "Relationship between FEMSA and FAWE: The FEMSA Viewpoint" (O'Connor, 2000b).

The two documents indicate that the role of "ownership" of FAWE over FEMSA has been widely misinterpreted. Judging from these documents it seems like the roles of FAWE and FEMSA at a national level has not been clear and that this has caused severe tensions in several countries. According to the final evaluation of FEMSA (O-saki & Bunwaree, 2003) this constrained the effect of FEMSA.

4.2.4 Phase 3: Mainstreaming

The Mid Term Review of FEMSA conducted in August 2000, recommend that:

The FEMSA programme should be extended into a third phase after June 2001, in order to give time for the consolidation of school programmes and for the development of mainstreaming strategies in country and across the African region, once the FEMSA products are documented and packaged ready for take up and replication by

> *other schools, organisations, local education authorities and education sectors (O'Bura et al., 2000, p. 51).*

Several versions of the process leading up to the mainstreaming phase of FEMSA exist among my interviewees and within various documents. The Coordinators of FEMSA claim that they were given the impression by the Regional Coordinator that the third phase of FEMSA should be carried out within the projects' original structure. FAWE on the other hand claims that the FAWE Executive Committee, based on the recommendations from a Task Force to advise FAWE on the integration of the Sub-Committees[42] had given the FEMSA Coordinators six months, starting from July 2001 to identify and document the FEMSA best practices which should provide the basis on which to mainstream FEMSA into the overall FAWE work programme (Mlama, 2004, p. 3). The Coordinators claim that they had been told that there should be an extension of FEMSA staring from December 2001 and that they were not told until November 2001 that the project was to be taken over by FAWE as early as in December the same year.

The Coordinators therefore expressed frustration at the December 2001 meeting in Nairobi (see chapter 3) about what they understood to be a sudden request by FAWE to finalise their work and hand the project over to them. Several of the Coordinators (including the Regional Coordinator) expressed uncertainty and distrust as to whether FAWE would actually carry on and mainstream the findings from FEMSA. FAWE, on the other hand, claimed that FEMSA was to be continued through FAWE's structures.

It is my understanding that much of the confusion was caused by conflicting interests between FAWE and FEMSA regarding who should push FEMSA forward, and that this has to do with funding as well as employment issues. I regard it to be beyond the scope of this thesis to go into details about what happened at this stage since my focus is not to study the organisational matters of FEMSA. The result of the discrepancies between FEMSA and FAWE personnel, and the difficult cooperation conditions this conflict obviously led to, does however seem to have lead to a situation where the lessons from FEMSA have not been sufficiently mainstreamed and carried onwards by FAWE.

In 2003 an external evaluation of FEMSA was conducted (O-saki & Bunwaree, 2003). The evaluation focused on studying the impact of FEMSA

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[42] The Task Force was chaired by RF and according to FAWE distributed to all FEMSA stakeholders for comments (Mlama, 2004, p. 3).

in each country. The evaluation did not critically examine what FAWE had done to mainstream FEMSA since it took over the project in 2001. The evaluation of FEMSA was written as if FEMSA was ended in 2001. The report does not mention a third phase of the project:

> *The FEMSA project started in 1996 and had a specific life time. The project covered some 12 countries and was spread in two phases with some only being included in phase 2 of the project. The latter came to an end in December 2001 (O-saki & Bunwaree, 2003, p. 6).*

The evaluation argues that little was done in the preparation phase of FEMSA to prepare for how the project was to be sustainable:

> *An analysis of FEMSA on the ground shows us that to some extent "expectations have been shattered" in that some of the "gains" achieved temporarily are not sustainable and not easy to replicate. One can easily argue that not enough attention was paid to the sustainability issue at the time that the project was conceptualized (O-saki & Bunwaree, 2003, p. 9).*

During the time I have worked with this thesis, little information about how FEMSA was taken forward by FAWE since 2001 has existed. The FEMSA web pages have not been updated since April 4th 2001. Still (October 13th 2004) FEMSA is presented on the FAWE web-pages as one of its main activities (see www.fawe.org). The National Coordinators I have met after 2001 have had little knowledge about the further developments of FEMSA. The Regional Coordinator of FEMSA knew nothing about the further developments of FEMSA when I contacted him in the last time in October 2002. Neither did the Norwegian aid management (The Norwegian Department of Foreign Affairs and Norad) or Professor Sjøberg have any information about how the project was taken forward by FAWE since December 2001. In 2004 Norad has done some work to find out what had happened to FEMSA after 2001. The Executive Director of FAWE, Penina Mlama, in March 2004 submitted a report "FAWE's management of the Project Female Education in Mathematics, Science and Technology in Africa (FEMSA) from its closure to-date" (Mlama, 2004). This report describes FAWE's version of the complications regarding the transition of FEMSA into FAWE's work programme and what has been done since December 2001 to carry on the work of FEMSA. In this report Mlama writes that due to the problems in the transition of FEMSA "it was until 2003 that activities picked up in a significant momentum" (Mlama, 2004, p. 4). According to the report, FAWE has now restored the contact with several of the former FEMSA Coordinators and is committed to carry on the FEMSA activities through its National Chapters. The report says that local FAWE chapters in seven former

FEMSA countries have now received grants from FAWE to carry out different types of activities targeting girls' SMT education. These activities resemble the activities undertaken in FEMSA's second phase. In the report the FAWE Executive Director states that:

> *FAWE will do its best to use the experiences of FEMSA and other experiences to continue the struggle towards improving the participation of the girls of Africa in science, mathematics and technology (Mlama, 2004, p. 16).*

It will be interesting to see what FEMSA experiences FAWE will use and what approach they will choose to mainstream and secure gender equity in science education in sub-Saharan Africa. As I will show later in this chapter, my analysis of FEMSA indicates that the recommendations and lessons from FEMSA are not unambiguous and can imply very different approaches to how gender equity in SMT education should be addressed.

4.3 FEMSA's analysis and recommendations

4.3.1 Coordinators' perspectives

The Country Coordinators played a central role in FEMSA due to the open formulation of FEMSA's goals. This chapter draws a picture of six of the Coordinators' perspectives regarding the purpose of recruiting more girls to science, their own perspectives regarding the main obstacles inhibiting female participation and performance in science, and what they believe needs to be done to increase female participation in SMT education. The profiles are constructed on the basis of six interviews with the Coordinators that were conducted in December 2001. The Coordinators are here given names after six days of the week. None of the Coordinators are labelled Sunday.

Monday

Monday believes that a prerequisite for a country to develop is that the people should master SMT. Females need science in order to master issues in their daily life, such as stopping a fire:

> *Because I used to say you can finds a rich man. This man can go and marry a woman who knows nothing. He builds a very big house and put everything in the house. And you know some day something happen. A fire. Caused by damage in the electricity. You know that is very common in modern society. And this man because he has everything in the house, he has something to stop the fire. I don't know what it is called in English. The lady would not know how to*

use it. So instead using this power to stop the fire, she uses the water from the washer to try to stop it. You see? She may be very surprised to see how the fire tries to extend when she put water on it. This is one way you can see how the ignorance of women in science can destroy everything that this rich man has done! (Monday, 2001).

Monday believes that female scientists would contribute differently to science in the sense that they would recognise the science in females' environment. Females would therefore focus on different things in their research but they would still be using the same methods as men.

Monday is not familiar with any feminist critique of science. She says it is hard to understand that there should be anything masculine about science since science and mathematics have never been difficult to her:

> *When I begun in university I studied mathematics I was not bad. I was one of the best students in my class. But I can tell you that my mathematics teacher used to do: When he started to explain one notion in mathematics, aha, after his explanation ha came to me and said: Miss, do you understand what I have done? If I said yes, then everybody would say: Really? The lady? Then he said that if I had understood it, everybody must have understood it (Monday, 2001).*

Monday repeatedly refers the discussion to her own experiences of being a girl succeeding in mathematics in her country where this was not common:

> *Because you know, I was very good in mathematics. I was the best in my class, in all my classes. Even at secondary school. But later I had the choice of whether to choose mathematics or arts, people were very surprised to find that I chose mathematics because they said mathematics is not good for women. And if I take mathematics, I am no more a woman because I did what is not good for women. Now so this is our society (Monday, 2001).*

Monday believes that one of the factors that has a negative impact on girls' participation and performance in SMTE is that her society does not encourage children to be curious.

> *I think that in our culture in Africa we do not encourage our children to do science. Because you know to do science you should be curious. You should be a very good observer. And in our science education we do not encourage these traits. In our society the way we are live with our children we will say to a child that asks questions: Not! Do not ask questions! And this is one way to kill this interest. Because in order to do science you should be curious, you should a very good observer, to see how things are working. To try*

> *to understand why people do like that you know. In our society we are not very happy to help our children aha (Monday, 2001).*

Another reason is that science education is built around boys experiences:

> *In physical science I used to do electricity. You see when you are a teacher and starts teaching electricity in a class you can see that in our society in Africa EVERY boy of more than 10 years know the electrical circuit. Because they are used to practice with this bulb and … But in the same society if you take one hundred 15 year old girls, maybe two have that experience (Monday, 2001).*

She also says that the textbooks used in science discriminates against females by portraying men as scientists and doctors, while women are portrayed sewing and doing other low status work.

Monday regards it as important to make girls relate to science and have them see the relevance of science for their own life. After having girls realise that science might be relevant for their lives, she believes that girls will start enjoying science education without many adjustments from science the way it is currently taught. Monday says that one way of making females realise that science can be relevant for them is to show them how scientific knowledge can actually make them better cooks:

> *And you know in Africa, every woman should know how to cook food (…) In my society, if a woman does not know how to cook food, she would be considered really bad (Monday, 2001).*

Monday does not believe in anything such as feminist science education. She believes that education material needs to be improved in order to make SMTE relevant for both boys and girls. She thinks that the same methods can be used to teach girls and boys SMT in a relevant manner. What needs to be changed are the examples used in the teaching of science.

Monday says that she is pleased with the interventions undertaken in her country. As a participant in the first phase of FEMSA she contributed in the planning of interventions. She expressed that she wished they would have had the opportunity to mainstream the experiences from the FEMSA schools into the education system.

Tuesday

Tuesday is concerned about the fact that half the population in her country has not had access to SMT for a long time. She says that women have a big role to play in the economy of the country, and they should therefore be given the opportunity of an education similar to that of males. Science is also part of our environment. Tuesday argues that it would have a positive impact on child care and that child mortality would be reduced if more females were enrolled in SMT. She says that education in Africa is carried out by women, since women are the ones who teach their children at home. Women should therefore know SMT.

Tuesday is not familiar with feminist critiques of science. She claims that there is no difference between how women and men are engaged in science, except that “women science is better”. This is because she reckons that the few females that have the strength to proceed in SMT in traditional societies are the best, and they will necessarily be successful scientists: “Nothing can stop them!” (Tuesday, 2001).

Tuesday believes that females feel alienated in science because all the examples in SMT books show men. She says that in technical schools females can have trouble because they lack males’ physical strength. She argues that studies in her country have shown that most girls drop out of school because of early pregnancies. Another reason she sees that might explain the underrepresentation and poor performance of females in SMTE is that science is theoretical and does not make use of everyday examples. She says that girls and boys are brought up to play with different things and that science relates mainly to the boys experiences. Girls should be given the same opportunities as boys to gain experiences that are relevant for the learning of science, for instance by being given the opportunity to play with toys that are normally only played with by boys.

Tuesday argues that in order to increase female participation and performance in SMTE it is necessary to equip schools better. More books are needed. She says that guiding and counselling centres should be built that could support girls and give them confidence. Tuesday believes that among the activities conducted by FEMSA in her country, it is the sensitising activities that have had the major impact. She did, however, wish that FEMSA had been able to set up a resource centre that could provide room for library, practical training and remedial classes for girls.

Wednesday

Wednesday says that females have to become aware of that the fact they are actually doing science all the time. They are in charge of the home and if women knew science this would have a positive impact on issues such as nutrition. She also claims that scientific knowledge is important for any nation to develop.

“Nononono! There is nothing like female mathematics!” Wednesday claims. She says that females do have a different approach to mathematics because of the way they are brought up. Boys are brought up to be aggressive. They have an advantage over girls in SMT classes because they are always the majority in these classes and also because they are not discriminated against in the way girls are.

Wednesday is not familiar with feminist critique of science. She says that many Africans see everything coming from the west as something good, and therefore do not contribute to such critique as the one being raised against science:

> *I would say that it is difficult for us to have a critique of the sciences coming from the African region, because we haven’t developed much on our own. We have so much depended on that of others. So unless we have to criticise the way the western science has gotten on to us, but at the moment I would say that we are passengers, you know? (Wednesday, 2001)*

Wednesday says that both the direct discrimination of females and the approach most widely used in SMT classes contribute to the low female enrolment and performance in SMT education. The examples used in SMT classes are masculine and build mainly on boys’ experiences. Wednesday thinks it is therefore important to change gender biased examples, but she asserts that the examples should be balanced and not over focused on girls. She says that science books should show males and females in untraditional gender roles, like pictures of girls fixing things and fathers that are doing dishes. In this way it would be possible to show that girls, because of their experiences, are more practically oriented than boys.

Wednesday says that she thinks FEMSA in her country has been able to do a lot. But they have in reality only worked for one year. She thinks it will be impossible to judge whether the project has had any impact before at least in five years time.

Thursday

“Females constitute more than 51% of the country’s population. They represent a potential that can not be neglected”, argues the Thursday (Thursday, 2001). Females are in charge of the home, health and the environment. The situation in people’s lives would be much better if females had some knowledge in science.

Thursday argues that scientific knowledge at a high level is crucial in order for the country to develop. The country can not afford to leave out 50% of the country's population from science. She also says that most people do not have the possibility to advance to a high level within the educational system. Science education in primary and secondary school should therefore focus on giving the pupils some basic skills, to account for all the girls that will only receive basic education.

Thursday is not familiar with any feminist critique of science. She asserts that men and women would have a different approach to science because women are able to do more than one thing at the time:

> *My basic view is that when women conduct research we are able to get a lot more out of the research (…) Women will try to tackle different things at the same time. They will put in a lot of details, which men think of as rubbish (Thursday, 2001).*

She does however say that women and men will carry out scientific research in the same way when "given prescriptions". She does not think there is any difference between males' and females' ability to engage in science and argues that there has not been any plausible proof that shows biology and not socialisation causes the different patterns of performance and participation of females in SMT and SMTE.

Thursday thinks there are two main factors that impact negatively on female participation and performance in SMTE. One factor is that science education obviously favours boys. The other main factor is the socialisation facing girls at home and the way in which this stereotyped socialisation impacts what happens in the classroom.

Science education should be inclusive, Thursday says. The way it is now it favours the boys. Teachers should be sensitised to realising the problem, and to adopt more gender inclusive methods. She explains gender inclusive methods as teaching methods that:

> *Make the girls identify themselves with what is going on. More participatory. Often you see that the boys use the apparatus in science class why the girls surround them and do not even touch. The teachers should try to involve all the girls in the group. After the class most of the girls will not have time to read and of course that is a disadvantage that should be taken care of (Thursday, 2001).*

Thursday says she wishes there had been more time to take part in the mainstreaming process of FEMSA. She expressed uncertainty towards how the project would be taken further after being handed over to FAWE and claimed that the uncertainty regarding the future of the project had been there all the time.

Friday

Friday says that women in Africa are responsible for the home and in charge of the children. If more women in Africa were scientifically literate, she believes that the basic problems of Africa, such as poverty and diseases caused by ignorance, could be reduced. If women gained basic scientific skills, then they could engage themselves in small, income generating activities, they could develop energy saving devices and hence have more time for other things. Friday also says that an equal right to education is a human right and that females through participation in SMTE could develop their own capacity as people. They could join the job market, become inventors, and solve some of the gender problems in science and technology.

Friday says she is familiar with feminist critique of science. She asserts that the reason why this critique was mainly developed in the west is that people in Africa do not have the luxury of being negative:

> *We don't have that luxury you know. First of all we are lacking the basic science to help us do the basic, things like hygiene, things like nutrition, things like disease prevention, like malaria. But if I talk about other things I want them to be given the science that helps them to do exactly, you know to minimise those. You know in developed countries they have the luxury to think about other issues. You have the time to think about criticising science (laughs)… All the basics are there so you can move on to the philosophical level (Friday, 2001).*

Friday says that science education in African schools is biased towards boys, teachers are biased towards boys and girls are constantly given the unwritten message that they are in the wrong place if they engage themselves in science: "So you start believing in it" (Friday, 2001).

Friday says it is important that science education at primary levels be designed mainly to empower boys and girls with basic skills and enable them to deal with every day issues, since most pupils will not move beyond primary school anyway. She believes that we compartmentalise science too early. Science education should be more integrated at early levels. It is crucial that science education moves from the known to the unknown and that examples therefore are changed so as to cater also to the girls perspective. It is important for the teacher to think of examples that are of relevance to girls. She asserts that the same content can be made relevant to both boys and girls, but that the examples have to be different because of their differences in experiences.

Friday says that one thing she wanted to have done through FEMSA was to focus more at teacher education: “Teachers at school level should be much more sensitised into gender issues” (Friday, 2001). She also says that more work should have been done to develop additional teaching and learning material and to develop examinations and tests that catered to girls.

Saturday

Saturday says that the main reason to include more girls in SMT subjects is that Africa lags behind the rest of the world in research, development and industrialisation and that industrialisation can only take place in Africa if both sexes contribute equally towards that goal.

She does not believe that science would be any different if more women were involved, except that both males’ and females’ perspectives would be involved. This is because science is objective:

> *No, if a person is really scientific, we know that bias cannot come in. But then if you are not in science, the basic principle of science is objectivity. And a person like you must know that (Saturday, 2001).*

She does however admit that more female engagement in the development of technologies could improve the production of remedies suited for women:

> *What do you think this sofa would look like if a man or a woman planned what this sofa would look like. You might find that this is more comfortable for women and not for men because it was designed by a woman (Saturday, 2001).*

Saturday asserts that science in it self is not masculine, but the way it is being presented sometimes is. She does not agree in any of the critiques raised against science claiming that it is western, masculine etc. She does not see how this kind of critique can have any relevance for projects like FEMSA:

> *To us Coordinators of FEMSA it was always very clear: The science in itself was never the problem. But it is what makes the perceptions about science. The people made it to be masculine; people make it look hard (Saturday, 2001).*

Saturday says that the psychological environment is crucial for how people transfer positive or negative perceptions about science education. Dynamics in the classroom, attitudes etc are factors that impact on how the project is perceived. Boys are pictured in school books doing hard scientific work. She claims that gender roles in her country are distinct but not biased. Girls and boys are engaged in different activities in the home. Yet girls and boys perform equally in primary school. The differences appear in secondary school. Saturday believes that the girls at this age agree among themselves not to choose science. Why they do that, she does not know:

> *In my country there is a bit of evidence that the girls themselves talk and agree that lets go to biology. And it appears that they are really influenced by each other. Some of them are influenced by their own parents. Their parents say you might not make it and therefore you better not do it. Because we don't have money to make you repeat. So there are many factors that come in (Saturday, 2001).*

Saturday asserts that FEMSA does not aim to feminise science, but to bring equity into science by having females realise that they can engage in science. She says there is a need to raise the consciousness among females about how a change in choices could impact on the development of their country. She says that girls have to realise that by not choosing to study science they are letting their entire country down and the choices they make impact the country as a whole. She says that the girls must begin to realise that the choices they make actually impact on the development of their country. She argues that even though there is much wrong with the educational system, the girls have to bear some of the responsibility themselves for being underrepresented in SMTE:

> *But in this case the very problem is the girls' individuals. And then you can look at the system because there are a lot of problems in the system (Saturday, 2001).*

Saturday says that positive encouragement is crucial for more girls to succeed in science and that this would have a much more positive impact than punishment. It is also necessary to give girls credit for other things than simply theoretical success. Willingness to help teachers and peers, showing up neatly dressed and on time to school should also be awarded.

With regards to the impact of FEMSA, Saturday asserts that "it is easy to sensitise, but it is hard to change systems" (Saturday, 2001).

4.3.2 FEMSA's analysis of the situation for girls in SMTE

DAE defined underrepresentation and underperformance of females in SMTE as one of the major educational challenges for education in sub-Saharan Africa. Based on this understanding, FEMSA was developed. In the Dissemination Report describing the background and research methodology of FEMSA (FEMSA, 1997-1), it is argued that FEMSA chose not to spend much time establishing the inequality quantitatively as the project members were of the opinion that enough documentation already existed regarding the underrepresentation and underperformance of girls in SMTE at primary and secondary school:

> *In the planning of the FEMSA pilot phase towards the end of 1995 it was felt that much quantitative data was already available in each of the four countries regarding the status of girls' participation and performance in Mathematics and Science at primary and secondary level. It was clear from previous studies that enrolment of girls, especially at secondary level was far below that of boys (FEMSA 1997-1, p. 8).*

Because of the assumption that enough data already existed documenting female underperformance and underrepresentation in science and mathematics education in primary and secondary school, FEMSA chose only to verify these data, through the creation of "Country profiles" from the four Phase 1 countries. FEMSA's findings regarding the status of girls' participation and performance in SMT subjects in primary and secondary schools is presented in Dissemination Report no 9 and 10. The report from *primary school* states that science and mathematics is compulsory in all the four countries at primary school level:

> *The rate of participation therefore is mainly based on the number of girls enrolled in school and this figure is affected by the number who drop- out of school (FEMSA, 1997-9, p. 4).*

The data presented in the FEMSA reports describing girls' participation in SMTE in primary school therefore refers to general participation and does not show participation in SMT subjects since no data according to FEMSA exists documenting underperformance in SMT subjects relative to other subjects at this level.

For Cameroon, female enrolment in primary school as % of total was, according to the FEMSA report 47.1% in the year 1994/95[43]. The dropout rates from start to end of primary school is according to FEMSA higher in Francophone parts (51% of the girls drop out) of the country than in Anglophone parts (29.6% dropout rate) (FEMSA, 1997-9, p. 5). The dropout rates for boys are not presented and no references to the source of these data are given in the Dissemination Reports.

FEMSA reports that there has been a steady increase in the enrolment in Ghana during the last five years, with an average female enrolment rate in 1994/95 of 46.1% of total participation (FEMSA, 1997-9, p. 5). (No data for boys provided). Tanzania, according to the FEMSA, report reached gender parity in participation in primary school in 1985, and states that "records from 1990-1995 indicate girls' enrolment in primary schools between 49,1% and 49.5% of total population" (FEMSA, 1997-9, p. 6). For Uganda, the girls' enrolment situation in primary school has improved after the introduction of Universal Primary Education in 1997 when four children in each family (two have to be girls if there are girls in the family) are guaranteed free primary education (FEMSA, 1997-9, p. 6).

When it comes to documenting differences in *performance* in science and mathematics at *primary level*, the FEMSA Dissemination Reports state that the country reports from the pilot countries show evidence that the performance of girls in SMTE in primary schools are lower than that of boys:

> *The performance of girls is generally poorer than that of boys in SMT subjects as stated in country reports. However the results presented here are for the general performance of the combined subjects – with the exception of Ghana where there are no examinations at the end of primary education (FEMSA, 1997-9, p. 11).*

It is not clear why FEMSA, if data did exist documenting gender differences in performance in science and mathematics at primary level, chose not to present these data in the Dissemination Report labelled "Status of girls' participation and performance in SMT subjects in primary school".

In this report, FEMSA presented some evidence (although without references) that girls generally perform slightly worse than boys in all

[43] It is not explained in the Dissemination Reports whether they refer to net- or gross enrolment rates. I interpret their reference to "total enrolment" to mean that they refer to gross enrolment rates.

subjects in Uganda and Tanzania. For Ghana, there are no such data and for Cameroon:

> *No statistics currently exist which give a proper indication of the performance of girls and boys at the end of primary school (FEMSA, 1997-9, p. 11).*

Judging from data presented in the Dissemination Reports, there was no evidence documenting female underperformance and underparticipation in science subjects relative to other subjects in primary level in any of the four pilot countries at the time FEMSA was started. It is not possible from the reports to compare boys' and girls' participation and performance in science education since data describing the situation for boys is often missing. It is evident from the way underperformance and underrepresentation is presented that the focus for FEMSA was on the girls, although some of the data that exists indicate that the participation and performance rates also for boys in many of the FEMSA countries were far from satisfactory.

For *secondary school* level students, the Dissemination Reports show some more evidence for gender differences in SMTE, although references to document the differences are somewhat scattered. Ghana shows that girls' participation in the Secondary Science Certificate examination in 1994 was significantly lower than the participation of boys, with the highest differences in chemistry and physics (FEMSA, 1997-10, p. 9). Uganda also documents a significantly lower female participation in mathematics and science at the Uganda Certificate of Education (UCE) in 1995 (FEMSA, 1997-10, p. 9). In Tanzania it is claimed that only 25% of the total number of girls registered in secondary school between 1990 and 1995 chose physics and chemistry. No data showing the situation for boys is provided. Female participation in science subjects in the ten districts that participated in FEMSA Cameroon in 1997 was between 2-24% (FEMSA, 1997-10, p. 10). No data is provided documenting the level of participation for boys. The report does not say if these numbers refer to a percentage of the total number of girls or if they represent the relative amount of girls' participation compared to that of boys.

The data presented showing the performance of girls in secondary schools, shows that where comparative data exists, the performance of girls in science education seems to be relatively lower than that of boys (FEMSA, 1997-11, p. 13). For Ghana, the differences in performance is however marginal with a generally poor performance for boys as well as girls (FEMSA, 1997-10, p.11).

It is clear from the statements describing FEMSA's background (FEMSA 1997-1), and also the evidence provided documenting the problem FEMSA was set up to address (FEMSA, 1997-9 and 10), that FEMSA did not put much emphasis on documenting the differences in females' participation and performance in SMTE. One of the initiators of FEMSA states that:

> *The premise was that there was a general feeling and some scattered old data that girls' access, participation and performance in SMTE was lagging far behind that of boys (Friday, personal communication, 2003).*

FEMSA proceeded as if evidence to differences in participation and performance patterns in SMTE were documented also at primary school level. It is not clear why FEMSA proceeded as if these differences were documented.

The evaluation of FEMSA, conducted two years after the project was handed over to FAWE, shows that no data existed even after FEMSA was completed, documenting sex differences in participation and performance in SMTE in many of the FEMSA countries (O-saki & Bunwaree, 2003, p. 81). The response to my request to FAWE in 2003 for updated data describing females' participation and performance in SMTE showed that not even FAWE had such data. Since no quantitative data documenting the differences in participation and performance for primary school existed, neither prior to FEMSA nor after the project was completed, measuring the success of FEMSA's quantitative objective of increased participation and performance in SMTE at primary and secondary school has been impossible.

4.3.3 FEMSA's analysis of obstacles

Obstacles identified by FEMSA

> *The FEMSA project began with the belief that more was required than mere collection of data and documentation of the problem. From the beginning there was a desire to probe beneath the quantitative data to find the reasons for the problem (…) (FEMSA, 1997-1, p. 8).*

A substantial amount of time and resources in FEMSA's first phase focused on detecting which obstacles caused the low participation and performance rate of girls in science and mathematics education. A guiding principle for FEMSA in this work was to ask the girls themselves and the people surrounding them about what obstacles affected girls' performance and participation in SMTE. By using PLA methodology, the FEMSA staff managed to get first hand information from pupils, teachers, and the broader community regarding the obstacles confronted by girls. These obstacles were thereafter used as a means to sensitise participants in the project and discuss proposed solutions. The findings from FEMSA's investigations are presented throughout 16 Dissemination Reports. The obstacles detected are in the reports presented as they came across in the interviews, questionnaires, focused group discussions, national seminars etc. In the Dissemination Reports FEMSA presents all the factors that were found to have a negative impact on girls' participation and performance in SMTE. The obstacles are not analysed according to what effect they might have had on male pupils. In the Regional Coordinator's summary of obstacles he presents the obstacles as if they only affect girls (The obstacles were presented under the headline "Reasons for Poor Participation and Lower Performance of Girls"). According to O'Connor:

> *The major School Studies carried out during Phase 1 indicated that the main reasons for the relatively poor participation and performance of girls in SMT disciplines were as follows:*
>
> - *Poverty, which often resulted in education of boys being given first priority when household incomes were limited.*
> - *Socio-cultural barriers, which have been augmented by the burden of HIV/AIDS, which has seen a halt to many of the gains in girls' education, made over the past ten years.*
> - *Attitudes of parents, teachers and students: there is a strong all-pervading, traditional conservative belief among parents, teachers and students that mathematics and science subjects are male preserve.*
> - *Insensitive teaching: Many teachers are unaware of the special difficulties that girls face in the learning of mathematics and science. There is little knowledge of the strengths and weaknesses that girls bring to learning of SMT. Most teachers, even female teachers, have higher expectations of boys. Many of the everyday examples of scientific processes used by teachers are drawn from the world of men and boys.*
> - *Didactic approach to learning of Mathematic and Science: The classroom approach to the learning of mathematic and science is almost entirely didactic: Lecture, note-taking and questions and answers dominate the classroom. Little practical work is done.*

- *Inappropriate and irrelevant syllabuses: Most secondary school syllabuses seem to assume that all students are going to become fully-fledged professional mathematicians and scientists at the end of basic secondary schooling.*

- *Poor facilities, lack of equipment and consumables. Even where facilities are available teachers do not use them, citing broad syllabuses and the time consuming nature of practical work.*

- *Ineffective and unsuitable examinations: mostly testing rote memory and knowledge of terminology and nomenclature.*

- *Lack of role models: there are few women teachers of single subject sciences or mathematics, and few girls, especially in the rural areas, even come in contact with a woman scientist (O'Connor, 2002a, p. 46-47).*

In the FEMSA Dissemination Reports, the obstacles are also presented as obstacles affecting girls without also discussing their effect on boys.

The obstacles are, in the FEMSA Dissemination Reports and also in the documents written by the Regional Coordinator, not separated according to their special effect on SMTE versus other school subjects. Some of the factors FEMSA identified will affect participation and performance in subjects other than science and mathematics. Factors such as poor economy (FEMSA, 1997-6, p. 9), parents giving priority to boys in access to education (FEMSA, 1997-5, p. 12 & 13; FEMSA, 1997-6, p. 4), early marriages (FEMSA, 1997-5, p. 13; FEMSA, 1997-6, p. 7) and teenage pregnancies (FEMSA, 1997-5, p. 14) are all factors that will impact on girls' access to education in general.

An understanding among parents that employment possibilities in SMT related occupations are poor (FEMSA, 1997-6, p. 9) and perceptions about science being better suited for males than females (FEMSA, 1997-11, p. 4 & 11; FEMSA, 1997-5, p. 13) will affect participation rates in SMTE in particular.

Similarly will a range of the factors FEMSA identified to affect *performance* in SMTE, also affect performance in other school subjects. Lack of resources in schools (FEMSA, 1997- 2, p. 2, 8 & 10; FEMSA, 1997-8, p. 10; FEMSA, 1997-14, p. 5, 9, 14, 15 & 16), over crowded classrooms (FEMSA, 1997-2, p. 4 & 6) (FEMSA, 1997-8, p. 10; FEMSA, 1997-14, p. 5 & 6), poorly educated and abusive teachers (FEMSA, 1997-14, p. 6) and parents that do not follow up their daughters' school work, are factors likely to impact negatively on girls' performance in all subjects taught in school.

FEMSA found that poor school economy will impact science education in particular since it constrains the possibilities to purchase lab equipment and hence the possibilities to carry out practical work in the lab (FEMSA, 1997-2, p. 8). This, according to FEMSA, led to a widespread use of teacher centred teaching approaches in science class (FEMSA, 1997-2, p. 1). FEMSA found that it was common for SMT subjects to be taught in the morning. This was based on the perception that the pupils needed to be rested and refreshed for these lessons. Since girls more often than boys came late to school in order to complete their home chores, FEMSA found that the girls tended to miss out on these particular subjects (FEMSA, 1997-6, p. 6; FEMSA, 1997-12, p. 8; FEMSA, 1997-14, p. 5). FEMSA concluded that because of the hierarchical nature of these subjects, girls due to their frequent absence, are likely to lose track of the content in SMT subjects (FEMSA, 1997-12, p. 8). FEMSA also found a severe shortage of teachers, particularly SMT teachers at secondary level (FEMSA, 1997-2, p. 5; FEMSA, 1997-6, p. 10). In-service training was found to be rare and of poor quality in all the FEMSA countries (FEMSA, 1997-2, p. 4; FEMSA, 1997-8, p. 8).

FEMSA found that most mathematics and science teachers in the schools they examined were males (FEMSA, 1997-2, p. 5). This, according to FEMSA, caused a shortage of female role models to show girls that it is possible for females to succeed in SMT fields (FEMSA, 1997-5, p. 14).

SMT education was by FEMSA found to be theoretical and examination driven in all four countries (FEMSA, 1997-8, p. 8 & 10; FEMSA, 1997-12, p. 6). Since examinations test content and recall and not skills and reasoning, science education, according to the FEMSA reports focuses on rote learning and recall of facts (FEMSA, 1997-12, p. 15). Classroom observations showed that the teachers tended to lack innovation in terms of material use and learning aids (FEMSA, 1997-8, p. 8). Group work was hardly used (FEMSA, 1997-14, p. 11). Syllabuses were theoretical and abstract and not at all relevant to the pupils' daily life (FEMSA, 1997-6, p. 10; FEMSA, 1997-12, p. 6 & 9). In addition to being irrelevant, FEMSA reports that the syllabuses, particularly at secondary schools were too long (FEMSA, 1997-2, p. 5; FEMSA, 1997-12, p. 9). The Dissemination Reports say that this affects girls in particular since they have less time than boys to study (FEMSA, 1997-12, p. 9). Most syllabuses were also found to be gender biased (FEMSA, 1997-12, p. 8; FEMSA, 1997-14, p. 16):

> *Most syllabuses are gender biased, for example physics, which emphasises topics such as power, energy etc which are more familiar, and of more interest to boys than girls. None of the SMT syllabuses make any specific reference of any considerations that might be required by girls in the study of this subject. Most SMT books and support materials such as posters and specimen are gender biased, most of them using boys for illustrations (FEMSA, 1997-14, p. 16).*

This was attributed to the low participation of females in curriculum development bodies (FEMSA, 1997-12, p. 8).

This Dissemination Report gives no reference documenting on what basis FEMSA assumes that boys are more interested than girls in power and energy. Neither is it specified on what basis they argue that some "considerations" should be more required by girls. The fact that science literature is biased because it uses boys as illustrations is not further explained. The reports do not claim on what basis they argue that syllabuses would be less biased if more women were involved in curriculum development.

The FEMSA reports says that FEMSA's pilot study has found that girls and boys consciously or unconsciously often were given different treatment by the teachers during SMT classes (FEMSA, 1997-14, p. 9):

> *It clearly emerges from the study that teachers' awareness of the fact that they have negative attitudes and that these attitudes are manifested in the way they teach and respond to students is low (FEMSA, 1997-7, p. 16).*

FEMSA's first phase reported that teachers were more likely to use positive reinforcement for boys than for girls (FEMSA, 1997-8, p. 8). Girls were often not encouraged to participate and the teachers showed openly that they did not believe in the girls. They demonstrate this by ignoring them, or by asking them simple questions (FEMSA, 1997-11, p. 6):

> *Classroom observations revealed that teaching methods used in most SMT classes tend to favour boys. Girls are generally being discriminated against in class by not being encouraged to participate in on-going discussions and activities, Most are happy to be left alone because they know that they can't cope anyway. However, those who wish to try, soon lose interest (…). Teachers tend to direct difficult and reasoning questions to boys and ignore girls altogether or ask them simple, recall questions. Moreover it was found that a good number of teachers in primary classes, particularly those teaching in the upper classes are not adequately trained. They lack*

creativity, do not use teaching aids and are ignorant of girls' problems (FEMSA, 1997-11, p. 6).

FEMSA reports that classroom observations showed that teachers sometimes restricted girls' opportunity to use equipment in science class (FEMSA, 1997-8, p. 8). Pupils reported on sexual discrimination of girls in science classes where teachers would humiliate girls by using them to demonstrate body parts during biology lessons (FEMSA, 1997-2, p. 10) (FEMSA, 1997-11, p. 7).

FEMSA also found that most of the SMT books available were gender biased with text and illustrations favouring the boys. This report does not offer more details to what type of bias was found in these textbooks.

Obstacles highlighted in interviews

My interviews of the Country Coordinators regarding what causes underrepresentation and underperformance in science indicates that the Coordinators share a similar understanding of what obstacles are facing girls as the ones presented throughout the Dissemination Reports. Saturday argued that "The way it (science education-my remark) is now it is not meant for girls" (Saturday, 2001). Friday claimed that the whole education system is designed in a way that gives girls the message that they are in the wrong place:

When the girls start to learn science it is so biased towards the boys the teachers are so biased towards the boys in their praxis and their examples that you get this unwritten message constantly that you are in the wrong place. This is not for you, particularly at the higher level so even before you go into the actual science, the attitudes of the teacher, the attitudes of the community. Everybody tends to tell you that you are in the wrong place. So you also believe that you are in the wrong place (Friday, 2001).

All the interviewed Coordinators argued that science education ought to be changed in order to address gender inequalities. They focused on the methods used for teaching and argued that teaching methods must change to accommodate girls' experiences. Several argued that it is mainly the examples being used that need to be changed in a way that accounts for the different experiences of girls:

The way you introduce one notion in science you should use the material that can make the children to understand what is going on. And the boy has an advantage because he is using more materials that is familiar than the girl. I think that the problem is just in the *beginning of learning science to help the children to understand what is exactly the purpose. After that when everybody has understood they can go ahead together and do the same thing (Monday, 2001).*

Common among the Coordinators was an understanding of females as being more practical than boys. The fact that science education in most countries is described as very theoretical according to the Coordinators makes it less welcoming for girls than for boys:

Yes they (girls – my remark) are more practical oriented. That is why they fail on our exams that are all about memorising a lot of things (Wednesday, 2001).

Science is not very practical in my country. They are trying to make it more practical (Tuesday, 2001).

Tuesday also reflected over why changing science education to become more practical was a problem when the resources were scarce:

Also our country is poor and you know to do practice you need to have the equipment. And the equipment is very expensive. And our government they won't, they have limitised this financial aspect (Tuesday, 2001).

The Coordinators who described girls as more practical than boys, did not believe that this was caused by difference in their biology but a result of the way they were brought up having different toys and different possibilities to gain experiences relevant for the learning of science:

Yes, but you should look at our culture. Boys are used to play on scientific games, electronic, while girls are with their mother and they play with a baby toy. They do not have many opportunities to play with these electronic toys. That is also in our families. If you have a small electrical problem for example, nobody can call a woman to go and look. But it is easy to call a boy (Tuesday, 2001).

Nobody has been able to convince me that girls fail in mathematics because of biology. None! (Thursday, 2001).

Girls' strengths and weaknesses

In the Regional Coordinators postscript to FEMSA (O'Connor, 2002b) references are repeatedly made to "girls' problems" in SMT (p. 2, 23, 31, 32, 33, 34, 37, 42, 43, 51, 52, 54, 55, 57, 58, 62 & 63) without any presentation and discussion of what these problems really are beyond the socio cultural factors identified in FEMSA's first phase. No reference is made in any of the

FEMSA documents to findings from other research that has attempted to explain the differences in females' participation, performance, interests and attitudes towards certain science subjects. Instead of building on previous research explaining these differences, FEMSA carried out its own research on girls' strengths and weaknesses in the learning of science and mathematics. At the AFCLIST/ FEMSA gender workshop in Nairobi in 2001, this research was presented as one of the main contributions from FEMSA. The paper presented in Narobi was written based on the outcome from a workshop held in Kenya that amongst other issues focused on "Sharing experiences on girls' strengths and weaknesses in the learning of SMT subjects" (Lenga, 2002). The paper represented an attempt to show that some of the characteristics of females that are commonly seen as weaknesses in terms of learning SMT can actually strengthen girls' ability to learn science. The article represented a collection of undocumented characteristics and stereotypes of what girls are like, many of the characteristics actually in contrast to the understandings of the differences between males and females referred to in "difference feminist" research in science education (See chapter 2). The paper presented was written on the basis of a workshop with teachers in Nairobi. As a result of this workshop the Kenya Coordinator presented the following characteristics of females' strengths in learning SMT:

1. *Girls are cooperative*
2. *Girls are responsible*
3. *Girls are creative*
4. *Girls are keen and observant*
5. *Girls have the will-power to excel*
6. *Girls are disciplined*
7. *Girls develop good command of language fast*
8. *Girls respond to positive motivation and influence*
9. *Girls are competitive*
10. *Girls like aesthetics*
11. *Girls are good at memorisation*
12. *Girls develop a curious attitude*
13. *Girls regard their teachers highly (Lenga, 2002)*

Referring to the weaknesses of girls in the learning of SMT, Lenga argues that girls do not have such weaknesses:

1. *Girls do not have weaknesses in the learning of SMT subjects. The so-called weaknesses emanate from "outside" the girls environment:*
2. *Comprehension of concepts*
3. *Attitude*

4. *Environmental factors* [44]
5. *The role of teachers and role models*
6. *Lack of continuity/consistency*
7. *Lack of self esteem, confidence and exposure*
8. *Emotions (…) Girls easily panic during examinations*
9. *Psychological changes*
10. *Mode of testing and revision (Lenga, 2002, p. 80-83).*

The work on girls' strengths and weaknesses was chosen as one of FEMSA's main lessons to the joint gender workshop in Nairobi and is often referred to by the Regional Coordinator in his summing up of FEMSA after 6 years (O'Connor, 2002b). The paper faced immense critique when presented at the FEMSA/AFCLIST workshop, also from people involved in FEMSA. The Regional Coordinator of FEMSA defended the findings of this paper in his summing up of FEMSA:

> *Much work remains to be done on researching the strengths and weaknesses that girls bring to their learning of SMT subjects, and what teaching approaches should be adopted to maximise their strengths and minimising the effects of their weaknesses. FEMSA Kenya has done significant work in this area. Although the FEMSA Kenya efforts at the school level were somewhat unfairly derided as being "unscientific" at the FEMSA/AFCLIST Gender Workshop held in December 2001, account was not taken of the way in which the intensive work in the schools was clinically examined at two intensive national Teachers' Workshops, attended by high powered professionals from the National Curriculum Development Centre, the National Examinations Councils, the Universities, the teacher training institutions and the Inspectorate. Credit must be given to the importance of small-scale research carried out in schools by professional teachers who know their girl students intimately and who are probably best suited to determining what are the girls' real difficulties and providing alternative approaches to those currently patently not working (O'Connor, 2002b, p. 52).*

In spite of the emphasis made on this "finding" in the reports written by the Regional Coordinator, I have not been able to detect any further explanation in any FEMSA documents, except form the article by the Kenyan Coordinator, to what the special problems of girls in the learning of science really are. In the Regional Coordinators summary of the main findings from FEMSA regarding what causes female underrepresentation and underperformance in SMTE, he wrote that one of the findings from FEMSA

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[44] Environmental factors in this paper refer to taboos /cultural practices that impact on the girls' previous experience with issues of relevance for science education.

indicated that there is “little knowledge about the strengths and weaknesses that girls bring to the learning of SMTE”. None of the Coordinators have used this expression in their explanations to what causes the inequality. Still, references to the so called “Strengths and weaknesses” for girls are repeated throughout all FEMSA documents written by the Regional Coordinator.

All obstacles identified through own research

The obstacles FEMSA identified were based solely on the project’s own research. The project did not review relevant research as stated to be an objective of FEMSA in the original plans (Sjøberg, 1994, 1995). Throughout the 16 Dissemination Reports documenting the findings from FEMSA, no reference was made to similar research carried out in Africa or other contexts. FEMSA’s findings were hence presented as if no other knowledge existed in this area. The reviews of FEMSA (Lexow & Kainja, 1998; O’Bura et al., 2000; O-saki & Bunwaree, 2003) claimed that the first phase of FEMSA did not add much new knowledge to what obstacles girls were faced with in SMTE.

A reason to conduct such an extensive study of obstacles could be that previous research in other contexts might be regarded as irrelevant for the context in which FEMSA operates. By referring to literature relevant to the issues FEMSA addressed, FEMSA could have added new knowledge to the possible (lack of?) relevance of studies carried out in other parts of the world to an African context. Since the FEMSA stakeholders did not examine previous research relevant to their project, it is however left unknown whether similar literature was not read because it was considered irrelevant, or whether the actors in FEMSA were unaware of the existence of such literature. For a project like FEMSA, carried out by highly educated academics, it would be expected that relevant literature should be read, cited and then critiqued as to the merit of the previous work. It is therefore plausible to assume that this literature was not familiar to the various FEMSA actors.

4.3.4 FEMSA’s arguments for change

The objective of FEMSA was to increase performance and participation of girls in science and mathematics and technology education in primary and secondary education. The objective was quantitative in the sense that it did not give any ideological explanation as to *why* the project regarded it as important to increase the participation and performance of girls in SMTE. FEMSA therefore did not restrict the actors to any pedagogical tradition and did not impose limitations regarding the type interventions and teaching methods the project wished to promote.

Since there was no agreed understanding in FEMSA regarding why increased participation and performance of females in these subjects was wanted and hence what type of education and initiatives the project wanted to promote, it is my understanding that these decisions were taken mainly at a country level. Each country's formulation of objectives and working methods have however not been made available to the public (see chapter 3). My study of FEMSA indicates that the various Coordinators had different understandings of the purpose of working towards increased female participation and performance in SMTE and hence what the goals FEMSA should serve.

In interviews with each of the Country Coordinators, the Coordinators mentioned development of their countries as an important reason to recruit more females to SMTE (Monday, Saturday, Wednesday). Some argued for the benefit of an improved economy of a country if the pool of potential labour educated in science and mathematics would be increased (Thursday, Friday, Tuesday). Other Coordinators saw the benefit to development more as a result of increased personal skills in the home arena and argued that the basic problems of Africa, such as poverty and fighting diseases, would be solved if more females acquired basic skills in science and mathematics (Friday, Monday, Wednesday, Tuesday).

Several of the Coordinators mentioned the potential impact in the homes if more females had skills in science and mathematics. Since women are in charge of the home, the impact of teaching females science would go beyond the benefit of the individual woman and contribute to improved child care and thereby reduce child mortality rates, improve healthcare, nutrition etc (Tuesday, Wednesday, Thursday).

One of the Coordinators argued that the personal economy of females would be improved since females could start small income generating activities, and have more opportunities to join the job market (Friday).

Only one of the Coordinators said that SMTE is suited to developing females own capacities as people (Friday). Two Coordinators mentioned the human rights aspect and argued that equal access to education and educational opportunities is actually a human right (Friday, Tuesday).

None of the Coordinators in the interviews argued that a reason to engage more females in science was to improve the quality of science as such. One of the Coordinators said that a reason to include more girls in SMT is that females would “solve the gender problems in SMT” in the sense that women would develop technologies that would accommodate the needs of women (Friday). Another Coordinator argued that a reason to recruit more females to SMTE would be that women would recognise the science in what they are already doing (Wednesday).

When asked questions regarding their perception on whether females would advance a different science, most of the Coordinators initially denied that females would advance a different science than males:

> *If a person is really scientific, we know that bias cannot come in. But then if you are not in science, you might not know that the basic principle of science is objectivity. And a person like you must know that (Saturday, 2001).*

One of the Coordinators (Wednesday) initially said that women would not pursue a mathematical inquiry that would be any different than that of males. She still claimed that males, because of their upbringing, were more aggressive than females, that they had more confidence, and that this would impact how they pursued mathematics. She did however put emphasis on explaining this difference as due to the way children are being brought up and not because of their biological and cognitive abilities.

The other Coordinators had alternative explanations regarding how the upbringing of males and females has an impact on their abilities to engage in science. One of the Coordinators claimed that females would conduct better scientific research because they were brought up to be able to deal with more than one variable at a time:

> *My basic view is that when women conduct research we are able to get a lot more out of that research (…) Women will try to tackle different things at the same time. They will put a lot of details, which men think of as rubbish (Thursday, 2001).*

Judging from the interviews, the perceptions of the Coordinators regarding the purpose of increasing female participation and performance in SMTE are, not surprisingly, varied. Since FEMSA only formulated a quantitative goal, it was left to the different countries to determine what interventions were to be implemented based on their individual understanding of why they regarded it as important to recruit female participation and performance in SMTE.

By not discussing the rationale for the importance of increasing girls’ participation and performance in SMTE, which at first sight might seem obvious, the formal documents of FEMSA have not restrained the actors to using any particular teaching methods to secure the goal of the project. Since the overall goal of FEMSA was to increase the participation and performance of girls, a range of teaching strategies, including strategies such as drilling and rote learning, are plausible as long as they lead to increased performance and participation. Such strategies were according to the review of FEMSA applied in several of the FEMSA countries (O-saki & Bunwaree, 2003). If the reason to increase the participation and performance of girls in science had been more explicit, for instance a reason being to advocate increase female empowerment, these teaching strategies might not be at all appropriate.

4.3.5 FEMSA's recommendations for change

One outcome of FEMSA's first phase was a set of recommendations regarding interventions to be undertaken in order to increase the participation and performance of females in SMTE.

The recommendations were made on the basis of questionnaires and interviews of pupils, teachers and parents in the four Phase 1 countries. The recommendations are presented together with the "diagnosis" of obstacles in the16 Dissemination Reports from the project. Several of the recommendations concern how females could be secured access to school in general. Other recommendations deal with how the physical condition in schools could be improved to increase female participation and performance in SMTE.

Recommendations that address the teaching and learning of SMT

In addition to such factors, several of FEMSA's recommendations targeted science education in particular and suggested how science education could be transformed in order to increase the participation and performance of females. Also these recommendations from FEMSA are displayed throughout the 16 Dissemination Reports. In order to visualise the implications of various aspects of the science education system, I have displayed these factors in a table:

Areas for change	Recommendations made in FEMSA's Dissemination Reports
Curriculum develop-ment	Policymakers should be sensitised to address gender issues in examinations and subject syllabuses (11-5) More females should be involved in curriculum development (2-10) (12-8) (14-17)
Content of curriculum	SMT curricula should be developed to build on local material, responsive to the labour marked (18-14) Content of the curricula should relate more to the normal, everyday activities of the community (12-10) Primary science and mathematics syllabuses should be revised to include content more relevant to girls' needs in their lives after school (11-4) (14-17) Syllabuses should build on everyday experiences and be gender sensitive (14-17) SMT curricula must be changed so as to not reinforce stereotypes (14-18) Gender bias should be removed from books, curricula and examinations (12-8)
Teacher distribution and employment practices	FEMSA recommends that only qualified teachers should teach SMT (14-18) also at primary level (2-6) Qualified science teachers should be distributed evenly across schools (2-6) There should be adequate remuneration for teachers and those in science fields to encourage others to follow in their profession (5-16) (8-12) (18-14) Strategies should be put in place to encourage more female teachers at all levels (18-14) Employment and deployment strategies should be gender sensitive (18-14) and more female teachers in SMT should be trained to handle girls and act as role models (2-6) (8-11) (11-4) (14-12) Female SMT teachers should be encouraged to teach girls (14-18) Teachers whose female pupils perform well in SMT should be given remuneration, not necessarily material but in the form of recognition from the community (18-14)
Qualifi-cations/ Teacher training	Pre-service training should focus on activity based and participatory learning approaches (8-11) and use of local materials (12-7) In-service training must be designed to help teachers understand students, especially, girls (14- 18) Through seminars and in-service programmes, SMT teachers should be sensitised on the special problems faced by girls (11-6) (11-12) and given orientations about teaching methodologies more appropriate for girls (2-6) (11-6) (12-6) The training of teachers should emphasize methods of teaching of SMT that are more relevant to the everyday experiences of girls, e.g. measurements, weighing, farming, cooking, animal husbandry etc (2- 6) Teachers should be sensitised through in-service courses and revision of teacher training curriculum, to change their attitudes towards girls and improve their teaching methodologies to cater to girls' interests (11-4) Pre-and- in service teacher training programmes should be changed to ensure the use of gender sensitive, pupil centred, participatory approaches which are said to encourage more effective learning of SMT at all education levels (14-18) (18-14) Counsellors should be trained to work with girls' problems (11-12) and the social problems faced by girls due to discrimination (11-4) Teachers should be sensitised to encourage girls in SMT, sensitise them about their rights (11-10) and involve girls more actively in laboratory work (2-6) Teachers should be sensitive to girls' discomfort during teaching of topics such as reproduction and should never harass or embarrass pupils by using them as specimen for demonstrating body parts/ functions (2- 10)

Teaching methods	Girls should be given extra tuition through remedial classes (12-15) Girls should be provided with counselling courses (11-12) and career guidance (11-12) A school policy with a compulsory period for doing homework and assignments in the evenings or immediately after school is recommended (5-16) (11-11) (6-13) (18-15) Syllabuses should be designed to focus more on the scientific approach and the development of a scientific and mathematical way of thinking, curriculum developers must be certain that such terminology as "scientific approach" is understood by all concerned and is translated into activities during teaching (12-10) Teaching methods should be more practically oriented (11-6) (14-17) Teaching must build on girls and boys experiences (14-11) and favour both boys and girls (14-18) Girls should be able to observe female role models in SMT (5-16) (11-12) This could be achieved by showing documentary films of SMT women (11-12) and by giving girls opportunities to observe female role models in SMT-careers (5-16)
Text books	Book policies which enable every student to buy textbooks at affordable prices should be promoted (2-9) Ways of ensuring that children have access to the textbooks they need should be explored (2-9) Students should be allowed to take SMT textbooks home (2-9) Efforts to remove gender bias from all aspects of the curriculum including stereotyping in textbooks at all levels should be intensified (2-9) (12-8) There should be no stereotyping of males and females in textbooks (14-17) Textbooks should be revised to have gender-balanced illustrations and examples (11-8)
Examin-ations	Female participation in national examination boards should be increased (12-8) Policymakers should be sensitised to address gender issues in examinations and subject syllabuses (11-5) Ministries of education should be encouraged to introduce and emphasize gender in the analysis and reporting of examination performance of especially SMT subjects (8-11) Examinations should test practical skills (12-16) Assessment and examination strategies should be changed in order to ensure that higher order thinking is encouraged and reliance on memorisation of facts is discouraged (18- 14)
Girls	There should be education campaigns and advocacy programmes to encourage girls (including street girls) to stay in school (5-16) Career guidance should be provided to girls (11-4) (14-13) and they should be given more opportunities to observe female role models in SMT careers (5-16) Girls and boys should be sensitised about girls' abilities to do SMT (11-4) Girls should also be sensitised to report harassment (11-9)

Table 4.2: Recommendations from FEMSA for how SMT education might be changed displayed throughout the Dissemination Reports from FEMSA (FEMSA-1 to 19) In this table the first number in each bracket refer to the number of the Dissemination Report where the recommendation is referred. The second number refers to the page. (11-5) for example means that the recommendation is written in Dissemination Report no 11 on page five. More than one bracket after each sentence indicates that the recommendation has been repeated in several of the Dissemination Reports.

In the Regional Coordinator's summing up of the lessons learned from FEMSA, he raised the following points as the main areas where change had to occur in order to increase female participation and performance in SMTE (O'Connor, 2002a, p. 50):

> *Experience from the FEMSA project over the past six years indicates that concerted action must be taken by the mainstream education system to ensure that systemic change is brought about in a number of areas.*
>
> - ***Attitude change at all levels:*** *Parents, teachers, students, education policy makers, administrators and field operatives.*
> - ***Curriculum development:*** *The SMT of the curriculum and the classroom must be more closely related to the SMT of the community, especially in the everyday lives of girls and women. Gender insensitivity and bias in curriculum support materials must be identified and eliminated.*
> - ***Teacher education:*** *Girls must learn SMT subjects in a supportive and sympathetic environment and benefit from activity based and girl-friendly teaching approaches. SMT subjects must be taught in such a way that the girls appreciate their importance in their lives after school.*
> - ***Assessment of girls' attainment:*** *It would be pointless to change the science and mathematics which is being taught, and to adopt activity and problem solving approaches in the way they are learned, if methods of assessment of students attainment test only the ability to memorise crammed facts.*
> - ***Remedial support for girls:*** *As they move through the school system, girls for various reasons find that they begin lagging behind the boys in SMT performance. Special effort must be made to provide remedial help for girls to make the playing field level, and to provide support for the girls in learning SMT topics, which they find more difficult than the boys.*

Many of the recommendations from FEMSA are based on "sensitising activities". Parents, pupils, and the broader society should be sensitised to do away with traditional beliefs about females, about the benefit of giving girls SMT education and on girls' ability to learn science. They should also be sensitised on the equal rights of boys and girls. Parents should be sensitised to decrease the working loads of girls and start family planning. Parents and teachers should also be sensitised to let girls and boys play with the same toys.

It is not clear in the FEMSA documents how the sensitising activities have been carried out. Neither is it clearly communicated what the recipients of this sensitisation have been sensitised to. The documents do not state whether the sensitisation has been based on an understanding of males and females as similar or different in their approach to science education (see chapter 2). It is therefore likely that the sensitisation activities have differed in the various FEMSA countries.

Some of the teachers from Mozambique interviewed for the 2003 evaluation of FEMSA, noted that they participated in a sensitisation workshop and were told to be more gender responsive, but were not given any directions as to how this could be done:

> *This is something that all teachers should know, but here many teachers do not even have teacher training, let alone gender training (O-saki & Bunwaree, 2003, p. 64).*

It is difficult to judge the effect of the sensitising activities on the basis of the evaluations carried out by FEMSA. In the Regional Coordinator's postscript to FEMSA, the sensitising is described as a major success while the external evaluation of FEMSA carried out two years after FEMSA was handed over to FAWE draws a somewhat different picture of the impact of the sensitising carried out through FEMSA:

The Regional Coordinator states that:

> *The girls have responded. FEMSA is having an impact already, 'like a bush fire', as one observer noted. FEMSA girls say they are happy, confident and can compete as equals in the SMT classes. Girls hold their heads up high, they are confident and they now enjoy SMT. They say the sky is the limit and they can deal with any SMT challenge. FEMSA has ridden on a great wave of enthusiasm generated by vigorous gender sensitisation efforts and has palpably touched the lives of girls in SMT classrooms. Due to a new perception in FEMSA communities regarding inherent female ability, participation rates in SMT have increased and there are many more girls studying in secondary school science streams than five years ago. In some schools the change is already visible. They are now performing well in many schools. Teachers, heads and parents are pleased with these signs which reinforce their work and spur FEMSA to more activity (O'Connor, 2002b, p. 8).*

While the evaluators do not believe the sensitising activities have succeeded:

> *In the opinion of the evaluators sensitisation cannot be described as a best practice here for two reasons. First the method used in*

sensitisation activities are the same transmission methods FEMSA was trying to discourage in the schools. If sensitisation meant increasing the awareness of participants, better pedagogical orientations such as interactive methods (discussion of personal beliefs, exchange of ideas on existing methods of teaching, demonstration of girl-friendly and unfriendly methods, narratives from girls and boys etc), and transformative methods (e.g. role playing of gender unfriendly methods, dramatization of the oppression of girls as if their fair treatment visits to exemplary classrooms, examination of and analysis of exemplary materials etc). would be the best methods of running the workshop. There being no evidence of use of these pedagogical methods, and failing to observe any classroom presentation, gives us doubt as to whether the so called "sensitisation" could be successful and hence, a best practice (O-saki & Bunwaree, 2003, p. 34).

In the recommendations stemming from FEMSA's first phase, the project had several recommendations addressing how school hours could be reorganised to provide girls with more time to study.

One suggestion form the first phase of FEMSA was to provide the girls with remedial classes and extra time to study. The review of FEMSA after the project's first phase warned against this practice because of the danger of stigmatisation of girls and the danger of creating an image of girls as more stupid than the boys (Lexow & Kainja, 1998). Reports from FEMSA indicate that such initiatives have been carried out in most of the 11 FEMSA countries. Remedial classes for girls was also pointed to by the Regional Coordinator as one of the main recommendations from FEMSA as a means to "provide support for the girls in learning SMT topics which they find more difficult than the boys" (O'Connor, 2002a, p. 50).

Another recommendation from FEMSA as to how science and mathematics lessons could be reorganised, was to include compulsory time to study after school hours. It is difficult to understand from the documents whether the suggestion is to make this study time compulsory for all students or only for the girls.

FEMSA recommends that syllabuses should be designed to focus more on the scientific approach and the development of a scientific and mathematical way of thinking, but curriculum developers must be certain that such terminology as "scientific approach" is understood by all concerned and is translated into activities during teaching (FEMSA, 1997-12, p. 10).

Based on the findings from the four pilot countries documenting an extensive use of rote learning methods and "chalk and talk," FEMSA recommended that the syllabuses should be designed to focus more on giving the pupils experience and knowledge of scientific methods. There is little written evidence from the project documenting how this education could take place in poorly equipped and over crowded classrooms.

Teaching methods must according to FEMSA be more practically oriented in order to arouse the interest of the girls (FEMSA, 1997-11, p. 6) (FEMSA, 1997-14, p. 17). Teaching must build on girls and boys experiences (FEMSA, 1997-14, p. 11) and favour both boys and girls (FEMSA, 1997-14, p. 18).

FEMSA recommended more practical education building on the experiences of both boys and girls. There seems to be an underlying assumption throughout the FEMSA project that making science education more practical will also make it more interesting for the girls. On what basis this recommendation is made is not clarified in the documents describing FEMSA.

In the recommendations from FEMSA towards how science education ought to be changed, no references to research about how children learn are provided. None of the Coordinators refer to previous research in their recommendations as to how science education should be transformed to develop a curriculum more suited to females. One of the Coordinators (Friday, 2001) argues that science should be taught from the known to the unknown, which reflects a constructivist understanding of learning. In the 16 Dissemination Reports no references are made to science education literature. In the presentations explaining the lessons from FEMSA as FEMSA was coming to an end (Naidoo, Savage & Zesaguli, 2002), none of the papers presented by FEMSA Coordinators had any reference to relevant research (except the one presented by the previous Coordinator from Uganda).

In the interviews with the Coordinators, the Coordinators all expressed different understandings regarding what it means to develop a curriculum more suited for females:

Recommendations suggested by FEMSA coordinators	Coordinator
Build on girls' experiences too	Monday, Friday
Show how science can make them better cooks (Show relevance of science for their daily life)	Monday
Same methods, different examples	Monday
More integrated science at lower levels	Friday
Same content – different approach and examples	Friday
Have girls realise that their country depends on them and that they should feel committed to serve their country by choosing science	Saturday
Give girls opportunity to play with same toys as boys to gain experiences relevant for the teaching of science	Tuesday
More equipment, books and a guiding and counselling centre for girls to motivate them	Tuesday
Change examples that are gender biased. Show girls that fix things and fathers that do dishes	Wednesday
Show that girls are more practically oriented	Wednesday
More gender inclusive methods = identification, participation, involvement	Thursday

Table 4.3: Recommendations suggested by FEMSA coordinators as to how female participation and performance in science education could be achieved.

Some Coordinators mentioned a general upgrading of the resources and equipment used to teach science. It was also mentioned that counselling centres ought to be built in order to provide guidance for female pupils and counsel them in SMT related issues.

One recommendation that was mentioned by several Coordinators was to organise education in a way that enabled the pupils to move from the known to the unknown by building science education on the experiences of females, and show how science could be relevant for pupils in their daily lives. One of the Coordinators said that one should design science education so as to show the girls that mastering science could make them better cooks since being a good cook was important for females in her country.

While some of the Coordinators were of the opinion that teaching methods as well as examples used in science class is needed to be changed in order to appeal to girls, others believed that the same methods could be used as long as the examples used were adapted to appeal to both boys and girls. One of the Coordinators said that the examples should be changed in textbooks so as to show males and females in untraditional gender roles. The other Coordinators were less explicit in the suggestions of how gender biased textbooks could be changed.

Trying to link science education closer to the girls' lives and at the same time trying to remove stereotypes might also create a dilemma for curriculum planners. FEMSA does not discuss how this dilemma might be resolved.

In the postscript of FEMSA, the Regional Coordinator for the first time give a résumé of what FEMSA, according to him, has defined as a "girl-friendly teaching/learning approach". This description has a clear focus on giving special attention to the girls and centres the education on their experiences, needs and interests:

> *Throughout the FEMSA countries and in the FEMSA School Centres there is now a much clearer understanding of what is meant by a "girl-friendly teaching/learning approach". The following are now agreed to be the core ingredients of such an approach, which teachers are increasingly trying to implement.*
>
> - *Providing group problem solving sessions, where girls and boys can freely interact.*
> - *Encourage a friendly, non-threatening, classroom atmosphere, where girls feel free to ask questions and indicate that they do not understand, without jeering or harassment from the boys.*
> - *Allowing girls to participate in experiments and practical activities. Teachers need to be trained and sensitised on the need to generate practical work in the laboratories in which girls play a role. Make sure that it is not always the boys that do the experiments and handle the equipment, while the girls are passive observers or recorders of the results.*
> - *Be alert to those topics and questions that girls find difficult to understand. Be patient enough to try to find out why the girls do not understand. Use this information as the basis for devising alternative teaching strategies and remedial work with the girls.*
> - *Demonstration of various innovative approaches: simulation games; case studies; role-play; story telling.*

- *The unwillingness to involve girls in discussions and answering challenging questions on their own, may affect their self-confidence and thus their participation in politics and other public offices after school. It is only when teachers create an atmosphere in the classroom where girls and boys are, and know they are, valued equally that girls will be positively encouraged to voice their opinions and ideas.*
- *Girls still tend to speak in monosyllables, in one-word answers, and as briefly as possible. Many teachers seem unaware of this, so teachers must encourage girls to give fuller and more expansive answers (O'Connor, 2002b, p. 22-23).*

Later in O'Connor's postscript he gives the following definition of a girl-friendly methodology:

> *The core elements of a girl-friendly teaching approach should be learner-centred and activity-based. The methodology should be interesting, enjoyable, participatory and varied (O'Connor, 2002b, p. 24).*

Girl-friendly teaching methods are by FEMSA thus defined as an education that uses activity based methods. Girl-friendly teaching methods should also be interesting, enjoyable, and varied. All these factors seem to add to a teaching approach that most likely would be interesting to boys as well as to girls. Underpinning FEMSA's description of girl-friendly education is still the notion that there are some issues that girls have more problems understanding than boys. It is recommended that the teachers are alert to what topics the girls find difficult to understand and try to design teaching methodologies that account for the girls' difficulties. Teachers should also develop remedial work for the girls based on the issues that girls find difficult. The problem is that neither FEMSA, nor other research that I have reviewed has been able to figure out what exactly these issues are. The FEMSA documents do not provide any evidence of issues that girls perceive to be more difficult than boys. It is evident from this description of girl-friendly teaching methods, that this teaching is developed on girls' premises. It is the girls' difficulties that are to be addressed and accounted for and the teachers are to make sure that all the girls participate fully in the education and are given the opportunity to work with their difficulties after school hours. This is recommended without any evidence as to what these difficulties are.

FEMSA recommend more in-service training for teachers with a focus on developing more practical, relevant and participatory teaching methods.

Teachers should be trained to build education around the pupils' experiences and to actively involve the girls in the SMT classroom, also in laboratory classes. No publications produced by FEMSA documents how this could be carried out in the context described through Phase 1 with over crowded classrooms and poorly equipped schools. The final evaluation of FEMSA (O-saki & Bunwaree, 2003) showed that little had been done to improve teacher training through FEMSA. Friday expressed in the interview that she wished that more had been done with regards to teacher training.

4.4 How did FEMSA approach gender equity in science education?

4.4.1 Introduction

In the following section I will make use of the theoretical framework developed in chapter 2 to analyse how FEMSA addressed gender issues. I first discuss the project's analysis of obstacles. Thereafter I briefly discuss FEMSA's argumentation for change before I analyse their recommendations for change. In my discussion of FEMSA's recommendations for change I first discuss the recommendations that reflect equality feminist perspectives and that in my analytical framework are seen to advance a gender-neutral science education. I thereby discuss some recommendations that can be seen to reflect difference feminist perspectives and hence lead to what I have described as a female-friendly science education. I discuss what I see as possible contradictions in FEMSA's recommendations, and conclude by presenting a brief discussion of my understanding of FEMSA's approach to gender equity.

4.4.2 The understanding of obstacles

FEMSA does not see science as problematic

The critique raised against science for being masculine both in its focus and content raised within feminist critique of science is not a part of how FEMSA understands what is keeping females away from SMTE. According to FEMSA's identification of what obstacles obstruct female participation and performance in SMTE, the factors are all external to scientific knowledge production. FEMSA therefore does not challenge scientific knowledge, but aim to make it more accessible to females. Some of the Country Coordinators argue that criticising science is a luxury they can't afford, and that a hypothetical androcenric bias in science is minimal problem compared to all the other obstacles obstructing girls' engagement in SMTE in sub-Saharan Africa. My impression after reviewing the documents describing FEMSA is that issues of androcentricm and criticism of science were not discussed within FEMSA. The key to increased participation and performance of girls to SMTE has, whether or not being considered as a factor by FEMSA, not been to question possible masculine biases within science, but to detect and remove factors that keep girls from being engaged in science education.

Sex rather than gender

FEMSA used sex as the main decisive factor for studying underrepresentation and underperformance in SMTE. No effort was made to compare differences in obstacles facing girls from the various FEMSA countries. Neither were the obstacles compared to factors found to affect girls in other contexts. Even though several of the identified factors will also impact negatively on boys' participation and performance in SMTE, FEMSA did not conduct any analysis shedding light on the situation for boys. Neither was the FEMSA material used to show potential differences in obstacles faced by girls with different religious backgrounds, girls brought up in rural–urban environments, different class background etc.

It might be argued that gender, here understood as social sex, is closely linked to biological sex in the context in which FEMSA operates since girls often are raised very differently from boys in traditional, patriarchal societies and therefore share many of the same experiences. But in spite of females sharing many of the same experiences and hence are faced with several of the similar constrains in their approach to SMTE in sub-Saharan African countries, girls with a variety of cultural, socio-economic and religious backgrounds are most likely also in this context faced with divergent obstacles. In FEMSA's presentations the possibility of varieties in obstacles within the group of females is not being explored. Stakeholders from FEMSA argued that investigations in the project's first phase showed that these factors were minimal and therefore decided to treat all females as one group in FEMSA's second phase.

The fact that obstacles are presented only according to the effect they had on females, is a clear indication that FEMSA was a female, not a gender project, focusing on sex as the main determining factor influencing on participation and performance in science education. FEMSA's choice to focus only on sex as a determining factor for analysis reflects what I have described as difference feminist perspectives. By emphasising differences between males and females rather than the similarities, FEMSA differs from ideas that are here described to be representative for equality feminism. The ideas implicit in FEMSA also differs from ideas within what I have described as postmodern feminism as FEMSA uses sex rather than gender as a main analysing factor. Much of the critique of science raised within a postmodern tradition is raised by women with other than a white, western, heterosexual background. This critique has often been levelled against feminist theoreticians for placing all females in the same category (white, heterosexual, middleclass), without accounting for the differences present within groups of people of the same sex. In a sense, FEMSA's ignorance of research findings other than what they themselves carried out could be seen to be an (unconscious) response to such a critique. FEMSA, by treating all sub-Saharan school girls as one homogenous group has, however, ignored the possible differences among girls, and thereby reflects perspectives that are in contrast to perspectives and understandings that I consider to be representative to postmodern feminist traditions.

Different types of obstacles

The obstacles FEMSA identified as having negative impact on girls' performance in SMTE, are very different in nature. Some of the factors are *practical constraints* such as lack of equipment, poor sanitary facilities and poorly educated teachers. These factors would also have a negative impact on boys. Another category of obstacles is the category counting constraints caused by various types of *discrimination*. Some of the discriminatory factors affect female pupils because they are girls, and would hence be expected to affect girls regardless of being involved in SMTE or not. Other factors were found to discriminate girls from getting involved in SMTE in particular. This type of discrimination does not only reflect an understanding of females as of less worth than males, but also reveal a perception of science as such, and how this enterprise is linked to masculinity. Such factors will, as FEMSA has shown, impact not only on girls' possibility to have education on equal terms as boys, but add further hindrances to girls' opportunities to participate and perform well in SMTE.

Inconsistencies in the perception of girls' and boys' abilities to learn science

A further categorisation that can be made of the obstacles identified by FEMSA, are the obstacles that are not caused by direct discrimination, but that come across more as a result of conscious or unconscious understandings of how sex/gender impacts abilities to engage in science and science education. In FEMSA's presentation of obstacles, the project is not being explicit in terms of its understanding of how sex/gender impacts on how children engage in science.

On one hand the Regional Coordinator claims that there are no differences in males' and females' abilities to succeed in science, and that any claim to such differences is caused by traditional, conservative beliefs:

> *There is a strong all-pervading, traditional, conservative belief among parents, teachers and students that mathematics and science subjects are male preserve (O'Connor, 2001, p. 7).*

On the other hand a continuing reference is made to "girls' problems" throughout the FEMSA documents. The Regional Coordinator's claim that "many teachers are unaware of the special difficulties that girls face in the learning of science" and the "limited knowledge regarding what 'strengths and weaknesses' that girls bring to the learning of SMT" (O'Connor, 2001, p. 7) moreover gives the impression that some of these conservative beliefs were also represented within the group of FEMSA actors. The fact that the Kenyan research on girls' "strengths and weaknesses" was presented as one of the main findings from FEMSA, is a further indication that FEMSA was not being consistent in its understanding of how sex/gender impacts on how children are engaged in SMTE.

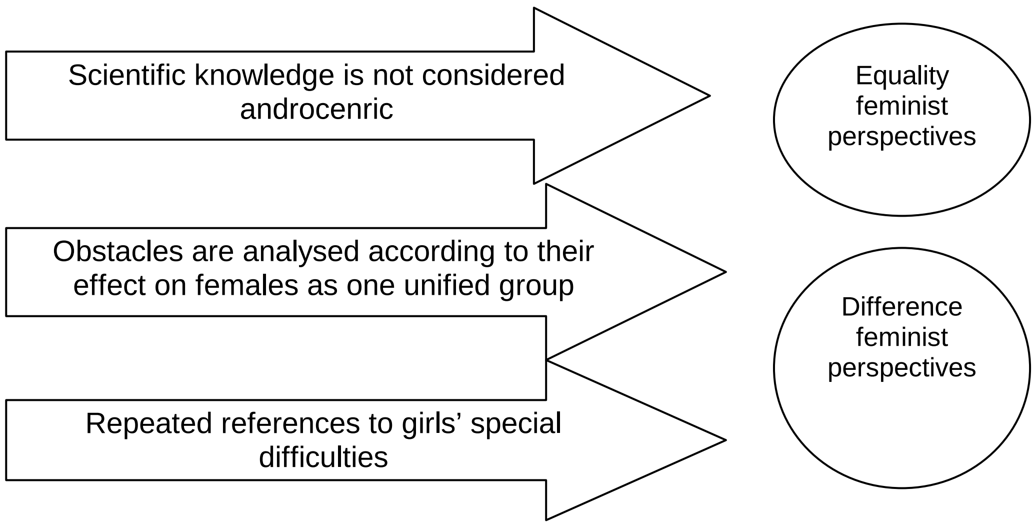
Several other examples can be found in the FEMSA documents that exemplify an understanding within FEMSA of girls being different than boys in their approach to science education. In Dissemination Report no 12 (FEMSA, 1997-12, p. 8) it is stated that topics such as power, energy etc. are more familiar and of more interest to boys than girls, without being explicit on what basis this claim is made. It is furthermore constantly being claimed throughout the FEMSA documents, and also in the interviews, that girls are more practical than boys and that a theoretical education will therefore impact more negatively on girls than on boys without substantiating this claim any further. The Mid Term Review of FEMSA commented on this confusion in the following way:

> *There is one lingering doubt for the MTR. There is no convincing evidence in the FEMSA programme that girls' SMT conceptual or cognitive learning problems – as compared with the socio-cultural context in which girls learn – are different in nature from those boys. The problem identification exercise has not been made sufficiently explicit in any of the FEMSA studies for the MTR to make a judgement on the point. Yet this is one of the fundamental issues underpinning the FEMSA programme, the FEMSA learning approach and remedial (O'Bura et al, 2000, p. 49).*

All in all, FEMSA is not consistent in its understanding of how sex/gender impacts on girls' and boys' engagement in science education and what impact this might have on girls' participation and performance in science education. The documents from FEMSA are therefore not explicit in their assessment of whether science education discriminates girls because it treats girls and boys differently, or whether it is regarded as discriminating against girls because it treats them similarly. Since both understandings are reflected in FEMSA's description of obstacles, it becomes difficult to know what action to take based on the obstacles identified.

Figure 4.1 sums up what I feminist perspectives I consider to be reflected in FEMSA's analysis of obstacles to female participation and performance in science education.

Figure 4.1: FEMSA's analysis of obstacles participation and performance in science education



Several of the respondents interviewed in FEMSA's first phase claimed that science education was a masculine domain and hence not suitable to females. Neither in the documents of FEMSA nor in the any of the interviews of FEMSA actors have I come across any claim that the masculine identity of science education might be caused by a masculine bias in scientific inquiry. Understandings formulated by their respondents of science education as masculine, were by FEMSA treated as everyday assumptions that they should be sensitised to get rid of. I have in my analysis found no claim by people involved in FEMSA of science to be influenced by its developers in a way that causes a masculine or androcentric bias in science knowledge. In that sense FEMSA reflects equality feminist perspectives to what causes female underrepresentation and underperformance in science education.

Other aspects of FEMSA's analysis of obstacles can, however, be seen to represent difference feminist perspectives. In FEMSA's analysis of the obstacles causing female underrpresentation and underperformance in science education, females are seen as one unified group. Obstacles are therefore not analysed according to their effect on different categories of females. The repeated references made to girls' special difficulties in documents written to represent FEMSA together with FEMSA's search for characteristics of females' strengths and weaknesses, also reflects perceptions of males and females as different in their engagement in science education. According to my analysis these dimensions of FEMSA can also be seen to reflect difference feminist perspectives.

4.4.3 Arguments for increased performance and participation of females in SMT and SMTE

The documents describing FEMSA's objective present the goal of FEMSA to be purely quantitative: increased female participation and performance in SMT subjects.

FEMSA did not communicate in its project documents for what reason the project aimed to increase the participation and performance of females in SMTE. This can be interpreted in different ways. One explanation to why this is not explicitly stated might be that the need for equal numbers of males and females in SMTE and scientific communities is regarded as being beyond debate. It is politically correct to work towards equal number of males and females in areas where such equality is not established. Another explanation might be that the project believed that more females involved in this enterprise would actually increase the quality of knowledge production within this field. A third option is a more pragmatic view on the role SMTE plays for development and that granting females equal access to science education will lead to increased social and economic development. Such arguments dominated among the Coordinators I interviewed. Only one of the Coordinators mentioned the potential science education has of empowering women with skills and knowledge useful to develop their capacity as people. Two Coordinators said that gaining equal access to science education was a human right. Some Coordinators also claimed that females would engage slightly different in science inquiry than males. These Coordinators focused manly on that different focus males and females would have on research topics. Some also claimed that women would include more details in their research. The Coordinators did, however, not emphasise improved or changed quality of science inquiry as an argument for including more females in science education. I would argue that the arguments for increased female participation and performance in science education raised by the Country Coordinators of FEMSA reflect a majority of equality feminist perspectives. Their focus does not seem to be to include more females in science education in to change science inquiry in a more “feminine” direction but to give more females useful knowledge to improve their daily life.

Although I find the arguments for increased female participation and performance in science education within the group of FEMSA actors to reflect a majority of equality feminist perspectives, the variety in arguments raised can still be seen to imply very different suggestions to how gender inequity in might be approached. FEMSA as a project did not focus on developing one unified understanding of what the project wanted to achieve by increasing the participation and performance of females in science education. This seems to have led to a great deal of confusion in terms of what has been regarded as successful interventions, or what in a FEMSA context is described as “best practice”. The lack of clearly expressed qualitative goals has hence had implications for the evaluation carried out of FEMSA. The evaluation of FEMSA (O-saki & Bunwaree, 2003) showed that the understandings of what was considered as “best practices” in FEMSA varied immensely between the eleven FEMSA countries. The lack of formulated qualitative objectives and pedagogical direction in the project seems to have caused difficulties in the evaluation of which practices have been best suited to meet the project’s goals. O-saki and Bunwaree (2003) claimed that some countries interpreted the best practices to be the practices that had the most impact on the performance statistics in SMTE in the selected FEMSA schools even though this could be a result of rote learning and drilling of facts in remedial classes paid for by FEMSA. Others interpreted best practices to be the practice that made girls more interested and confident in science, even though these methods obviously also contributed to a further alienation of the boys. Again other countries had interpreted “best practices” to be the activity that was regarded as most successful in their country and in that way all countries had a best praxis even though there were no proofs showing that the intervention had been a success (O-saki & Bunwaree, 2003, pp. 25-28). The fact that no data seems to exist in the FEMSA countries documenting the participation and performance rates of females in SMT subjects, makes it impossible to measure whether the formulated quantitative goal of FEMSA was ever met.

4.4.4 Recommendations for change

Through the development of my analytical framework, I have showed that different understandings of how sex impacts males' and females' approaches to science and science education can be seen to imply very different recommendations for how gender inequity in science education could be addressed. In the following chapter, I will analyse FEMSA's recommendations for change using this framework. By doing this, I make explicit some of the possible contradictory recommendations that lie implicit in FEMSA because the project did not have one common understanding of how sex/gender impacts on how males and females engage in science and science education.

Equality feminist perspectives reflected in FEMSA

Many of the recommendations from FEMSA for how female participation and performance in SMT could be increased are gender-neutral in the sense that they do not reflect any particular understanding of differences and similarities in males' and females' engagement in science education. Such recommendations include suggestions to improve learning facilities in schools for instance by distributing education facilities more evenly across schools, be more innovative in terms of fabricating teaching equipment and maximise the use of already existing laboratory equipment.

Since FEMSA is a project developed to increase female participation and performance in SMTE, several of the recommendation also suggests ways of granting female pupils equal access to education. Such recommendations are to make girls' education mandatory, impact parents to decrease girls' working loads, change legislation to secure girls' rights to education and grant scholarships and sponsorship to girls. These recommendations aim to grant females equal opportunities to males in science education.

Recommendations like these do not reflect any understanding of any differences in males' and females' interest and abilities to engage on equal terms in science education, provided that the girls are granted the same opportunities as male pupils to participate in education. Implicit in these recommendations is the understanding that girls and boys have equal qualifications to perform well in SMTE. In this thesis such understandings have been described as representative to equality feminist perspectives (see chapter 2). It is my understanding that several of the recommendations from FEMSA reflect an understanding of males and females as equal in their qualifications and engagement in science education:

- **FEMSA recommended that girls and boys, teachers and communities in general should be sensitised about girls' equal abilities to engage in science education.**

In several of FEMSA's recommendations the importance of sensitising teachers, societies and girls themselves to realise girls' abilities to engage in science education on equal terms as boys is highlighted. Such recommendations reflect an understanding of the inequity in some science subjects to be caused mainly by external forces. Gender equity in science education can be established by changing discriminatory practices that obstructs females' opportunities to engage in science education on equal terms as males. One factor identified by FEMSA to have a negative impact on female participation and performance in science education was the tendency to underestimate females' ability to succeed in SMT and SMTE. FEMSA therefore tried to identify and remove external obstacles and sensitise society to realise that females are equal to males when it comes to their abilities to succeed in science.

- **FEMSA recommended that girls should be exposed to female role models**

One of the recommendations proposed by FEMSA was to expose girls more to female role models who had a record of succeeding within science and/or science education. The rationale for doing this was to show girls that females can succeed on equal terms as men in occupations that require scientific knowledge and skills. FEMSA recommended that girls should be exposed to female scientists and female science teachers. According to my understanding of FEMSA, the project did not reflect any desire to visualise female role models that are engaged in science in a *different* way than their male counterparts.

In science education projects, operating within what in this thesis have been described as *difference* or *postmodern* feminist understandings, exposing girls to female role models could, however, serve a different purpose. If one believes that women would contribute with something different to science than males, one could expose pupils to role models that represent and visualise this difference. These would be women who had contributed to science in a different way than men. In the FEMSA documents there are no indications that the project's aim is to expose the girls to female role models who have a record of engaging differently in science than their male colleagues. The recommendation in FEMSA to expose the girls to more female role models can therefore be interpreted to reflect an equality feminist perspective (see chapter 2).

- **FEMSA recommended that gender bias should be removed from text books, curriculum and examinations.**

One recommendation from FEMSA was to *remove gender bias* from all aspects of the curriculum, text books, and examinations. FEMSA also recommends that there should be *no stereotyping of males and females* in textbooks and that the textbooks should be revised to have *gender balanced* illustrations and examples.

FEMSA did however not provide further directions as to how this can be done. As shown in chapter 2, there are several ways of removing gender bias in science education material. One option is to make sure to use personal pronouns such as "he and she" equally. Another option is to remove all references to sex in an effort to make the teaching material gender-neutral. A third way might be to eliminate the traditional way of portraying males and females and portray them in untraditional gender roles: Father does the dishes, while mother fixes the car. By not being more explicit in their definition of "gender neutrality", FEMSA gives no clear guidance as to how bias should be removed.

Difference feminism in FEMSA

Several of the recommendations proposed by FEMSA reflect an understanding of males and females as different when it comes to their approach to science and science education and that sex is a determining factor causing this difference. In this thesis I have labelled such understandings "difference feminist understandings". According to difference feminist perspectives, males and females are seen as different in their approach to science. My analysis of FEMSA indicates that the following aspects of the project can be seen to reflect an understanding of males and females as different:

- **FEMSA found it more important for the Coordinators to be females than to have gender training**

According to the criteria used to select the Country Coordinators (FEMSA, 1997-1, p. 5) more emphasis was made on the importance of having the right sex than of having an academic background in gender issues.

My understanding is that the selection criteria for FEMSA Coordinators reflect a perception within FEMSA of sex as an important factor for action. While it is required that the Coordinators from FEMSA "should be a woman", there is no request for staff that is trained in gender issues beyond the fact that they should *be aware of the problems* and *have a strong interest* in changing the situation (FEMSA, 1997-1, p. 5). There was accordingly no requirement that the Coordinators should be current with respect to the literature and research associated with the presumed central tenets of FEMSA. According to FEMSA's selection criteria, being a woman that had succeeded in science and that had an "outstanding expertise in SMT education" is sufficient as a background in order to know what should be done to attract other females to science; since you are a female, you will know other females and their needs.

Common to the Country Coordinators of FEMSA seems, however, to be that they are rather atypical women in the sense that they have chosen a field of study that has been regarded unattractive or unapproachable to the majority of other women in their context. The obstacles that contributed to keeping other females from science, have in other words not affected these individuals in a way that has kept them form pursuing a career in science. This could be because they were able to come up with strategies that enabled them to trespass the barriers. But it could also be that the obstacles most other females faced did not affect these women in the same way either because of atypical cleverness in the subjects, atypical interest in the subjects or atypical responses to the obstacles they were faced with.

The Country Coordinators from FEMSA seem to share similar experiences of being females engaged in science in traditional communities. Several of them say that they did not find science difficult and that they were the best pupils of their class:

> *Because you know, I was very good in mathematics. I was the best in my class, in all my classes. Even at secondary school (Monday, 2001).*
>
> *I was always the top in my class (Thursday, 2001).*

Common to several of the Coordinators also seems to have been that they, in contrast to their fellow female pupils, did not regard SMTE as difficult:

> *In our experience with FEMSA, teachers actually make comments like girls have to work very very hard to make it in science. It is not like ordinary people who can make it in science. But science in itself is not hard. And when you go into it you will discover that it is not hard. And that is why all the Coordinators are from the science fields because we know that it is not. We are already in it. But for some, actually for the Coordinators who are not from science, they might*

have had that difficulty, I don't know. But for me I am from science, I have not had those difficulties (Saturday, 2001).

All the Country Coordinators also seem to have had strong personal integrity and an ability to cope with harassment and trespass cultural barriers affecting them as females choosing science:

> *Normally when you are good in maths and science they suppose you are sort of masculine. And memorising at school, some of my friends would call me "heshe" you know. Because I was good in the science subjects. Because they did not associate science and mathematics with something feminine (Wednesday, 2001).*

> *But later I had the choice of whether to choose mathematics or arts, people were very surprised to find that I chose mathematics because they said mathematics is not good for women. And if I take mathematics, I am no more a woman because I did what is not good for women. Now so this is our society (Monday, 2001).*

Another common feature for the FEMSA Coordinators seems to have been their ability to cope with discouragement and discrimination within the education system:

> *When I begun in university I studied mathematics I was not bad. I was one of the best students in my class. But I can tell you that my mathematics teacher used to do: When he started to explain one notion in mathematics, aha, after his explanation ha came to me and said: Miss, do you understand what I have done? If I said yes, then everybody would say: Really? The lady? Then he said that if I had understood it, everybody must have understood it (Thursday, 2001).*

> *Then when I went to Germany to do my PhD in Mathematics I wanted so bad to show that a girl could do just as well as a boy. It was not easy to find a German professor who wanted to supervise me. Everybody said: No, you see when I want to supervise somebody, I want them to finish. I said: I will finish. They said "No but you see mathematics is very difficult, even for the white people. And I said "What?" I was almost giving up when I found one who would supervise me. But they made me do a lot of adjustments because our system is different from theirs. I decided then that when I come back one task will be to make sure that women get the same opportunities as the boys in science and mathematics education (Thursday, 2001).*

In spite of being among the very few females choosing science in their respective countries, all the Coordinators in FEMSA continued, and succeeded, in their scientific careers. Perhaps some of these women are actually the least suited people to come up with strategies as how to accommodate obstacles since several of them were not affected by the obstacles that seem to have kept other females from continuing studying science and mathematics?

The review team, after FEMSA's first phase, recommended strongly that the national project teams should be expanded to include persons with other than a scientific background and argued that the need for people with a different expertise than science had been underestimated:

> *The composition of the national research team was on the basis of the researchers' expertise within the field of mathematics and science, and was not complemented by expertise in collection of ethnographic data(…)There is a lack of conceptual clarity in the Project Document as how quality and ethnographic data are to be defined. Hence these areas of concern were open for relative free interpretations by both the Project Committee at large as well as the national team members (Lexow & Kainja, 1998, p. 21).*
>
> *To a certain extent the need for professional expertise seems to have been underestimated in the beginning of the project (Lexow & Kainja, 1998, p. 23).*

The evaluation of FEMSA undertaken in 2003 concludes that this recommendation was not followed:

> *One would have expected that some of the lessons learned from the first phase would help address some of the weaknesses of the project, but this did not happen (O-Saki & Bunwaree, 2003, p. 10).*

The evaluators recommended that the staff structure in the local chapters of FAWE set up to follow up initiatives on gender and science education, should include experts on gender, not only women with a science background:

> *The challenge is to review staff structure of local chapters urgently and ensure that at least one programme officer with special skills and knowledge in the field of gender, education and development be brought on board (O-Saki & Bunwaree, 2003, p. 84).*

- **FEMSA recommended that more females should be involved in curriculum development and examination boards.**

FEMSA recommends that more females should be involved in curriculum development and examination boards. This is suggested as a way to diminish masculine bias in curricula and examinations. This recommendation reflects the expectation that an increased number of female examination and curriculum developers would imply a difference in curriculum and examination development. This recommendation hence reflect an understanding of males and females as different, since gender bias in curriculum and examinations is expected to diminish by increasing the number of females enrolled in the development of such documents.

- **FEMSA recommended that science education should be changed to account for girls' special interests.**

FEMSA recommended that science education should be changed to accommodate for girls' special interests. This recommendation reflects an understanding of interests to be closely linked to sex. As shown in chapter 1, research into what characterises females' interests in SMTE has been criticised for maximising differences between boys and girls and minimising similarities between the two sexes. A recommendation to change science education to account for girls' special interests therefore runs the risk of enforcing stereotyped understandings of what constitutes males' and females' interests. Combined with FEMSA's recommendation to build more single sex schools and thereby separate males and females physically, this might contribute to marginalising boys and girls with different interests from the mainstream and also to uphold stereotypes about males' and females' interests.

- **FEMSA recommends developing female-friendly teaching methods.**

One of the recommendations from FEMSA was to develop female-friendly teaching methods in SMTE. The request to develop teaching methods that are female-friendly reflects an understanding that different methods are required to give females a proper science education as well as the recognition that girls and boys are different in their approach to science education. As shown previously, FEMSA does not substantiate explicitly what such "female-friendly" teaching methods really are besides a more stimulating and exiting education.

The Country Coordinators seem to differ in their understanding of what constitutes female-friendly science education. Some argue that science education must treat everybody in the same way because "The way it (science education – my remark) is now it favours one" (Thursday, 2001). Others argue that girls require different methods and/or examples. Many of the Coordinators also claimed that females were more practical than males, and that this difference needed to be accounted for in science education.

The documents from FEMSA do however repeatedly refer to “teaching methodologies more appropriate for girls” (see for example FEMSA, 1997-2, p. 6; FEMSA, 1997-11, p. 5 & FEMSA, 1997-12, p. 6) without being explicit in terms of describing what such methodologies are like.

- **FEMSA recommended developing a science education that accounted for girls special difficulties.**

One of the recommendations from FEMSA was to develop a science education that accounts for girls’ special difficulties in SMT. FEMSA does not give any examples of what exactly these difficulties are, beyond the “evidence” provided in Lenga’s article on girls’ strengths and weaknesses (Lenga, 2002). The repeated references to girls’ special difficulties reflect an understanding of these difficulties to depend on the pupils’sex. Thus it reflects an understanding of girls as having more difficulties than boys in science education.

- **FEMSA recommended extra tuition for girls.**

Another recommendation from FEMSA that clearly reflects an understanding of males and females as being different in their approach to science education is the recommendation to provide girls with extra tuition in order to have them perform better in SMTE. Besides creating a notion of girls as less able than boys when it comes to learning SMT, this recommendation can come across as very discriminating to low performing boys who might have a greater need for extra tuition than high performing girls.

Contradictions in FEMSA’s recommendations

By analysing FEMSA in the light of the theoretical framework outlined in chapter 2, it seems like the project reflects a mixture of equality and difference feminist ideas.

The recommendations from FEMSA were based on the findings from the first phase of the project, not on particular theories about females and science education. The project attempted to lend an ear to the voices of the girls themselves and to build the interventions on problems identified by people who were faced with the obstacles. In the attempt to let all the voices be heard, FEMSA did not develop the recommendations further than just to publish them. A closer look at the recommendations does, however, uncover some possible contradictions in FEMSA’s recommendations for how gender issues should be addressed.

- **FEMSA recommends sensitising girls about their equal abilities of doing science and tries to identify the "special problems" for girls in SMTE.**

One of the main recommendations that came out of the first phase of FEMSA was to sensitise the girls about their ability to engage in science education on equal terms as boys. Girls, parents and communities were to be sensitised to understand that girls had the same possibilities as boys to succeed in science education. The perceptions held by community, parents and pupils that science is more suitable for males than females should be eliminated through sensitisation campaigns in schools and communities. FEMSA reflects a strong faith in the power of "persuasion", or what they have labelled "sensitising". The perception held by many of FEMSA's respondents in the project's first phase that science is masculine and hence not suited for females was by FEMSA treated as an "everyday assumption" that could easily be eliminated. The fact that this assumption is also a common feminist critique of science was not discussed in the documents from FEMSA.

The assumption inherent in the recommendations and initiatives carried out by FEMSA, that girls and boys have equal abilities to do well in science, corresponds with perspectives that in this thesis have been placed under the umbrella labelled "equality feminism". Solutions to female underrepresentation and underperformance according to this understanding is, as previously explained, by and large a question of removing external obstacles keeping girls away from science, developing ways to persuade girls to choose science, and sensitising them about their equal abilities to succeed in this field (see chapter 2).

FEMSA recommends sensitisation of girls, teachers and the broader society to realise that girls are equally suited as boys to succeed in SMTE. Parallel to the sensitisation activities FEMSA does however, at least according to the Regional Coordinator, focus heavily on detecting "the special difficulties" girls have in learning science. The strong focus on detecting and explaining differences present in FEMSA's documents reflects an opposite view from what is prevalent in equality feminism, and hence corresponds with perspectives present within "difference feminist" perspectives. The attempt to detect and describe differences in males' and females' approaches to science education, reflects the underlying assumption that sexual differences has a strong impact on gender, or the social sex of individuals.

The consequences for the teaching of SMT of two different understandings of how sex/gender impacts on pupils' approach to science education, was discussed in the development of my analytical frame. If education is built around a perception that males and females are different, then one should try to accommodate these differences in the planning of initiatives aiming at gender equity. Sensitising strategies would, according to this approach therefore be insufficient, and fail to take the differences seriously. FEMSA, however, did not only adapt sensitising strategies, they also tried to detect and develop teaching strategies building on girls' special interests, abilities and experiences. An explanation to the adoption of both strategies could be an understanding of the obstacles facing girls as external, caused by cultural practices and not a result of girls' cognitive abilities. The repeated references to girls' special problems without a thorough explanation as to what they are does, however, result in a consequent double communication that was not dealt with and discussed in FEMSA: namely that girls and boys *are* different, that they must be handled differently, given different education, different attention, different methods for learning, but that they at the same have the same potential to engage similarly in science education as boys.

Other recommendations provided by FEMSA can also be seen as problematic and reflect contradictory understandings of actions needed to increase gender equity in science education. One such recommendation is:

- **FEMSA recommends encouraging girls to play more with boys' toys and recommends science education to be developed to account for girls' special interests.**

At first sight these recommendations do not necessarily seem incompatible. Still, they can be seen to represent two very different understandings of which actions are needed in order to increase gender equity in science education. The recommendation to increase the exposure of girls to toys normally played with by boys reflects a desire to develop similar experiences and interests among girls as those of males. Such strategies are by Eisenhart and Finkel (2001) described as "compensatory" strategies. They claim that such strategies tend to treat disadvantaged (in this context underrepresented and underperforming females in science education) according to their special needs, but only with the aim of enabling them to measure up to a standard already set by others (the high performing boys). The assumption is that gender inequity in science education could be solved if only the girls could learn to behave a little more like boys. In my mapping of approaches to gender equity in science education, I have placed such strategies within a gender-neutral approach.

The recommendations, also advocated by FEMSA, to base science teaching on the girls' experiences and interests might, however, be seen to represent a different approach to reach gender equity in science education. This approach, in contrast to the previous, recommends changing science education to account for girls' special interests and experiences instead of the other way around. Such recommendations have in my theoretical framework been regarded as possible implications of a female-friendly approach to gender equity grounded in difference feminist ideas.

- **FEMSA recommends the development of female-friendly teaching methods as well as a gender-neutral science education.**

FEMSA does not discuss the differences between a female-friendly and a gender-neutral science education. While "gender-neutral" science education is the concept most widely used in the Dissemination Reports produced as a result of the first phase, the Regional Coordinator uses "female-friendly" most of the time in the documents he has written. The concepts are used without specific definitions and without distinguishing the meaning of one concept from the other. It seems like the concepts in FEMSA are interpreted to mean the same thing.

By not being explicit about the project's understanding of the various concepts, the message communicated to the actors who were to carry out the interventions becomes unclear. The concepts could be interpreted in several different ways and hence enforce different and sometimes contradictory interventions in science education (see chapter 2). By not being more explicit about what type of initiatives FEMSA wished to promote, the interpretation of how this should be understood is left to the actors in the various countries. The evaluation of FEMSA after the project was completed showed that the different countries' Coordinators and groups did in fact interpret this in very different ways (O-saki & Bunwaree, 2003):

Although FEMSA had as one of its aims to draw from the life worlds of the girls to develop gender-sensitive science lessons, hardly anything was done in that direction. At best, some of the curriculum materials were re written in a less sexist language and more pictures of women and girls were inserted in school booklets. But gender responsive and gender-sensitive lessons did not form the core content of science curriculum and classes at some FEMSA centers (O-saki & Bunwaree, 2003, p. 9).

In most cases the efforts in FEMSA have been more up to what is described in chapter 2 as female-friendly strategies since the initiatives were targeted particularly towards girls. Remedial classes for girls were implemented in most of the FEMSA countries. Malawi organised special study groups for girls, while other countries sent the girls to science clubs and organised income generating activities to support the education of needy girls.

Although FEMSA's first phase showed that a large percentage of the boys did not succeed in science in the pilot countries, the focus throughout FEMSA has been on the girls, not on the poorest performers. This could mean that high performing girls would be given priority over low performing boys. Although some initiatives in FEMSA also benefited the boys, the girls were the group given priority in most FEMSA activities. The rather limited statistics presented to show the impact of FEMSA (O'Connor, 2002b) actually show in some countries a decline in boys' participation after FEMSA. The comments to the statistics do however focus only on the increase in girls' achievements and does not mention the rather disappointing results for the boys[45].

4.4.5 Conclusion

In chapter 2 I identified various understandings of how sex/gender might be seen to impact on science inquiry through a review of feminist critiques of science. The identified perspectives were used a basis to reflect over different understandings of how sex/gender might be seen to impact on how children engage in science education. I then suggested some possible implications for science education reform programmes aiming at gender equity operating within each identified understanding.

By using this analytical framework to study FEMSA, I have shown that perceptions can be found within FEMSA as a project that reflect understandings of females and males as similar as well as different in their engagement in science and science education. FEMSA also through its recommendations reflects attempts to promote some actions that would be characteristic to what I have described as a gender-neutral approach to gender equity in science education and some that would be characteristic of a female-friendly approach.

My conclusion after studying FEMSA is thus that the project does not reflect a unified understanding of how sex/gender impacts on how children engage in science education. This has resulted in what I see as some contradictory recommendations as to how gender equity could be sought.

In spite of these contradictions, my impression of FEMSA is still that the project as such as it is summarised and presented by the Regional

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[45] The evaluation of FEMSA in 2003 argues that the limited amount of statistics that are presented showing impact of FEMSA are both problematic, unreliable and misleading and that the explanations provided to the statistics are not plausible at all (O-saki & Bunwaree 2003, p. 24).

Coordinator, reflects a majority of difference feminist perspectives. The focus on girls only and the repeated references to girls' special difficulties indicate a perception of females as being different than males in how they engage in science. FEMSA also reflects an understanding of the differences between pupils of the opposite sex to be more important than the differences between pupils across sex divides. The fact that research documenting particular strengths and weaknesses of *girls* was presented as a major finding from FEMSA as the project was coming to an end (in spite the fact that the opposite perceptions were argued strongly by some of the Coordinators), further underpins the perceptions of FEMSA of males and females as different in their approach to science education.

On the other hand FEMSA does not reflect any understandings of science knowledge to be marked by the sex/gender of the researcher. No critique is raised within FEMSA against science for being androcentric and marked by its (mostly) male developers. My understanding after studying FEMSA is that the FEMSA actors regard scientific knowledge production to be unproblematic and that their issue of concern is to make this body of knowledge accessible to female science students. FEMSA therefore does not reflect difference feminist perspectives in terms of how they consider sex/gender to impact on scientific knowledge. I have identified no recommendations within FEMSA as to how the nature of science should be taught. Based on their unproblematic understanding of scientific knowledge production I would assume that the actors of FEMSA would not recommend that the nature of science was questioned in the manner that it is suggested by difference feminists.

Figure 2.6, displayed in chapter 2, shows how one particular understanding of the influence of sex/gender on scientific inquiry might impact on how science education is organised to increase the participation and performance of females and also for what image of the nature of science that should be reflected through science education.

My analysis of FEMSA indicates that this initiative reflects unlike perceptions of how sex/gender impacts on *children's* engagement in science education (mainly difference feminist perspectives) than of how sex/gender impacts on *researchers'* engagement in science inquiry (mainly equality feminist perspectives).

Some feminists and science educators who make use of feminist theories in their work claim that science education initiatives should be consistent in this regard. They have criticized science education initiatives targeting females for not critically challenging the perception of science as objective knowledge (Eisenhart & Finkel, 2001; Harding, 1992; Kenway & Gough, 1998). Critics argue that unless androcentric and masculine practices within science inquiry are identified and challenged, there is no purpose in recruiting more female scientists. Brickhouse (1994) argues that science needs to be taught in a way that enables students to understand its multicultural nature, its controversial character and its relationship to the world, so that their masculine image of science will be challenged and hopefully changed. Kenway and Gough (1998) and Eisenhart and Finkel (2001) explain the limited effect of science education initiatives targeting girls by pointing out the fact that they do not challenge the masculine discourse in science.

If the FEMSA actors believed that women would carry out a qualitatively better science inquiry than males, and a major aim of FEMSA had been to recruit more female scientists, it would have weakened the project that they didn’t recommend teachers to show the social influence on science knowledge in science education. The FEMSA actors did, however, not reflect strong beliefs in females as able to contribute something different from males in science inquiry. It is my understanding that FEMSA did not first and foremost aim to recruit more female scientists. Therefore the critique raised above, in my opinion does not necessarily affect FEMSA. I do, however, believe that it would have strengthened the project and developed more consistent and effective interventions if a clearer understanding of how sex/gender impacts on pupils’ engagement in science education had been expressed.

5. AFCLIST

5.1 Introduction

African Forum for Children's Literacy in Science and Technology (AFCLIST) is currently one of the major initiatives transforming science education in sub-Saharan Africa. After being started as a Grants Programme under the Rockefeller Foundation (RF) in 1988, AFCLIST eventually transformed itself in 2003 to becoming a Non Governmental Organisation (NGO) registered in Malawi and the USA. The focus of my study is to understand how AFCLIST addresses gender issues in science education. The purpose has been to study AFCLIST's understanding of gender inequity as a challenge to science education in sub-Saharan Africa and their agenda and recommendations to how this challenge could be addressed.

Although AFCLIST is not an organisation focused exclusively upon gender per se, the organisation has as one of its guiding principles that all its activities shall address gender issues. AFCLIST works to transform science education for the benefit of both boys and girls, with an understanding that improving the quality of science education will benefit girls as well as boys. Based upon its organisational mission, AFCLIST has therefore not developed "official" recommendations to how gender issues should be addressed. I therefore base this chapter on the documents describing AFCLIST in general, some articles written by persons in the AFCLIST network, a brochure where AFCLIST describes its focus on gender, and numerous interviews of the members of the AFCLIST network. I have also participated at a number of meetings and seminars arranged by AFCLIST where such issues have been discussed.

AFCLIST is a complex entity to understand. It has a range of different programmes, it supports a broad variety of projects, and it has developed and changed extensively over time. In order to understand how AFCLIST addresses gender issues, I will therefore give an introduction to the organisation in general before I move towards the main focus of how they address gender inequity in science education in sub-Saharan Africa.

I open this chapter by giving a brief overview of how AFCLIST has evolved and changed since it was started in 1988. I then present AFCLIST as it functions today, both in terms of current goals and working methods. In order to understand how AFCLIST addresses gender issues, I find it crucial to understand the overall structure of how the different programs of AFCLIST are set up to accommodate the organisation's "theory of systemic change". I will therefore present how AFCLIST believes that change in science education occurs and how it has organised its work to facilitate this change.

I then turn to focus on how AFCLIST addresses gender issues. I open this section by presenting the main initiatives AFCLIST has undertaken to address gender issues in particular. I thereby introduce the perspectives of twelve members of the AFCLIST network regarding gender issues in science education. To secure the greatest possible anonymity of my 12 Interviewees, I have chosen to name them after the 12 months of the year. October, November and December are all members of the secretariat.

Prior to becoming an NGO in 2003, AFCLIST was organised as a network of innovative science educators, whose understandings have been crucial for the initiatives undertaken in the various countries where AFCLIST was in operation. I have constructed the profiles of the actors on the basis of interviews carried out in 2002 and 2003.

After presenting the profiles of the actors, I present AFCLIST's analysis of challenges to science education in sub-Saharan Africa and their understanding of what factors are causing gender inequalities in science education. I thereby present the argumentation within the AFCLIST network for why this inequality should be addressed.

AFCLIST's approach to gender equity is then analysed through the lens of the theoretical framework developed in Chapter 2.

5.2 The development of AFCLIST

5.2.1 1988 – 1997: A project under the Rockefeller Foundation

AFCLIST was started as a grants project of RF in 1988 to address the low quality of science education on the African continent (Lewin, 1996, p. 11). Guided by recognized scientists, educators and media experts from Africa and elsewhere, RF decided that AFCLIST should be a small Grants Programme to encourage innovative science educators throughout sub-Saharan Africa (Lewin, 1996, p. 12). AFCLIST was to address the need to generate popular understanding in Africa among children and young adults of the principles and practical applications of science and technology. The premises under which AFCLIST operated were that:

> *1. Widespread appreciation of modern science and technology is essential to realizing the goals of science-led development.*
>
> *2. Learning about science and technology must be rooted in popular culture, stimulating people in their daily lives to reach out for labour-saving and health creating or income-generating devices and ideas and then to engage in adoptions, inventions, and applications.*
>
> *3. Such learning must begin early and inspire children to make the connections between text-and-test science and community-based improvisational science and its power of local-inquiry, discovery and application (Fabiano, Naidoo & Savage, 1997, p.3).*

It was later decided that AFCLIST should be a project under RF's Regional office in Nairobi. According to AFCLIST's secretariat (November, 2002), RF soon realized a need for AFCLIST to become more proactive in promoting the activity, and to do so, commissioned a part time consultant. A year later RF employed a Technical Assistant who had participated in the original formulation of AFCLIST to assist grants holders in developing their projects in their own respective countries (November, 2002). Although AFCLIST was a project under RF, emphasis was made to include a large proportion of African science educators in the development and governing bodies of the project (December, 2002). In 1989, AFCLIST set up an advisory board to help formulate policy and provide some distance between RF and the skeleton secretariat. Luminary African and international scientists, educators, and media experts constituted the board (Lewin, 1996, p. 12).

Between 1990 and 1997, AFCLIST continued as an activity of RF. During these years an increasing number of proposals were submitted to the secretariat. As a response to this and also as a means to depersonalise selection of projects, AFCLIST established a grants committee (November, 2002). The grants committee consisted of only African science educators (October, 2002). Increasingly the secretariat became engaged in visiting projects to provide a range of professional inputs, monitor their progress and to encourage further development of proposals (November, 2002).

Early in the 1990s members of AFCLIST realised the need to bring African science educators together to identify the main challenges facing science education in sub-Saharan Africa (November, 2002). The meeting was convened in Durban in 1995. African Science and Technology Education (ASTE'95), gathered 150 science educators, mostly from sub-Saharan Africa. The outcome of this meeting was an agreement amongst African science educators about the major challenges facing science education in Africa in the next millennium (Naidoo & Savage, 1998).

The ASTE meetings made recommendations for how these challenges should be followed up. The meeting recommended that the issues that emerged as the key challenges to African science education needed to be followed up by a central organising body such as AFCLIST:

> *Participants recognised that recommendations require systematic and persistent following up that can most effective be implemented by a Regional science education organisation such as the African Forum for Children's Literacy in Science and Technology (AFCLIST). AFCLIST has demonstrated its viability by the impact it has made on thinking and practice in African science education. ASTE '95 urged professionals, policy makers and donors to provide the support necessary to enable AFCLIST to continue to play the supportive and catalytic role necessary for science educators in Africa (Naidoo & Savage, 1998, p. 217).*

According to the technical advisor of AFCLIST, the Rockefeller Foundation, Advisory Board, Secretariat, and Grants Committee from the beginning had a shared vision of AFCLIST ultimately becoming an African-owned organisation, rather than an activity of RF. The challenges identified at the 1995 meeting in Durban necessitated a more focussed and intense action programme if a significant impact was to be made. In addition, establishing AFCLIST as an organisation based in an African institution would permit a broader range of actions than it had as an activity of RF, accountable to US regulations (November, 2002). The AFCLIST secretariat was therefore asked to advise RF on possible institutions that could host AFCLIST as a project. As a result, five institutions were evaluated. The University of Durban-Westville (UDW) in South Africa together with Chancellor College (CC) in Malawi was selected to host AFCLIST (Lewin, 1996; UDW, 1997). In 1997 AFCLIST became a project of the UDW, implemented jointly with CC initially funded largely by RF. This last grant (some US $1,000,000) from RF was to support the project's activities as well as to buy it time to broaden its funding base (Moock, 1997).

5.2.2 1997 -2002: A Pan African Initiative

Until late 2002 AFCLIST was an initiative of UDW and CC with a mandate to follow up the priorities identified at the ASTE'95 conference. The participants at the ASTE conference recommended that donors would support nodes or centres of excellence associated with AFCLIST to ensure capacity building throughout Africa (Naidoo & Savage, 1998, p. 217). The recommendation was to set up nodes focusing on curriculum innovation, policy research, teacher education, examinations, the media, teaching large classes and gender studies (Naidoo & Savage, 1998, p. 218). As a response to this, AFCLIST started rebuilding its structure to involve more than the original Grants Programme. A Nodes Programme was established to institutionalise on-going research for innovative and appropriate approaches in science and technology education as well as to pass such a culture to subsequent generations. A networking and a publications programme was set up to support these initiatives (December, 2002).

5.2.3 AFCLIST today

Organisational structure

AFCLIST is at present (2004) registered as a Non-Governmental Organisation (NGO) in Malawi and in the USA as AFCLIST USA, INC., a non profit organisation, to facilitate fund raising. AFCLIST is currently preparing to register as a NGO in South Africa and Brussels. AFCLIST currently organises its work through five main programmes: grants, nodes, publications, networking and impact programmes.

AFCLIST is still organised with a joint secretariat at the University of KwaZulu Natal[46] in South Africa and Chancellor College in Malawi. Each of the secretariats is staffed with a full time secretary. The two secretaries are the only AFCLIST actors who are fully employed by AFCLIST.

The governing body of AFCLIST is the board, still consisting of luminary science educators from different African countries as well as representatives from USA and Norway. The grants committee has five members, fully comprised of African science educators.

Goals

In 2003, AFCLIST expressed its agenda, in the form of a mission statement, the following:

> *AFCLIST's mission is to contribute to the social, economic, and political transformation of sub Saharan Africa through the promotion*

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[46] University of Durban-Westville was in January 2004 merged with the University of Natal to form the new Institution University of KwaZulu Natal.

of inquiry science and technology education with its scepticism, rules of evidence, passion for understanding the phenomena of the world, and application of that understanding to improving the quality of life (AFCLIST, 2003, p. 2).

The stated goals of AFCLIST cannot be seen in isolation from the organisation's formulated philosophy describing what AFCLIST beliefs should be done to reach its goals.

The AFCLIST philosophy of educational reform is based on capacity building and theories of organisational change as well as on a conviction of the importance of inquiry learning. It believes that nationals must be deeply involved in innovation for change to be sustainable and fit the economic and cultural realities of countries in sub Saharan Africa. Furthermore AFCLIST believes that a critical mass of staff from key educational institutions must be supported for extended periods for change to occur (AFCLIST, 1998b, p. 1).

The mission statement of AFCLIST states that the overall goal of AFCLIST is to "contribute to social, economic and political transformation of sub Saharan Africa". This goal should be reached through educational reform based on AFCLIST's philosophy of classroom learning. According to the AFCLIST philosophy, the changes should be sustainable and fit the economic and cultural realities of sub-Saharan Africa.

The outcome of the 1995 ASTE conference was the identification of five major challenges facing science education in sub-Saharan Africa (Naidoo & Savage, 1998). After becoming an independent inititative in 1997, AFCLIST has organised its work to address these identified challenges. AFCLIST has identified five contexts in where these challenges can be addressed. These contexts are the classroom, the schools, the local community, the education system and the society (Savage, Naidoo & Fabiano, 2001).

The overall aim of AFCLIST is to work towards "systemic reform" in science education throughout Africa (AFCLIST, 1998c). AFCLIST has developed a "Theory of systemic change" that describes how AFCLIST works to secure change in education systems. AFCLIST acknowledges that the resources they have at their disposal are limited and they thus have to approach the system in a different way in order to impact the system and secure change. AFCLIST's philosophy is therefore founded on the belief that this change is most likely to occur if one looks at the education system in a systemic (holistic) way and builds capacities within individuals to work towards changing this system (AFCLIST, 1998c).

AFCLIST's working methods

Through its different activities and programmes, AFCLIST aims at following up their "theory of systemic change". By first identifying how the projects can best work to impact the system and thus reach their goal of systemic educational change, AFCLIST has developed programmes designed to accommodate the different dimensions of the theory. Based on my study of the AFCLIST documents and my interviews with AFCLIST actors, I have constructed the following understanding of the different levels of AFCLIST's theories and the programmes set up to follow up the different levels:

AFCLIST theory of systemic change	AFCLIST programmes to stimulate systemic change
1. Identification and nurture of innovation	- **Grants programme** - proposal writing workshops - technical assistance
2. Adding value	- **Networking programme** - special skills workshops - visits by AFCLIST's secretariat - sponsoring participation in meetings and conferences - involvement in AFCLIST's secretariat activities
3. Extracting value	- **Publication programme** - sponsoring participation in meetings and conferences - networking - advocate meetings amongst grants holders - publications to teachers, other science educators and policymakers - web-pages - forming partnerships
4. Facilitating impact	- **Nodes programme** - encourage grants holders to use their experiences to impact the system (write textbooks, engage in educational systems and so forth) - forming partnerships - impact programme - develop master's study in science education

Table 5.1: How AFCLIST's programmes are organised in order to stimulate systemic change.

1. Identification and nurture of innovation

In order to increase project ownership and thus sustainability of the initiatives AFCLIST suppors, AFCLIST has chosen to support projects that already exist rather than to start new projects (Savage et al., 2001). The first level of AFCLIST's theory for educational change is thus to identify innovative science educators. These science educators should preferably be linked to key science education institutions in order to increase impact of AFCLIST and secure a solid research base for the projects funded (December, 2002). AFCLIST arranges project proposal workshops for applicants to grants and assists them in developing their proposals (Savage et al., 2001).

The main AFCLIST programme set up to identify and nurture innovation is the Grants Programme (Naidoo & Savage, 1998). The Grants Programme was the initial program of AFCLIST (AFCLIST, 1998a). Grants were given to action research projects with a potential to change practice. After AFCLIST was established as an independent organisation, it was decided that support could also be given to policy studies with a potential of leading to sustained change that would support inquiry, activity based science learning (AFCLIST, 1998a). The grants given in the initial stage of AFCLIST were in the order of up to 85 000 US$ (October, 2002). Since 1997 AFCLIST has distributed two types of grants, big and small grants where the big grants are no bigger than 30 000US$ (AFCLIST, 1998a). The grants committee recommends proposals for funding big grants while the small grants are distributed by the secretariat.

2. Add value to projects

AFCLIST has identified four principles basic to facilitating change. These are project ownership, a risk free environment, institutional linkages and technical assistance (Savage et al., 2001). By following upon the grantees through various network activities, workshops etc, AFCLIST tries to use the competencies and experiences from some actors in the network to benefit the others.

The major purpose of the AFCLIST network programme is to challenge, extend and support grantees' professionalism (AFCLIST, 2003). African science educators expressed at the ASTE conference a need to have arenas to meet within Africa. AFCLIST developed the networking programme to address this need:

Because even at that 95 meeting a lot of academics felt a total isolation and they kept on stressing this idea that you know the only way we meet with other people is outside the continent because we cant get a grant to meet on the continent. And we get invited to all these meetings. We get a grant from so and so and we go to another continent and we end up not talking about Africa. We talk about all these other continents. And then so what do you expect us to do, if we want to be invited we write on the issues that are not talked about in Africa. Because we don't want to be isolated (December, 2002).

The networking programme is based on the idea that it is important and inspiring for people engaged in improving science education to have the possibility of coming together and sharing ideas and experiences (Savage et al., 2001). It also creates an opportunity for African science educators to meet and discuss challenges facing science education in Africa. Through its networking program AFCLIST thus sponsors people to come to international meetings, conferences and workshops. Project staff has been sponsored to visit similar projects to increase impact. AFCLIST has also arranged several workshops for its actors in order to come together and develop certain skills or ideas such as action research methodology, print production, environmental education, gender issues and writing for publications. In order to increase communication amongst its different stakeholders and grantees, AFCLIST also has a web site. The secretariat contacts the different actors on a regular basis by e-mail and phone calls in order to inform them of relevant news and to keep reminding them of their AFCLIST membership (November, personal communication, 2003). On several occasions I have heard different AFCLIST actors referring to the network of AFCLIST actors as "the AFCLIST family".

3. Extracting value

A central idea behind AFCLIST's structure and organisation is that it is crucial to share knowledge and learn from each other. AFCLIST has various ways to extract value from their projects in order for the experiences to be used by others. Through meetings, sponsoring of participants to international conferences, internet pages and various publications, AFCLIST tries to spread information and lessons learned throughout Africa (Savage et al., 2001).

A main hindrance for African science educators also highlighted and discussed at the ASTE meeting in 1995, was the inability for them to publish their work due to a total lack of African journals resulting in African science educators writing for a western audience instead of an African context

(Naidoo & Savage, 1998). In order to publish in western journals, science educators from Africa have adjusted their writing to make it relevant for the western research community. According to December (2002), this has taken focus away from the challenges that face African science education and thus reduced the amount of relevant research that is carried out in an African context. The idea behind AFCLIST's publication programme has been to accommodate this problem by making it possible for African science educators to publish their work in publications focusing on an African context (Savage et al., 2001). Through its publication program, AFCLIST aims at increasing the possibilities for African science educators to publish their work without having to adjust to a research agenda set by western developing countries. In 2002 AFCLIST offered a grant and became an official partner of the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE). The aim of the partnership and the grant is to promote publication and reviewing/ mentoring skills throughout Africa (Rogan, 2002). Through this partnership AFCLIST hopes to:

> *1. Encourage new researchers in MST education on the African continent who have already done some research (i.e. masters or doctoral thesis), but who have not yet published their work, to become published.*
>
> *2. To develop new reviewers/mentors throughout the African continent.*
>
> *3. To develop a continental-wide database of new subscribers (both libraries and individuals) for the SAARMSTE journal "African Journal of Mathematics, Science and Technology Education" (Naidoo, 2002).*

As an initiative to reach this aim, AFCLIST and SAARMSTE in relation to the SAARMSTE conference in Swaziland in 2003, arranged a joint workshop in writing for publications.

4. Facilitating impact

AFCLIST wants to impact systems and promote systemic change within educational systems. Two programmes have been set up to increase sustainability of projects and to increase impact on a broader educational system, the nodes programme and the impact programme.

In order to increase sustainability and link projects closer to universities or governing educational bodies, AFCLIST has established seven nodes. The nodes are meant to be resource centres for research and development within the particular fields that were identified as the most challenging to science education reform at the ASTE meeting. The nodes have been established in order to extend the duration and impact of projects and to institutionalize the ideas within the universities. The aim of the nodes is that they shall be power centres serving all of sub-Saharan Africa with research and innovative ideas within the different fields of study. The nodes are hosted by Universities (Swaziland, Ghana, Malawi, South Africa and Zimbabwe) and governmental bodies (Zanzibar and Kenya). The nodes hosted by universities are all located at universities that already have ongoing research within the relevant fields. So far nodes have been established within the following fields of study:

1. Teaching science, technology and mathematics in large, underresourced classes, at the university of Venda for Science and Technology, South Africa and at Bindura University in Zimbabwe.

2. Linking school science and technology with science in industry and indigenous technology, at the University of Swaziland and University College of Education Winneba in Ghana.

3. Environmental science, at Chancellor College in Malawi and at National Teachers' Resource Centre, Zanzibar.

4. Examinations, in Nairobi, Kenya.

Through the impact programme AFCLIST tries to create connections between AFCLIST and the broader society. Through the organisation of impact workshops, different stakeholders are brought together to discuss how the AFCLIST experiences can be implemented to secure change in different contexts.

5.3 AFCLIST and gender issues

5.3.1 Introduction

I will now turn to focus on what AFCLIST has done in particular to address gender issues. AFCLIST is not a gender- and science education organisation, since its focus is to increase the quality of science education for all children. AFCLIST has thus chosen to focus on girls and boys equally. AFCLIST’s basic approach in addressing gender issues is to implement a gender focus in all activities instead of focusing on gender projects in particular. They argue that choosing to focus on one problem over another, results in losing the holistic picture of all the issues that need to be addressed.

Still, AFCLIST has included as a basic principle that all the activities AFCLIST supports shall address girls. In the following sector of this chapter, I will present AFCLIST describing why and what it has done to address gender issues. I also try to establish an understanding of the perspectives of different members of the AFCLIST network regarding their understandings of why and how gender issues in science education should be addressed.

5.3.2 AFCLIST initiatives that address gender inequity

1. AFCLIST adopted as a "guiding principle" that all its activities shall address gender issues

AFCLIST has established as a guiding principle that all AFCLIST funded projects should address gender issues. All grants proposals must outline how they are planning to address gender issues (AFCLIST, 1998c). By this AFCLIST seeks to mainstream gender issues into all its activities by applying as a guiding principle that "all projects should address gender issues" (AFCLIST, 1998c).

According to my interviews with members of the AFCLIST group, the guiding principle of addressing gender issues in all AFCLIST's activities does not seem to be integrated in the AFCLIST activities. Although all of the actors interviewed said that they believe that gender issues were important and that they believe that AFCLIST has this as an important focus, very few could give me examples of how they themselves "addressed gender issues" in their own work.:

> *There is nothing that I can think of that we do to address gender issues. I would just like to say that we have not really done anything of it in terms of programmes and encouraging girls and all other things, because our system already does that (Swaziland).*
>
> *In our project we did not focus on girls (Malawi).*
>
> *Our project didn't really have a gender focus (Swaziland).*
>
> *It is not a focus unless I see it when I observe (Venda, South Africa).*

None of the actors I interviewed from the different nodes said that they had focused on gender issues specifically. On my request to whether my interviewees had discussed gender issues within their local AFCLIST node, seven representatives from three nodes (Swaziland, Malawi, Venda) say that they have never discussed gender issues within the group. The three quotations are drawn from the three different nodes I visited:

> *No, not here in my group. In my project we did not focus on girls (Malawi)*

> *No, never. I don't think it has ever been an issue (Venda, South Africa)*

> *No, never (Swaziland)*

It is not stated clearly anywhere in AFCLIST's documents what AFCLIST means by "addressing gender issues". What they are clear about in this regard is that gender issues should be seen as an integrated part of all the projects and not in isolation from AFCLIST's other activities. As I shown in Chapter 2, there are ranges of different ways to "address gender issues". By not providing guidelines, AFCLIST has hence left to the different actors to decide in what way they believe gender issues are best addressed. I will later show how the AFCLIST actors have different understandings of what it means to address gender issues in science education.

2. AFCLIST conducted a gender analysis of its written documents

In 1999, Stella Erinosho conducted a study of AFCLIST's publications in terms of the each document's gender sensitivity. Erinosho's article, "Towards making science accessible and friendly for all: A gender analysis of some supported initiatives", reported that of all the AFCLIST initiatives she analysed, only one was what she called "gender-sensitive and gives recognition to the image of women in science" (Erishino, 2001a, p. 98). The other publications were found to have an overrepresentation of men, both in illustrations and editing bodies. They generally portrayed females in passive or gender stereotypical roles, and some had examples of masculine language. Erinosho's conclusion was that:

> *While one may conclude that AFCLIST has supported relevant initiatives that incorporate interventions towards making science friendly to African children, it has yet to strengthen the gender components of some of these programs. The stereotypic perception of the role and status of women in relation to science is still being perpetuated in a subtle form in many of the initiatives that were reviewed (p. 98).*

Based on her findings, she offered several recommendations to AFCLIST, as follows:

> *(…)AFCLIST must therefore see itself as an important contributor to change and strengthen the image of women in science. Therefore as part of the way forward in science education "into the next millennium", AFCLIST should be supported to implement the recommendations of the ASTE meeting for the establishment of a node for gender. Of the importance in this regard is the need to:*
>
> - *Monitor gender equity within AFCLIST and in the science and technology system in Africa.*
> - *Develop and execute gender sensitisation training;*
> - *Identify and set up priorities and an agenda for research and development;*
> - *Develop, execute and research demonstrative gender interventions; and*
> - *Establish a resource centre for gender equity that promotes networking and dissemination (p. 98).*

In addition to the recommendations above, Erinosho recommended a closer link between indigenous and every day knowledge in order to make science education more relevant and applicable to girls (p. 99).

3. AFCLIST strives to ensure female representation in its governing bodies

> *AFCLIST strives to ensure that women are well represented on its governing bodies (AFCLIST, 1998c).*

In AFCLIST's own descriptions of what they have done to address gender issues, they often highlight that they have a policy of having equal numbers of males and females on boards and in the administration. While they have succeeded fairly well in securing an equal number of females on boards, the administration is still 100% male dominated. All the members of the secretariat are men, and both the full time employees in AFCLIST are also men.

Securing an equal number of men and women in governing bodies is a common move for organisations to make in order to secure gender equality. This action can reflect an understanding that securing an equal number of men and women in itself is a way to secure gender equity. It can also reflect an understanding and belief that women will consider different things, and be more consistent about gender issues than men. AFCLIST does not provide any explanation as to why they regard equal representation of males and females to be a goal. Since they tend to highlight this whenever describing what they have done to address gender issues, it is plausible to assume they do believe that it would have a positive impact on their work to secure gender equity in the organisation beyond the fact that equal numbers might be regarded to be a goal in its own right.

My interviews of the AFCLIST women do not give any indication that they, because of being women, are more concerned about gender issues than males. A common feature among the AFCLIST women is that none of them say they have experienced any problems in being women choosing science (July, 2002, March, 2002, August, 2002, May, 2002). They all say they performed above average in science in school. None of the female actors I interviewed said they found science particularly difficult. One of the actors says she was given the same opportunity as her brothers to attend school, but that she ended outperforming all the boys:

> *From my own experience I grew up in a community that was not quite traditional but the traditional ideas that were there were quite strong. But it was also kind of modern in the sense that, you know, girls were no longer expected to be supported. You could go out and work for mammon. Become a teacher.. So you could all those things that in that particular sense. And when we started going to school we were all sent and well, I outperformed the boys. So I am the only one who has come this far (June, 2002).*

One actor who went to a girls' school says she therefore was never given the impression that girls were any less able than boys to succeed in science. She still suspected that the boys were getting a better education in this subject, although she did not know that was the case:

> *I went to a girls' school. I was interested in science. I did very well in science, but I don't think they ever highlight that there was something special about science and that it was not for girls. That never really occurred to me. What I had in my mind was that generally we girls perform worse than boys. Being at a girls' school I wasn't very confident that we were getting the best. Because we thought that the kids in the boys' school were getting much more than what we were getting. So I worked extra extra hard. Because I never had that confidence to say that what we are getting is not as good as what the boys are getting. But I didn't have that notion that girls can't do science (March, 2002).*

Several of the interviewees that did not attend single sex schools said that they were one of very few girls to choose science, but that this didn't have any impact on their performance. The female actors in AFCLIST seem to share an ability to tackle discriminatory attitudes directed at them from their teachers:

> *When I was in high school I loved physics. And our teacher used to say: OK girls, stand back. The boys will do the experiment and girls take your notebooks and you will write results. The boys are going to tell you what they see and you write. As much as we wanted to handle things we were not permitted. And our teacher was a male teacher at that level (July, 2002).*

Several of the AFCLIST women told me they had been one among very few females studying science at university level. They were however not affected by the fact that most of their fellow students were males:

> *I never thought that science was for boys and I never had difficulties. Yes, I think that even when I went to college there were actually two girls doing science. Myself and Elizabeth. (…) I took physics, she took mathematics and something. So in my subject I was the only girl. But I wasn't so self-conscious that I was the only one. I went to class I came out and that was it. The only thing that I now find funny is that in student pairs there were two of us. So it had to be a boy. We were working together. We would start out very well but we always ended up quarrelling. (laughs) I don't know why that used to happen.*
>
> *But you never thought that "Hi, I am the only girl around here. Why aren't there any other girls?" (interviewer)*
>
> *No, I didn't.*
>
> *You didn't? (interviewer)*
>
> *No (laughs) after all there were only two of us in the science so…*
>
> *(March, 2002)*

The fact that she was the only girl in science clubs, and that the fellow students would tell her they did not think of her as a girl, did not stop August from continuing her science studies:

> *You know my only experience; I never experienced gender differences, in the treatment of girls and boy (…) because I was a tomboy. So people (i.e., my former classmates at secondary school) would say, "Hey, we never thought of you as a girl." Hahaha (…) I was always the only girl in the Science Club. I mean I never saw any barriers in terms of what I could do (August, 2002).*

All the female AFCLIST actors seem not to have been affected by the obstacles that have impacted negatively on the participation in science education of other females in their context. They do not seem to be very conscious about gender issues in their work either for AFCLIST or in their work as teachers:

> *Now I must admit I am not one of those who think so much about the () for male/ female. And that is since my experience has always been that I just want a good education system, I don't have this need to focus on the one group. And I think that is because I have grown in a situation where there has been equal knowledge. So I can't say, this is what should be done for girls, although this latest result showing that they are not performing well compared to boys. It is a clear indication that one has to start thinking about it (May, 2002).*

> *While I was teaching I would plan and say oh this is exciting and then go and teach. I would not be thinking; exiting, is this exiting for girls or boys or just exiting? (…) I thought biology was interesting. And if I should try to convince people to study biology, I would just say, "Hey! Can't you see this is fun? Hahaha (August, 2002)*

Judging from the interviews of the female actors in AFCLIST, it seems like the organisation's policies of securing equal number of males and females in boards and administration has not necessarily led to a greater awareness of gender issues in the organisation. My study of AFCLIST indicates that the secretariat is important deliverers of premises of AFCLIST, and strongly influences the organisation's ideas and policies. If AFCLIST regards the policy of having equal numbers of female representation as a tool to secure gender inequity, it is hard to understand why more effort has not been taken to reduce the inequalities in the administration.

4. Cooperated with other institutions that promote gender equity

Cooperation with FEMSA

AFCLIST has on several occasions cooperated with FEMSA. AFCLIST's Deputy Director has represented AFCLIST in FEMSA's Consultative Group. One of the members of AFCLIST's grants committee was also a Country Coordinator of FEMSA in Uganda. But the cooperation between FEMSA and AFCLIST has not been without conflicts. Much of this conflicting situation seems to have been caused by competition for funding. FEMSA was established at a time when AFCLIST, according to my interviewees, had decided to focus more intensely on gender issues through the establishment of a gender node. The node was recommended by the ASTE conference as a way to accommodate the gender disparities that were identified as major obstacles to science education in sub-Saharan Africa.

According to Norad and their consultant on science education issues, Professor Sjøberg, FEMSA was never set up as an alternative to AFCLIST. The donors considered AFCLIST as an organisation isolated from FEMSA and with a different purpose and target group. “But we could not see the point of them setting up a node on gender when we already had FEMSA” (Volan, 2002). Volan claimed that Norad would not have supported AFCLIST were it not for Professor Sjøberg’s contacts and strong recommendations, although she did approve of AFCLIST’s writings and basic ideas.

According to the secretariat, AFCLIST did, however, feel that FEMSA was set up using many of AFCLIST’s basic ideas, but without informing AFCLIST about the establishment of FEMSA:

> *Indeed, much of the draft FEMSA establishing document was directly taken from those of AFCLIST (November, 2002).*

According to the AFCLIST secretariat, there was tense disagreement and confusion between AFCLIST and FEMSA about their roles in dealing with gender issues on the African continent. AFCLIST, according to November, felt that they were ‘persona non grata’ on gender issues as these should be handled by FEMSA:

> *I felt under pressure during the whole FEMSA affair to pay no more attention to gender issues (November, 2002).*
>
> *And one of the reasons we have haven’t gone in as much as we wanted (to work on gender issues- my remark) is because people have said no, this is a protected area (October, 2002).*
>
> *In fact in the earlier agreement on gender, we felt that AFCLIST wouldn’t do so much gender work. That it would be primarily FEMSA’s role and that we would pass on gender proposals to them whenever we got them (December, 2002).*

The tensions were resolved by the production of a position paper (AFCLIST, 1995) clarifying the roles of the two initiatives, and legitimising each initiative’s unique role. According to the deputy director, AFCLIST also realized that due to the limited resources in Africa, the organisation could not avoid dealing with such important issues as gender differences in science education:

In the reality we can't deal with the science and technology education without dealing with the gender issues because the child in the classroom is not a boy or a girl, it's a mix of the two (October, 2002).

In 2001, AFCLIST and FEMSA arranged a joint workshop in Nairobi on gender issues (See chapter 3). The purpose was to learn from each other's experiences and sensitise each other about what the two projects had done on gender issues. Unfortunately, this workshop was arranged at the time when FEMSA was taken over by FAWE. There was considerable uncertainty amongst the FEMSA delegates about its future, and possibilities for planning further cooperation between FEMSA and AFCLIST on gender issues was limited. After the workshop, AFCLIST approached FAWE with a request to write a joint report reflecting on the workshop's outcomes. FAWE turned this offer down, leaving the report to be written and printed by AFCLIST (Naidoo et al., 2002).

Cooperation with Gender and Science and Technology (GASAT)

AFCLIST sponsored and monitored four women who presented papers at the GASAT Africa conference in Lilongwe, Malawi in 1997. The papers presented were drafted at an AFCLIST meeting. The AFCLIST staff also assisted the presenters in the editing and printing of these papers (AFCLIST, 1998c).

5. AFCLIST has produced publications on gender and science education[47]

In 2001, AFCLIST published a collection of papers dealing with gender issues. The papers have all been presented at international conferences (GASAT conference in Malawi in 1997 and GASAT 9 conference in Ghana in 1999). The ten papers were written by six persons who where all supported by AFCLIST to present their papers at these conferences (Reddy, Naidoo & Savage, 2001).

[47] After I had completed my analysis of AFCLIST's text, a new book with a chapter on gender issues (Mulemwa, 2004) has been produced by the organisation. The book is a resource book for science educators (AFCLIST, 2004). I have not included this publication in my analysis of AFCLIST.

6. AFCLIST has arranged science camps with a minimum number of girls

AFCLIST started arranging science camps in Zanzibar in 1989. The science camps required that 50% of the participants had to be female. According to AFCLIST (Savage et al., 2001) these camps have had major impact on many of the girls who have participated in these camps, and given them an opportunity to engage in science in spite of traditional cultural expectations normally placing restrictions on what activities females are expected to enrol in. In an interview, the technical advisor of AFCLIST mentioned the science camps as the AFCLIST activity he was most proud of in terms of its impact on female participation.

7. AFCLIST has produced brochure named "AFCLIST and gender equity"

AFCLIST has produced a brochure describing AFCLIST's policies and activities focusing on gender (Savage et al., 2001). This brochure describes the relevance of AFCLIST's work through the lens of what impact it might have on gender equity in science education. The brochure describes the different contexts AFCLIST has identified as to where change occurs (e.g., classrooms, schools, local community, education system, and the broader society) and argues that more research is needed to better understand how these contexts influence female participation in science. The brochure argues that research is needed that questions the relevance to Africa of research and assumptions regarding girls' approaches to science which have been carried out in other contexts:

> *(…) Endless assumptions are made at all levels in countries of sub Saharan Africa on the capabilities of girls; the impossibility of using examinations to promote inquiry learning, of doing so in large, under resourced classes; the lack of science and technology in the lives of African children. AFCLIST and similar organisations are causing educators to increasingly question these and other assumptions (Savage et al., 2001, p. 12).*

In this brochure AFCLIST describes what they believe are the appropriate "tools of change" to secure gender equity in science education:

> *To improve girls' participation and performance in science and technology in countries of sub Saharan Africa, we must identify those conceptual tools that most effectively contribute to change. We argue that these tools are research defined as acquiring and analysing information significant to the identified educational*

> *contexts; theory building that leads to a better understanding of the dynamics of those contexts; and an application of this understanding that leads to systemic change. AFCLIST further contends that it is imperative that these tools become part of, and institutionalised by the countries with whom it works since they, not AFCLIST, will be the actors. To use an analogy from science, no outside agency can hope to be the reagents in systemic change; they can only be the catalyst (Savage et al. 2001, p. 14).*

AFCLIST also positions itself in relation to FEMSA, however without providing any description of FEMSA. The brochure comes across as a rather fragmentary position paper describing AFCLIST's ideas about gender issues.

8. AFCLIST develops a Master's study in science education where gender inequity is developed as one of six modules

In 2003, AFCLIST started developing a master's study in science education that is supposed to be implemented in several universities in sub-Saharan Africa. One of six modules in this study is to focus on equity and development. At the first workshop discussing the content of these modules, AFCLIST identified gender inequity and HIV/AIDS as the major factors having a negative impact on equity and development in sub-Saharan Africa. It was decided that the module should be developed to focus on these particular aspects. At the present the module is still being developed (October 13, 2004).

9. AFCLIST facilitated a debate on gender in science education for the Mozambique Minister of education

The workshop to start the work on the development of the Master's study was arranged in Mozambique in 2003. In the course of this workshop, the Minister of Education in Mozambique requested that AFCLIST facilitate a workshop on gender issues in science education. At this workshop actors involved in AFCLIST were requested to present their analysis of what caused female underrepresentation and underperformance in science education and how this situation could be addressed.

5.3.3 Actors' perspectives on gender issues

The profiles of the AFCLIST actors regarding their perspectives on gender issues have been established on the basis of interviews carried out in 2002 and 2003. These actors are in different ways connected to AFCLIST. Some of them as grants receivers, others as members of the different AFCLIST nodes. I have also included profiles of the three members of the AFCLIST secretariat (October, November and December). All the members of the AFCLIST network that I present here (except for the technical advisor) are engaged in AFCLIST in addition to holding full time jobs. The work they do for AFCLIST is done mostly on a voluntary basis. Several of the actors became engaged in AFCLIST through applying for a grant and have later kept the connection to AFCLIST in various ways. None of the actors I present here have received grants to focus particularly on gender issues.

January

January believes it is important to have more females involved in science. If more females were involved in science, this would benefit the environment in a positive way, it would improve food production and the quality of child rearing. It would also benefit the girls to learn about sexual education.

January is not so sure whether women would advance a different science than men. He says they might focus on different things due to their different backgrounds and will also perhaps be more detailed in their work as he has seen the tendency for girls to be more detailed when being engaged in science in school. Still he doesn't believe that we would have a very different science if more women were involved.

He says he believes the reasons for girls' underrepresentation and underperformance in science education might have to do with the fact that girls tend to shy away from areas they find difficult and that girls generally tend to find science more difficult than boys.

In order to get more girls involved in science education it therefore becomes important to support girls particularly, give them extra attention and guidance and be very tolerant and patient. Teachers should adapt a "motherly teaching approach" towards the girls. He says that in order to have more girls become interested in science it is important to use more group work and seek to demystify science by bringing in science that appears relevant to girls by emerging from contexts the girls are already familiar with.

January thinks that AFCLIST has a strong focus on gender issues. All the projects AFCLIST support have to address gender issues and all the project proposals have to show how they are to address girls in their work. He says that they have never discussed gender issues within the node. Still he feels that they address gender issues, although not directly, by addressing environmental education since this will also benefit the girls.

January says that the literature he has read about gender issues is basically drawn from the book “ABC of gender”.

February

February believes it is important to have more females engaged since they represent 50 % of a country’s human capability. He also sees it as a right for boys and girls to be given the same opportunities. He says that according to feminist theories, women would advance a different science. He finds the argumentation within the feminist critique very convincing. He believes that more female scientists would have a positive impact on science as research topics would be more balanced according to what men and women find important.

February says that in order to increase the access of girls to science, one has to begin to think differently about school logistics. The governing bodies have to make sure that there is an equal amount of boys’ and girls’ schools in a country so that girls have an equal opportunity to access science education. In his own country this would mean having to build more secondary boarding schools for girls as there are now more places allocated boys. February believes that the same science content can be equally interesting for boys and girls, but that it is important that the teachers vary their teaching approaches in order to accommodate boys and girls. Teachers should adapt more girl-friendly teaching methods. An example of more girl-friendly teaching methods would for instance be for the teachers to focus less on war and arms production in science.

February believes that AFCLIST has a strong focus on gender issues. He has been told that AFCLIST has appointed a special person to watch the gender aspects of the proposals.

February says he has addressed gender issues in varying ways through his work supported by AFCLIST. He says he once wrote a paper on gender issues for a meeting arranged by FEMSA. He says that their project aimed at having an equal number of men and women in their committees, but all the women dropped out. In his current project where he looks at the role of stories in science teaching, he makes sure that the stories should be equally interesting for boys and girls, for instance by including stories about female scientists like Marie Curie.

February has read feminist literature, and mentions writers as Harding, Keller and Mc. Clintock.

March

March thinks it is important for more girls to be involved in science, as it will increase their live chances and job opportunities. It would also enable them to take part in the world of decision-making and would be helpful in the management of their own lives.

March believes that women would advance a different science since they are much more practical than men.

She says that girls tend to love science in lower grades, but tend to lose interest in science as it becomes more theoretical and focused around memorizing and rote learning, Girls generally seems to have lower self confidence in their own abilities in science than boys tend to have.

In order to increase the participation and performance of girls in science, March think it is necessary to avoid gender discriminatory attitudes in science classes, have more group work, use more gender-neutral examples and generally try to accommodate girls interests in the teaching of science.

March says that her impression is that AFCLIST has never focused on gender specifically. There has, however, always been gender awareness in projects supported by AFCLIST. She says that her impression is that AFCLIST addresses gender issues through increasing the general quality of education for both boys and girls. March says that she has never discussed gender issues within an AFCLIST context. In her own work supported by AFCLIST, she addresses gender issues through collecting gender segregated data and by being conscious about girls' and boys' interaction with each other in the classes she works in.

March says that she has never read any literature about gender issues in science, besides the basic readings in science education.

April

April believes it is important to have more females involved in science as he believes that it would benefit the country if more people were scientifically literate. If there were more female scientists, there would also be more female role models, which again would show more girls that it is possible for them to engage in science. He does not believe that women would advance a different science than men.

In order to have more girls interested and performing in science you have to increase the general quality of science teaching April says. He shows that this is possible through his science clubs where there are actually more girls than boys involved.

April thinks that AFCLIST has a strong focus on gender issues and that all the projects AFCLIST supports have to be gender sensitive. He thinks AFCLIST does enough to address gender issues.

April has not read any feminist literature about science, but he has read the gender publications from AFCLIST written by Vijay Reddy and Jane Mulemwa. He thinks this literature is “very very wonderful stuff”.

May

May says she is not one of those who tends to think so much about the distinction between males and females. This is because she has grown up in a society where females have equal access to education. Still she now sees the importance of increasing the performance of girls in science, as research has shown that although girls in Swaziland have equal access to education they tend to perform worse than boys in science which again implies a lower participation rate of women in science at tertiary level. She thinks it is important to increase girls’ possibilities to engage in science because girls and boys should have the same opportunities. May says she never thought about whether men and women would advance a different science.

May says it is difficult to say yes or no to whether AFCLIST has a strong focus on gender. She says that her impression of AFCLIST is that the organisation has never seen girls issues as more important than other issues challenging science in Africa, like for instance linking school and industries closer together. She thinks that AFCLIST’s focus is sufficiently strong on gender issues. AFCLIST has raised the consciousness about this issue among the actors of the network. Within her node, they have never discussed gender issues. Still, she says, gender issues are being accounted for within the node although not being subject to academic discussions. As an example, they try to use an equal number of he and she in their publications and they also show women in roles that are traditionally associated with men in their publications.

May says that she had not heard about feminist critique of science until she heard about it from me for the first time at the gender meeting in Nairobi in 2001, but that she did find it very interesting as “it really makes one think”.

June

June thinks it is important to involve more females in science for different reasons. Not only is it important for the economy of a country, if more females gained access to science it would also have a positive effect on food production and other aspects of the home.

June believes that it would impact scientific inquiry if more women took part in science. She says that at present women’s voices are not being heard within scientific communities. She believes that women tend to be more caring and that this would impact what kind of science they would advance. She believes that women, in their scientific inquiry, would tend to take the needs of the family into consideration, and not as many men produce scientific knowledge and technology only for the sake of the production.

In order to increase the participation and performance of girls in science, she says it is crucial to sensitise the teachers, the girls and the boys. The teachers should not allow the girls to ‘take the back seat”. June says research and her own praxis has shown that girls perform better in science if they can see the relevance of what they do. It is therefore important that the teachers’ recognize what the girls already know and try to make the “exotic” science relevant to girls by linking it and recognizing what the girls already know.

When it comes to AFCLIST’s gender focus, she says that she does not know how strong a gender focus AFCLIST has, but that they definitely have a focus on gender issues. Their agenda has always been to increase girls’ participation She believes that AFCLIST’ s agenda is broad enough to allow for a strong gender focus, and that it would be limiting if AFCLIST focused on that aspect alone since there are so many other things that are also important. She does however admit that they might have done more within her node to address gender issues. June says she has never addressed gender issues within the node. The reason why they have not addressed gender issues is that there has never been a gender bias in access to education in her country. Although they don’t address gender issues formally through the node, she says that each individual within the node is conscious about gender issues both in the collection of data for the node and in supporting female students in their work at the university.

Without being able to remember exactly what she has read, she says that she has read a lot around the issues of gender and science. She thinks that much of this writing tends to go to the extremes.

July

July sees a lot of reasons why it is important to include more females in science. First of all, having access to science increases the girls' opportunities. As the whole word depends on science, it is important both for the girls themselves and the development of the countries that girls have the opportunity to participate in science. Females are the main socialising agents as they in most cases are in charge of what is happening in the homes. Because of the important role they play in the home, the possible impact of teaching more girls science is huge. More science skills amongst women would potentially have a positive impact on diet as well as the cultivation of a country.

July is not really sure whether it would change science per se if more women were involved. She believes that science is objective and truth is truth no matter who discovers it. The way you get to this truth might however vary. She does however say that she believes that the humanity of research might benefit if more females were involved as she believes that women look at the world in a slightly different way than males. She believes that women are more likely to utilize good scientific knowledge than science for its own sake.

July believes that the reason why girls tend to perform less well than boys in science is that science education accommodates and builds on the boys' experiences more than that of girls. Science has for a long time belonged to the world of men and teachers tend to be little sensitised only to a small degree concerning gender bias in science education.

In order to increase girls' participation and performance in science, she says it is important to ensure that research matter is accessible and related to the girls' prior knowledge. She says that by focusing on improved quality in science teaching one also targets girls. The girl child however needs some extra attention since she has been underrepresented in science for such a long time. In the process of targeting girls it is necessary to teach science according to what is familiar to them.

July says that since AFCLIST is aiming at popularizing science for all children they are also addressing girls. She does not know how much AFCLIST addresses girls in particular. She has never discussed gender issues within the node and thinks that they should have focused more on these issues, but that presently they are doing as best they can simply to get the AFCLIST work done. Addressing girls was not an intentional focus of their project. She does, however, believe that the work they do within the node by linking science concepts closer to the daily lives of the pupils, will also benefit the girls. In that way the gender issue becomes a “by-product” of the node’s work.

July has read on the issues of science education and girls. She has however never read any of the feminist critique of science, but she is interested in getting references from me so that she can start reading within this field.

August

August believes it is important for girls and women to become scientifically literate in the sense that they can both use and construct science, She does not believe that women would advance a different type of science when compared to men, but she does think they might interpret their results in a different way. For example, would one by sending women to space be able to get a female perspective on space. She believes that women would be more likely to focus their scientific activities around issues of relevance for life at home and less around issues of relevance to warfare.

August believes that the underrepresentation and underperformance of girls in science has to do with the socialization of girls in society. Girls are brought up in a strong hierarchical structure to respect their fathers and other males. She also says that the reason why girls are underrepresented is that they are actually given a choice whether or not to study science.

August believes that the same curriculum can be of relevance for both boys and girls. In order to make science education appear relevant for boys and girls however, one must consider carefully what teaching methods would appear interesting for boys and girls and not take for granted that the same methods are equally interesting for both boys and girls.

August says that AFCLIST has a strong focus on gender issues. She says that all projects must ensure gender balance and she believes that I will be able to see that in all the work AFCLIST does. She particularly points to the fact that in the work AFCLIST does to address indigenous knowledge they are very cautious also to make sure to include the knowledge of women. She believes that AFCLIST, instead of establishing a special node on gender issues, should make sure that all the projects address gender issues.

In her own work for AFCLIST, August says that gender is not a focus unless she sees it when she observes in classrooms. She says she is not a person who thinks in categories. In her practice with teachers, she is however aware of how they address girls in their teaching practice.

August says that she read a lot around gender issues and feminist critique of science when she studied for her PhD in USA. It has however not impacted her in any particular way, because “I do what I do”.

September

September says that girls should not be pushed into science unless they want to learn it. If they can cope with it, then they should be encouraged to do science. He does however think that we need many people with scientific skills and therefore everybody should be encouraged to learn science. “We live in a high tech world”, he says, “everything depends on science these days”. Everybody capable of doing science should therefore pursue it in order to develop the nation. He does not believe that women would advance a different science than men.

September says that there is a long way to go to reach gender equality in science education. Girls are being brought up to take care of children and not to pursue science. He believes that girls need extra encouragement in order to take up science; this is however only a question of persuasion. Neither the content nor the methodologies used in science classes need to be changed in order to make it more interesting for the girls.

September believes that AFCLIST has a strong focus on gender issues. He says they produce a lot of publications focusing on gender and that they highlight the dangers of discrimination. He says that it is his intention to address gender issues in his work for AFCLIST, but he has not yet come this far. He has never discussed gender issues within an AFCLIST context, including the node he is connected to.

September has read the AFCLIST publications focusing on gender issues but has never read any feminist critique of science. He is generally sceptical to the feminist movements as he thinks feminists tend to go to the extremes. “No happily married woman tends to be active in these types of organisations” he says.

October

Girls have been lagging behind for so many years that it is important to give them some extra attention in order to increase their performance and participation in science education, says October. This is important both at an individual and developmental level. From a developmental perspective females form an important part of a country's human capital. At an individual level increased scientific skills among females are important for the general household maintenance, nutrition and so on. October says he is not to sure that women would advance a different science, but it might be at an individual level in terms of utilising scientific knowledge differently.

Girls in sub-Saharan Africa generally have less access to science than boys. There is also a perception among girls that science is very difficult. The perception that science is difficult has a different effect on boys than on girls because boys are brought up to be competitive. However, choosing to focus on science is a sacrifice both for boys and girls, since it does require a lot of work.

Gender equity in science education can be addressed at different levels, October says. At one level one can seek to have pictures of girls and boys in atypical gender roles. At a deeper level one can change the syllabus to account more for girls' interests. Basically he believes that attracting girls to science is more a question of presentation than of content.

October says that AFCLIST started supporting projects based on how innovative they were, and not based on their gender focus. Later AFCLIST decided that every proposal submitted had to address gender issues. He says that he believes AFCLIST would have done more to address gender issues if it was not for FEMSA. Gender issues have been a "protected area" because of FEMSA and FAWE, he says. He says there is a need for AFCLIST now to collect and analyze everything AFCLIST has done on gender in order not to replicate research that has already been carried out.

November

November believes it is important to recruit more females to science education both from a family maintenance level point of view as well as for the impact on the informal economy. He doesn't personally believe that women would advance a different type of science than men, although he is open for the possibility since different people do focus on different things.

November says that there are a number of reasons for why girls are underrepresented and underperforming in science education. It has to do with the whole system from society to schools. There is a strong gender bias at the grass root level he says.

November claims that in a properly organised classroom, gender issues is not a problem “I swear to God it’s not!”. He therefore sees dealing with gender issues as a second priority after getting other things right. Still, he admits that even in a well-organised classroom, the teacher can unconsciously behave in a gender-biased fashion. In that case the teachers need to be sensitised to involve the girls instead of ignoring them. He believes the same curriculum can be relevant for both boys and girls; it is a matter of securing high quality inquiry based teaching. November believes that in order to diminish the gender bias in girls’ participation and performance in science education the school culture as well as the local community has to be targeted.

Gender issues are according to November a subsidiary objective for AFCLIST. But a “very very important second priority”. He says that AFCLIST has been funding gender projects since its inception and would have done a lot more on gender if it were not for the conflict with FEMSA and FAWE.

December

December thinks it is important to increase the participation of females in science and science education. Women, besides being significant players in the home, form the bulk of 50% of a country’s human capital, he says. If a country is to develop, women can’t be left out. December says that it is impossible to know whether women would advance a different science than men, and that it is impossible to make any claims in this regard since nobody knows about this. He does, however, believe that women in general are more empathic then men and thus perhaps would create a more socially responsible science.

December says that understanding why girls are underrepresented in science is complex and requires an understanding of societal factors at different levels. He believes focusing only on gender issues in education in sub-Saharan Africa is a mistake, since there are so many other factors that need to be put in place simply to have children participating and getting a good quality education at all. Gender issues are part of the equation, he says. By choosing to focus only on gender issues you would lose out on other important things.

He says that he don't know if he can say whether AFCLIST has a strong gender focus or not, but that all AFCLIST's projects do focus on gender. Gender issues in science education are one of several issues which AFCLIST has chosen to focus on.

December has read feminist critique of science. He does not, however, see how the influence of one theory can be separated and seen to have a more major influence than another on how people work. He says that lots of different theories have influenced what he thinks about things and that no project builds on one isolated theory. He says it is crucial to begin to understand the connection between theory and praxis and theory and politics.

5.3.4 AFCLIST's analysis of obstacles

AFCLIST constructs its official understanding of what the main challenges for science education are on the challenges expressed as an outcome of the ASTE conference in 1995. This meeting gathered 150 science educators primarily from sub-Sahara Africa. At this meeting, gender inequity was identified as one of several challenges to science education in sub-Saharan Africa. Other factors identified were large classes, few resources, poor teacher education and centralised examinations (Naidoo & Savage, 1998). These factors have formed the basis of what AFCLIST believes has to be addressed to secure the desired change in science education.

The AFCLIST secretariat argues that the obstacles facing science and technology learners are complex and should not be simplified into merely a question of gender inequity:

> *Now if you, you might say: Hi, why don't you make it simpler? But that's exactly the problem that most projects running do. The more you simplify the complexity of the problem, you almost run through what is the magic formula for this thing. What is the single, most important event for a change (December, 2002).*

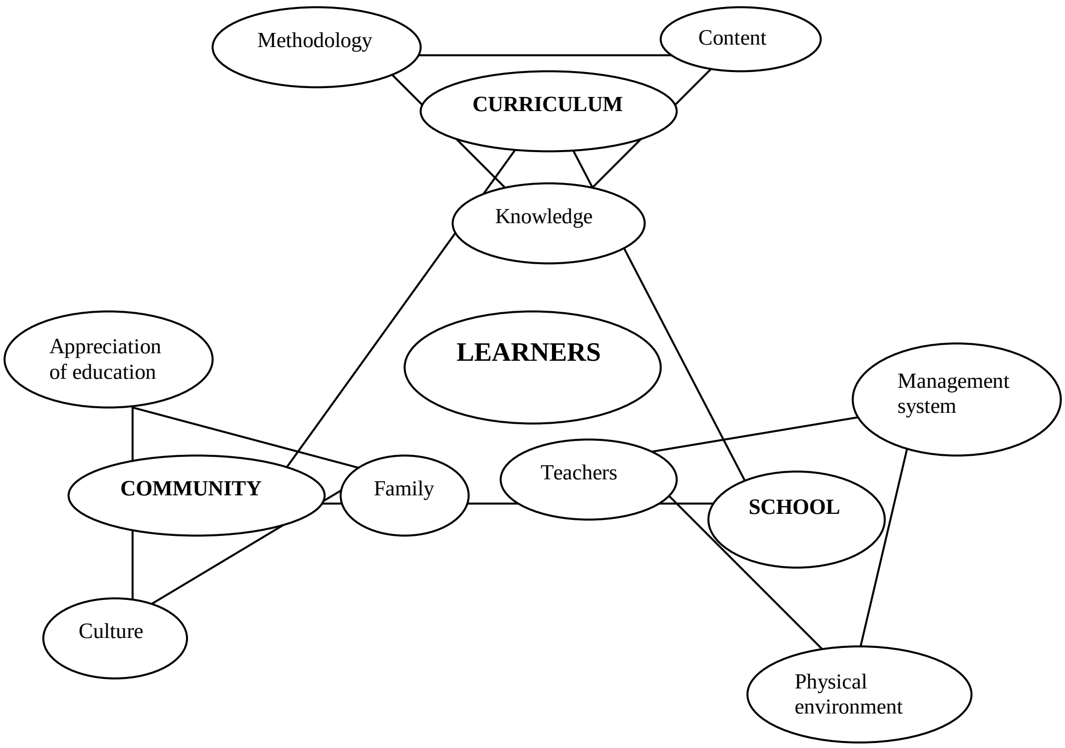
The AFCLIST secretariat upholds that gender inequity can not be seen in isolation from these other factors:

> *Gender is part of the equation, and if you are having exclusive focus on gender you are not going to solve any problems. But you could insist that a project should focus more heavily on gender (December, 2002).*

Obstacles outside the science classroom

At the FEMSA-AFCLIST workshop in Nairobi 2001(see chapter 3), FEMSA and AFCLIST were to share their experiences on gender issues in science education with each other. At this meeting the three articles that were presented as AFCLIST's experiences, all focused on placing the problem of underrepresentation of females in science education in a broader context, emphasising the importance of also focusing on factors external to what goes on within the science classroom. In one of the articles presented, Mulemwa (2002)[48], presented a paper showing how females' participation and performance in science and technology is a function of several factors, and how all these factors are interrelated and should therefore be addressed simultaneously:

Fig. 5.1: A triangular framework of fundamental influences of a learner (Mulemwa, 2002, p. 156.)



Mulemwa pointed to the fact that in order to improve the situation for the learner, all these factors have to be addressed:

> *The important message is that the factors (or sub-factors) of each triangle should be addressed concurrently rather than separately, as*

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[48] Jane Mulemwa was the first Coordinator for FEMSA in Uganda. She has later become involved in AFCLIST as a member of the Grants committee. The paper presented at the FEMSA/AFCLIST workshop was presented as an "AFCLIST experience" although the paper was written based on her experiences from FEMSA.

> *is often the case, to maximize the impact of interventions in these aspects at the school level. Similarly, the interplay of the sub-triangles with the main triangle must be viewed in a more holistic manner to facilitate faster achievement and sustainability of the desired impact of interventions aimed at improving the participation of learners, especially girls in SMTE (Mulemwa, 2002, p. 159).*

Mulemwa based her paper partly on her findings from FEMSA Uganda. The paper does however differ from the other documents I have read that are written to present FEMSA in its positioning in relation to other research and its focus on the learner, not only limited to female learners.

In one of the other papers presented at the Nairobi meeting as a lesson from AFCLIST, factors other than those targeting females in particular were argued to be the ones proven to have most impact on females' participation in science education (Reddy, 2002). Reddy argued that countries that have succeeded in increasing female enrolment in science and science education are characterised by having policies that ensure higher and more effective financial spending in the education sector. They also have a science and technology policy that links science to science education and to labour markets and in that way have managed to secure higher economic growth and absorbance of graduates into the labour marked. Reddy states that:

> *None of the high performing schools had special policies to ensure growth in female enrolment. There was a higher participation of girls because schools were in close proximity and tuition was free. Therefore it is important to consider an improved quality of education for all and within that there will be increased participation and performance rates for girls (Reddy, 2002, p. 112).*

On this basis she said that a lesson for AFCLIST and FEMSA is to be realistic about what the outcomes of classroom based interventions can be because there are areas like the socio-cultural and family and labour markets that perhaps we can not engage in.

Lack of quality in science education

It is my understanding that AFCLIST considers lack of quality in science education to be the major critical factor influencing learners' access to and performance in science and technology education. They argue that gender initiatives have to be seen in the broader context of improving quality education:

Programmes should attempt to improve the quality of education for all and it is within this framework that special strategies need to be developed for gender improvements (Reddy, 2002, p. 115).

According to my interviews of the secretariat and my reviews of the AFCLIST documents, I would argue that Reddy's quote is fairly representative for how AFCLIST analyses the obstacles and solutions to increased female enrolment in science education. The secretariat of AFCLIST argues that you can not address gender inequity in schools in Africa without seeing it in a broader context of poor quality education:

I don't think you can talk about gender equity when the basics of science education are so fundamentally flaud on the continent. So for me, I don't think you can fix gender equity without even thinking about science education and its quality generally. Because most of the kids don't have access to quality (December, 2002).

Another member of the secretariat argues that creating a classroom environment suitable for learning is a prerequisite before you can start dealing with gender issues:

Ok so gender equity in my view is subsidiary to promoting the type of classroom that I can't be bothered to define since you probably know what it is I am talking about(…) So, having achieved an overall goal, then it (gender issues-my remark) becomes an issue (November, 2002).

According to November, focusing on gender aspects before dealing with increasing the general quality of classrooms will not bring any progress:

Because it is my believe that if you focus on gender first, you are actually not getting anywhere because all you are doing is maybe perhaps persuading a teacher to increase the opportunity where he is being authoritarian to girls as well as being authoritarian to boys, you know? (hahaha) And I don't really see that that will bring any progress you know (November, 2002).

Gender specific obstacles

AFCLIST's "official" understanding of what obstructs female participation and performance in science and technology education as it is formulated throughout most of its official documents, seems to be that most of the negative factors impacting female participation and performance are caused by factors which also have an impact on male learners. AFCLIST has therefore designed its initiatives to target learners as a group more than only focusing on females. When asking the various AFCLIST actors to explain why fewer females than males are included in science education, they do however come up with a range of factors that explain the underrepresentation and underperformance of females in particular. The papers published by AFCLIST that focus on gender issues in science education also mention more gender specific factors to explain the low numbers. Based on reviews of AFCLIST documents and interviews with the actors, I have constructed the following list of explanations found within AFCLIST as to why females are underrepresented and underperforming in science and technology education:

	Factors which affect girls' participation and performance in science education
FACTORS WHICH AFFECT ACCESS TO SCHOOL	Marginalisation of girls and women in traditional communities (Nassor, 2001a, p. 2)
	Conflicting role expectations that girls face (Nassor, 2001a, p. 3)
	Early marriages (Nassor, 2001a, p. 3, 2001b, p. 103)
	Poor households – families can't afford sending girls to school (Nassor 2001a, p. 3, 2001b, p. 103)
	Physical distance to school (Nassor, 2001a, p. 3)
	Duties the girls have at home (Nchesi, 2001, p. 81)
	Love affairs between students and teachers (Nchesi, 2001, p. 81)
	Lack of professional ethics amongst teachers (Nchesi, 2001, p. 81)
	Raping of girls (Nchesi, 2001, p. 81)
	Primary schools are not the responsibility of the state; parents tend not to send girls to school (Reddy, 2002, p. 111)
	Culture that favours boys and give priority to their education (December, 2002)
FACTORS WHICH AFFECT ACCESS TO SCIENCE ED	Scientific career is seen as incompatible with feminine responsibilities (Erinosho, 2001b)
	Girls are not encouraged to study hard subjects (Erinosho, 2001b, p. 13)
	Girls do not see the relevance of science to their future careers (Mbano 2001a, p. 21)
	Girls are brought up to realise that science is for boys (September, 2002)
FACTORS WHICH AFFECT PERFORMANCE IN SCIENCE EDUCATION	Girls lack role models (Nassor, 2001a, p. 2; Reddy, 1998, 2002)
	Influence of the home, school and society at large (Erinosho, 2001b, p. 12)
	Traditional image of science and technology that alienates women (Erinosho, 2001b, p. 12)
	Traditional upbringing of girls that denies their opportunities to promote a "scientific orientation" (Erinosho, 2001, p. 13)
	Sextyped differentiation of infant toys (Erinosho, 2001b, p. 13)
	Overrepresentation of male science teachers (Erinosho, 2001b, p.13)
	School texts and curriculum material portray girls as being passive (Erinosho, 2001b, p. 13)
	More male than female illustrations (Erinosho, 2001b, p. 13)
	Male oriented school culture (Nassor, 2001a, p. 3)
	Teaching methods which favour boys experiences (July, 2002; Nassor, 2001a, p. 3)
	Text books which present girls in negative, stereotyped and passive ways (Nassor, 2001a, p. 6).
	Gender discrimination in classroom culture (Nassor, 2001a, p. 6)
	Research (CASE) shows that reasons for low female participation is more due to social factors than ability (Mbano, 2001b, p. 78)
	Teachers perception about the ability of girls to learn science (Mbano, 2001b, p. 78)
	Stereotyping of girls (Nchesi, 2001, p. 81)
	Girls perform poorer in mixed schools (Erinosho, 2002, p. 118)
	Girls perform poorer on multiple-choice exams (Erinosho, 2002, p. 118)
	SMT teachers are gender insensitive and ill-equipped in the psychology of girls (Erinosho, 2002, p. 118)
	Science is male stereotyped, and existing cultural beliefs do not support female participation in S&T (Erinosho, 2002, p. 118)
	Girls are brought up to be less competitive than boys (July, 2002; October, 2002)

Table 5.2: Obstacles which affect female's performance and participation in science education.

Several of the actors mention differences in the upbringing of boys and girls as an important factor impacting negatively on girls' access and performance in science education.

December (2002) argued that female underrepresentation in science education is caused by a number of factors that prevents girls from even coming to school, such as cultures that favour boys and lack of resources caused by poverty. He said that the different factors have to be seen in relation to each other:

> *If you are going to fix the problems of why girls are not in school, you got to change the whole culture, you've got to make sure that more resources and fees are given to parents because they will think that they will send a boy instead of a girl because that is a better investment..(December, 2002).*

Several of the AFCLIST actors claimed that girls are brought up first and foremost to take care of their families and not to be engaged in science:

> *You have to understand that in African communities there is a long way to reach gender equity. Women remain inferior to men. And if you go to school, you are going to a different world where they talk about gender equity. When you go back home, there is an unbalance, you know. Then men are superior to girls. Girls are taught that they should look after the children. And then this is part of their culture (September, 2002).*[49]

Socialisation not only impacts on what roles girls are brought up to take and hence whether or not they are encouraged to come to school, it also, according to the AFCLIST actors', impacts on what prior experiences the pupils bring to school that are of relevance for their learning of science. One of the actors claimed that the prior experiences of boys are more relevant to the learning of science than the experiences girls bring to school:

> *Boys are encouraged to play with electronic objects, to put things together, to take them apart. Girls are supposed to keep clean, and keep order and do things that are domestic. So they are not encouraged to play with cars, ok? So the humanistic element is for girls, ok. The things that you can take apart and rebuild are for boys (July, 2002).*

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[49] This actor works at a former black university in the homeland of Venda in South Africa. The university is situated in a little city appearing very rural far north in South Africa close to the border of Zimbabwe. During the interview about gender issues, feminism and science education, my interviewee told me that it was common in this area that women kneeled when talking to men.

Arguments of socialisation as an important obstacle are also presented in the gender publications published by AFCLIST (Erinosho, 2001b, 2002; Mbano, 2001a, 2001b; Mulemwa, 2002; Nassor, 2001a, 2001b). Several of the actors also argue that the socialisation of females impacts their self- confidence in terms of choosing to study subjects that are considered to require a lot of work. (Erinosho, 2001b; Mbano, 2001a, 2001b). October (2002) argues there is a perception among people that science is difficult and that it demands a lot of sacrifices. Because of the difference in the ways girls and boys are brought up this has a specifically negative impact on girls since they, according to October, are brought up to be less competitive than boys:

> *The reason why the girls will struggle in physics and mathematics is that boys have been brought up to be competitive, to fight (…) If girls are brought up to believe they can do well, they will do well. If they are brought up to believe that there is a limit to what they can achieve, then that's what will happen (October, 2002).*

Nellie Mbano (Mbano, 2001a, 2001b) has received grants from AFCLIST to try out the Cognitive Acceleration through Science Education (CASE) methods in Malawi. The purpose of the study was to see whether the poor performance of girls in science and mathematics in Malawian schools could be explained by a possible mismatch between pupil's cognitive ability and the cognitive demand of the school science curricula (Mbano, 2001b, p. 67). The study showed that both boys and girls in Malawi accelerate their cognitive development through using the CASE programme over a 2-year period. Only for the boys however, the increased cognitive development translated into increased performance in school science and mathematic. Mbano concluded that this could be explained by social factors causing low confidence and poor self-perception among girls. Several of the actors I interviewed also pointed to the fact that girls tend to have lower self-confidence in science than males (January, 2002; July, 2002):

> *And also there is this perception that this is a difficult subject and difficult things are better handled by males, ok? (July, 2002).*

January argues that girls tend to shy away from topics they find difficult and that girls often find science difficult.

Studying the AFCLIST papers focusing on gender issues, most of the well-known factors that have been shown to have a negative impact on girls' participation and performance in science are mentioned. These include factors such as overrepresentation of male teachers, biased school material portraying more males than females, stereotyped images of females and also pictures portraying females in more passive roles than males (See for instance

Erinosho, 2001b, 2002; Mulemwa, 2002; Nassor, 2001a). These articles also highlight factors such as the fact that it is common for teachers to have less confidence in girls' abilities and that they discriminate against girls in science classrooms and so forth.

5.3.5 AFCLIST's arguments for gender equity in SMT and SMTE

AFCLIST's goals and objectives describe what the organisation wants to achieve without giving any specific reference to gender. The arguments for change are political in the sense that they want to contribute to *social, economic and political transformation* in sub-Saharan Africa. To my question regarding why AFCLIST has still chosen as a guiding principle that all AFCLIST supported projects should address gender issues, October responded that girls have been lagging behind for so many years that it is important to give them some extra attention in order to increase their performance and participation in science education:

> *I think we have to make sure that the one group of people who are already lagging behind the other should be encouraged significantly (October, 2002).*

The AFCLIST secretariat argues that one important reason to involve more girls in science education is the positive effect this will have on the family:

> *Within the African context if you are talking about family maintenance levels, you are talking about women(…) Family maintenance in almost every single aspect you know, feeding, child rearing, family health, the whole bloody lot (November, 2002).*

> *Now why should girls and women be involved in science education generally? For me the reasons are straight forward. First is if you take women and mothers and girls they are more significant players in the house. The quality of care, the decisions they make etc etc. Impacts on the health of the child etc. See? We should make them more scientific literate, understand what they do so they could use it (December, 2002).*

All the members of the secretariat also argue for increased female participation from a human capital perspective, claiming that females form an important part of a country's human capital, and that female competencies should be utilised equally as males:

> *If you do that (leave out the girls from science education-my remark) you are not going to have a representative group of people that are*

contributing towards the development of science and technology in general and development in particular (October, 2002).

At another level and this comes out and it is stronger in a West African context, women are extraordinary important force in the informal economy. We should assist in doing that so much better (November, 2002).

Fifty per cent of the population in Africa are women and if you want to make sure you will be competitive you must exploit every human capital need that you have with women. No if you don't use them, you miss out (December, 2002).

All the interviewees believe that the low participation and performance of females in science and science education is a problem that needs to be addressed. The following arguments are given to why more girls ought to be recruited to science education:

Arguments for why more females should be given the possibility to participate and perform in science education:	**Arguments raised by:**
To have improved family health	July, March, November, December
It would benefit the children	July, December, November
It would improve the farming	January
The production of food would improve	January
To have better economy in the country and hence increased development	September, June, October, November, December
To become role models for others	July
Because the world depends on science	July
It would have a positive impact on the environment	January
To better survive in a scientific and technological society	July, March, January, June, October
To become scientifically literate	August
Because women would have more opportunities	July, March
To be able to participate in decision making	March
Women could contribute positively to science	October

Table 5.3: Arguments raised by actors in AFCLIST for why more females should be given the possibility to participate and perform in science education.

Within the gender papers published as "AFCLIST publications" I have located the following arguments:

To implement government policies on education for all (Nassor, 2001a, p. 1).

Important for human development (Nassor, 2001b, p. 102).

Women bring life into this world. An educated woman would be a better mother and act as a teacher for her children (Nassor, 2001b, p. 104).

Females are consumers of products of science. The products would be better if women were involved in producing them (Nassor, 2001b, p. 104).

Since the psychology and outlook of men and women differ, it follows that science and technology should benefit from the perspectives of both sexes (Erinosho, 2001b p. 12).

Because the products and processes of science and technology affects the lives of all, both men and women should be involved in decision making on technology (Erinosho, 2001b, p. 12).

Most of the arguments raised by the AFCLIST actors to why more females should be recruited to science education claim that more scientific literate females would in different ways benefit the society because of the role females play in families. Several of the actors also claim that it would benefit females as such to have a science education. Arguments raised are that women need such skills to better survive in an increasingly technological society. It is also claimed that women would have more opportunities if they had more scientific skills and that they would also be able to contribute more in decision making etc. Several of the actors also raise the point that women would be more empowered and thus improve their own quality of life by acquiring some scientific skills than an actual changed of scientific inquiry.

One of the actors says that he believes women would contribute positively to the development of science. February claims that he finds the argumentation within feminist literature that women would contribute with something different to science convincing:

If you read the feminist literature they say that maybe science would be a bit different if it was done by women (…) Perhaps there would be a balance, I don't know, but their arguments seem convincing (February, 2002).

February did not go more in detail as to what feminist literature he has read.

How do women impact science?

To my question regarding whether a reason to increase the recruitment of females in scientific and technological occupations could be that females engaged in science and technology would contribute with something different than males would to these fields, I got various replies from the members of the AFCLIST network:

Would females contribute with something different to scientific and technological inquiry than men would?	**AFCLIST actor**
Women would have a different focus than men	July January
Women's science would be more socially responsible	July
Women are more practical. Therefore they would come up with better solutions in technological research	June December March August June
Girls are more detailed and thorough. Research carried out by women would thus differ because of the way women work	January
Women would get the same results, but they would interpret them differently than men	August
There would be no difference	September April

Table 5.4: AFCLIST actors' perspectives on whether females would contribute with something different to scientific and technological inquiry than men would.

Within the AFCLIST network, the whole spectre of opinions regarding how the researcher's sex/gender impacts on research exists. One of the actors says that he does not believe science would be any different if more females were involved. He says that the reason to recruit more females to science is to change a discriminatory praxis that has kept females from being involved. Working to include more females in science should be done since it will benefit girls themselves, not because of its benefit to science:

> *Would a woman conduct science differently from a man? No (…) You can only recruit more girls because they have been discriminated (…) But you do this for the girls' sake, not for science's sake (September, 2002).*

Several of the actors do not have definite opinions about what effect the researcher's sex might have on the research being utilised. One member of the secretariat says he is not too sure that women would advance a different science, but it might be at an individual level in terms of utilising scientific knowledge differently (October, 2002).

Another secretariat member argues that he doesn't personally believe that women would advance a different type of science than men (November, 2002):

> *I do not believe very strongly in the argument that there would be a different science if more women were involved. You know, I do think that it is actually a gender-neutral past time. Even in selection of problems (November, 2002).*

Several of the actors are of the opinion that women have a different focus than men in their approach to science. This would find expression in different research focus and a more social socially responsible science:

> *Right now the voices of women are not clearly heard. I do believe that there are certain things women are particularly good at. Because of our make up, you know. We are naturally more caring, and you know, I believe that's what we are (June, 2002).*

June argues that women's voices within academia are seldom heard. She says that women are more caring and that this ability would benefit research. July's argument resembles June's when she argues that women have different ideas about research benefit than men and that they are more likely to be concerned about the benefit of their research to humanity than simply pursuing science for its own sake:

> *Yes, for instance I think that men and women have different ideas even about humanity of research benefit (…) I think we look at the world in a slightly different way. And I think women are more likely to look, to utilise the good rather then science for its own sake. You know I think that some of the incredible amount of money that may be spent on research that is really not likely to benefit us. I mean look at the arms. Incredible amount of money goes into research on arms (…) But people are starving, you know. And there are many more important areas where we could focus and I think that maybe women perspective has not really been dominant in science (July, 2002).*

She does however seem to believe that it is the research focus that would be changed if more women were involved, not the methods used in scientific inquiry:

But do you think that even the scientific inquiry would be different with more women involved (interviewer)?

I'm not really sure. In that sense, I mean a truth is a truth no matter who discovers it. If it is truth. I think the way you get to that truth may be different (July, 2002).

December says that it is impossible to know whether women would advance a different science than men, and that it is impossible to make any claims in this regard since nobody knows about this. He does however believe that women in general are more empathic then men and thus perhaps would create a more socially responsible science.

I think that they can impact on what I call socially responsive science. Because they have much deeper sense of empathy. So for me science would begin to have a much more social consciousness and environmental consciousness and ethic. That's where the value would lie in much of what they do (December, 2002)

On my question regarding on what basis December believes females to be empathic and hence more able to advance a more socially responsible science than men, he answers in the following way:

Because that is inherently what they do. They nurture nature. And you see that at home. Women tend to be the one that, I mean we have seen that on the experiment of budgeting, women drawing up a budget based on women's perspectives was totally different from what the finance minister would draw up. But because the way they think about health, because it is very personal it is about their experiences around their family. It doesn't mean that they left men out of it (…)I think they are much more empathic then men. I think they tend to be far more empathetic then men. And if you have the right collection, yeah, women can think as fuckers too (…)(December, 2002).

March also believes women would have a different perspective on science, and that science would benefit from having more females engaged in science. She does however put emphasis on how females are more practical than males, who are more theoretical, and that this would impact their research:

I think that males and females have different perspectives in the way we look at problems. Therefore in any field you have to have different views (…) In any sort of decision making you can see the different perspectives. And women tend to be more practical, male tend to be more theoretical. So definitely, having more women participating would be a useful thing rather than having just one part which has only one way of looking at things (March, 2002).

January (2002) says that he is not sure whether science would benefit from having more females engaged. In spite of that he believes females tend to be more detailed than boys, he does not believe they would engage differently in research except for focusing on different things:

> *Yes, as a scientist I am not sure why we need more female scientists let alone the fact that I think that girls do more details than boys (…) I don't think females would engage differently in research, besides focusing on different things (January, 2002)*

5.3.6 AFCLIST's recommendations for change

AFCLIST has identified five contexts where change should occur in SMTE. In the brochure "AFCLIST and Gender Equity" (Savage et al., 2001), these contexts are described and recommendations provided for what AFCLIST regards as five context where change should occur:

1. The context of the classroom.
2. The context of the schools.
3. The context of local communities.
4. The context of the educational system.
5. The context of society.

I would argue that most of the recommendations in the "official" AFCLIST documents are formulated to target male and female learners equally. The various papers dealing with gender issues in particular, do however, come up with various recommendations as to how science education might be changed for the purpose of increasing the participation and performance of females in SMTE. In the table the recommendations are presented in accordance with the contexts AFCLIST has described as to where change ought to occur:

Contexts for change	Recommendations for how gender equity in science education could be increased, suggested by AFCLIST
Classrooms	Teachers must be innovative in terms of developing ways of teaching in contexts of overcrowded, underresourced classrooms (Naidoo & Savage, 1998, p. 214)
	Teachers need to be sensitised and trained on gender issues (to learn that the differences between males and females are only biological) (Nassor, 2001a, p. 9, 2001b, p. 103)
	In order to improve girls' participation and performance in science and mathematics the interventions should address both males and females (Nassor, 2001b, p. 112)
	It is important to conduct a stimulating and safe learning environment for both boys and girls (Nchesi, 2001, p. 88)
	Inspiring lectures are important (Reddy, 2001b, p. 123)
	More female science educators are needed to act as role models (January, 2002; Nassor, 2001a, p. 9; Reddy, 1998, p. 98)
	Teachers need to change to inquiry approaches to learning (Nassor, 2001a, p. 9)
	Boys' interests are around control/construction and technical activities, while girls are more attracted to nature and domestic subjects, health related and academic subjects (Refers to one article from 1987) (Erinosho, 2002, p. 118)
	Science education must be changed to accommodate for girls choosing SMT subjects more for its usefulness, while boys may choose science out of interest (no reference) (Erinosho, 2002, p.118)
	Science education should accommodate for girls being more predisposed for cooperative, collaborative, and group work environment. They like active problem solving, contextualised and problem centred teaching methods (Erinosho 2002, p. 121)
	Girls' interests must be incorporated into science education (February, 2002; June, 2002; March, 2002)
	Same science content can be made interesting to girls by using examples that are familiar to them (August, 2002; July, 2002; March, 2002)
	More group work should be applied in the learning of science (March, 2002)
	Science has to be demystified (January, 2002)
Schools	More research is needed to determine what influence school climate and the influence of the local communities have on schools. The education system has to be constantly innovative in terms of reorganising its functions to accommodate for changes in society (Savage et al., 2001)
	The existing resources within the schools have to be used more effectively (Savage & Naidoo, p. 215)
	Teachers could work double shifts in order to ensure that all the learners, including the girls, are given access to education (Nchesi, 2001, p 88)
	After school science clubs should be "a must" in all schools in order to give the pupils more time to engage in science education than what is possible within the traditional school hours (Nchesi, 2001, p. 88)
	Schools should be encouraged to engage more in popularising science, for instance through science fairs in the communities (Nassor, 2001b, p. 111)
	More research is needed to develop strategies for teaching science in large and under resourced classrooms (Savage & Naidoo, 1998, p. 215)
	Remaining single sex girls' schools should be turned into science education schools for girls (Erinosho, 2002, p. 118)
	Single sex science education in co-educational schools has shown good results in other contexts (Reddy, 1998, 2002)
	Pupils should not be divided physically by sex, but by level (Mulemwa, 2002, p.154)
	School time tables should be flexible and accommodate poor pupils (Reddy, 1998, p. 98)

Local communitites	More research is needed to determine the influence of communities on pupils' participation and performance in science education (Savage et al., 2001, p. 4) Programmes should be mounted to educate parents and the communities about the value of schooling, the nature and role of science and technology and the about science and technology related professions (Reddy, 1998, p. 98)
Educational systems	It is important "first to get science education right, then implement equity measures if necessary" (Savage & Naidoo, 1998, p. 214) Curriculum developers must make sure that all subcultures of the country are represented in the materials, such as rural/urban, male/female (Savage et al., 2001, p. 4) The education system must be designed according to the resource situation in the African context. The teachers have to be innovative in terms of making the most use of the existing resources (Savage et al., 2001, p.4) Given all the science being taught in home economics, this subject should be made compulsory for all pupils regardless of their sex (Green, 2001) Textbooks must be revised to avoid showing girls in negative, stereotyped ways (Nassor, 2001a, p. 9) Examinations should be transformed to reflect the spirit and goals of the science curriculum and encourage good practice (more research needed to develop examinations) (Savage & Naidoo, 1998, p. 219) Since girls perform better in essay tests, more essay tests should be used instead of multiple choice tests (Erinosho, 2002, p. 118) More research should be carried out to see whether the success reported in Germany with teaching science in single sex groups in co-educational schools might be replicated in African countries (Reddy, 1998, p 98) All teacher education programmes should incorporate activities that make teachers aware of how certain practices disadvantage girls (Reddy, 1998, p. 98) Intervention programmes should be established that develop cadres of elites and provide employment opportunities (Reddy, 1998, p. 98) Science teacher training programmes and curriculum materials should incorporate language training (Reddy, 1998, p. 98) All teacher training programmes and curriculum materials should contain components that enable teachers to teach in multigrade classrooms (Reddy, 1998, p. 98)
Societies	Science education should be designed to accommodate for the situation of the society (Savage et al., 2001, p. 10) Scholarships and bursaries should be set up to target poor pupils and special target groups (Reddy, 1998, p. 98) A centre of excellence with a strong emphasis on science and technology should be set up in a rural area, with a special quota for girls (Reddy, 1998, p. 98) Outstanding girls in the primary and secondary school system should be supported to move into tertiary education and should subsequently be provided with high level, visible jobs in the government and the private and public sectors (Reddy, 1998, p. 98) Girls need extra encouragement in order to participate and perform well in science education (January, 2002; June, 2002) One should avoid discriminatory attitudes towards girls (March, 2002) Science education does not have to change, what is needed is to persuade girls to choose science (April, 2002)

Table 5.5: Recommendations suggested by AFCLIST to how gender equity in science education could be achieved.

Within the group of people involved in AFCLIST, one can find a range of different recommendations to what has to be done to secure gender equity in science education. The recommendations range from the ones arguing that no particular changes have to be made beyond simply improving science education in general, to the ones arguing that different methods and content are needed to make science equally relevant and interesting to girls as to boys. I will revisit and analyse the recommendations from AFCLIST in the next section of this chapter.

5.4 How does AFCLIST approach gender equity in science education?

5.4.1 Introduction

I will now turn to analyse AFCLIST's approach to increased gender equity using the theoretical frame developed in chapter 2. An analysis of how AFCLIST addresses gender issues has to be based on several premises.

First and foremost AFCLIST, until it became an NGO in 2003, operated as a network of innovative science educators. AFCLIST therefore has not had official policies in the same sense as an organisation would have had. AFCLIST has been guided by a "philosophy" and has had "guiding principles".

The different actors are therefore not restricted by rules defined by AFCLIST. Still, the documents describing AFCLIST, refer to it as one entity with one united understanding of the various aspects the initiative aims to address. Throughout the documents describing AFCLIST, it is written that "AFCLIST believes", "AFCLIST aims" and so forth (See for instance the description of the AFCLIST philosophy (AFCLIST, 1998b)). My reading of the AFCLIST publications and interviews with the different actors in the AFCLIST network indicates that the views described as "The AFCLIST view" first and foremost reflect the perspectives of the secretariat. This does not mean that the actors do not agree with the secretariat's understandings, but that the guiding principles and philosophy has not always penetrated throughout the network.

5.4.2 Understanding of obstacles

AFCLIST does not regard androcentric bias in science to cause gender inequity in science education.

According to my understanding, AFCLIST regards science and science education as crucial tools for development. In the documents I have had access to from AFCLIST, I have seen no attempts to criticise scientific and technological knowledge and research praxis for being androcentric. The focus of AFCLIST is to improve the quality of science education by developing innovative ways to teach and learn science in contexts with limited resources.

Few of the AFCLIST actors reported that they had read any feminist critique of science. Only one of the actors I interviewed assumed that this literature had had any impact on his thinking (February, 2002). One of the actors claimed that it is impossible to distinguish which theories have impacted on practice, since practice is most often influenced by a whole range of different theories (December, 2002).

One of the members of the AFCLIST network said that she heard about feminist critique of science for the first time through me at my presentation at the FEMSA/AFCLIST gender workshop in Nairobi in 2001. She did however admit that these theories “really make you think” (May, 2002).

Although several of the actors argued that they do believe that women would advance a different science than men, nobody explained female underrepresentation and underperformance in science in terms of being a result of having a scientific body of knowledge developed mainly by men on men's premises.

AFCLIST does therefore not seem to see science, its content and development as an obstacle that has a negative impact on pupils’ participation in science. The concern for AFCLIST is to make it possible for people in sub-Saharan Africa to benefit from the scientific body of knowledge, not to challenge the knowledge production.

The documents written by members of AFCLIST do not reflect perceptions of science as such to be influenced by the sex of the researchers who have developed it. Accordingly, the documents reflect what I have labelled equality feminist perspectives in my analytical framework. AFCLIST does, in line with what I have described as efforts characteristic of initiatives based on such an understanding work to increase female participation to science education by trying to remove external factors preventing females from engaging in scientific activities instead of trying to change androcentric practices within science inquiry.

Lack of quality education is seen as a main obstacle

The challenges AFCLIST has identified to have negative impact on females' access to and performances in science education are the same for male and female children. Nowhere in the AFCLIST documents is it claimed that females should be any less capable than males to succeed in science education.

The factors identified at the ASTE meeting are reflected in AFCLIST's understanding of what challenges are crucial for science education in Africa. Lack of quality education is hence understood as the main challenge to science education in Africa. This lack of quality is caused by irrelevant and content driven education systems in underresourced and overcrowded classrooms. Addressing this lack of quality will, according to my understanding of AFCLIST, be expected to impact positively on boys as well as girls. In interviews the secretariat argued that you can not start by addressing gender issues in science education as long as the quality of education in general is a poor as it is. They argue that gender inequity can not be changed without also considering the lack of quality in education in general.

While AFCLIST claims that all children are faced with obstacles caused by poor quality in education, female pupils are faced with an additional set of obstacles affecting them.

In the AFCLIST documents written by the secretariat, the focus is not on elaborating which factors have a particularly negative impact on girls' participation and performance in science. In my interviews of the AFCLIST actors regarding why females throughout sub-Saharan Africa are underrepresented in science education, the answers did not reflect understandings of females as having any particular difficulties learning of science.

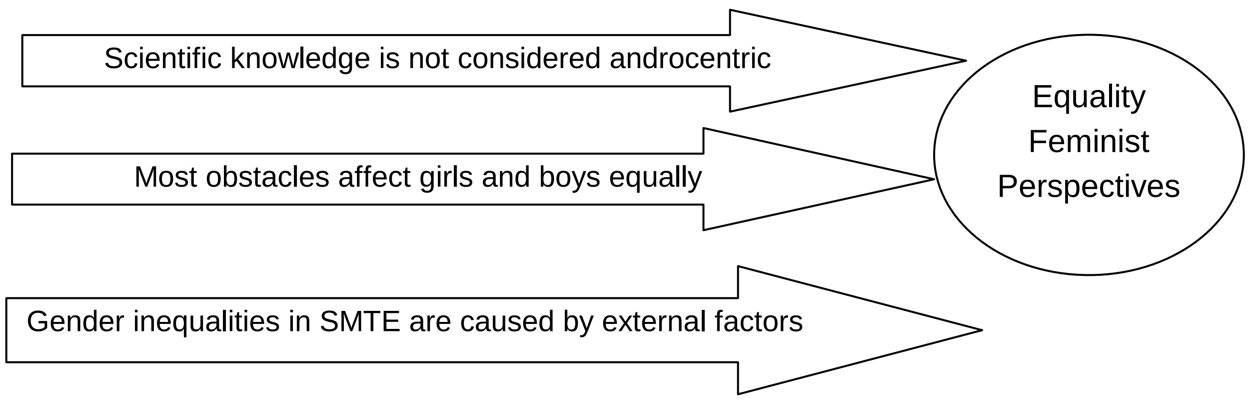
Such perspectives are only present in one of the articles I have reviewed that are written by people involved in AFCLIST. In this article, Erinosho (2002) claimed that girls are less likely than boys to succeed in multiple choice tests, and more able to succeed in essay type tests. In this article it is also referred to “girls’ special psychology” and how this impacts on their learning of science subjects. Claims are made characterising girls’ special interests (domestic, health related and academic subjects) and it is maintained that girls are predisposed for cooperative, collaborative and group work environment and that they like problem solving, contextualised and problem centred teaching methods. The data to substantiate these claims are, however, weak and the references in this paper contain several mistakes.

I consider the paper to be rather atypical for how the rest of the AFCLIST network describes obstacles to female participation in science education. I have not come across claims that female are any different in their engagement in science education from boys in any of the documents which describe “AFCLIST’s understanding”.

I would therefore argue that AFCLIST in general tend to tone down the differences in how females and males approach science education. They claim that gender inequity is not a problem in a properly organised classroom, and argue that most of the factors that impact negatively on girls also have a negative impact on boys. They maintain that the factors impacting particularly negatively on girls are caused either by low quality in science teaching or by their socialisation and upbringing.

AFCLIST hence, with a few exceptions, seems rather consistent in its understanding that science education discriminates against girls by treating males and females differently. My analysis of AFCLIST therefore indicates that AFCLIST falls under the category of “equality feminism” in terms of its understanding of obstacles to female participation in SMTE.

Figure 5.2: AFCLIST’s analysis of obstacles to female participation and performance in science education



5.4.3 Argumentation for change

AFCLIST's argumentation for change is based first and foremost on the basis that science education is crucial for development and that citizens need to be scientifically and technologically literate in order for a country to develop. AFCLIST's main objective is therefore to make science education more suitable to contributing to development. My understanding is that achieving gender equity in science and science education is, by AFCLIST, seen as a means to increased development, not as a goal on its own.

October argued that the reason for AFCLIST to focus on gender issues, and the grounds for adapting as a guiding principle that all AFCLIST funded projects should address gender issues, was based on an acknowledgement of females underrepresentation in science education at all levels of the educational system, and that extra efforts were needed to redress this inequity.

December admits that this guiding principle also came about as a result of external pressure from donors, putting gender issues high on their agenda.

"Add on arguments"

When I asked the AFCLIST actors why they regard it as important to increase the female participation in SMT and SMTE, the argumentation varies. Most of the arguments raised are what I have labelled "add on arguments". By this I mean arguments claiming that the rationale to enhance female participation in science is first and foremost that it is important to include more people in science and science education in order to increase development. Since females constitute half the world's population, it is crucial to get them involved in science education and hence enable them to contribute to economic and social development.

"Add on" arguments include those which argue from the perspective that it would benefit the home environment if more women were scientifically literate, since that could lead to improved child rearing, better health, farming, food production etc. It also includes arguments from a human capital perspective, claiming that a country has to utilise all its human capacity in order to develop, including women. All these arguments are well represented within the AFCLIST network. Several of the actors argue from the point of view of understanding the advantages of female involvement to the local community and also for the gains it would be expected to bring to the economic development of the various countries.

“Empowerment arguments”

A second set of arguments emerging from the AFCLIST actors constitutes what I would label “empowerment arguments”. In this category I would place arguments claiming that gender equity in SMT and SMTE is important first and foremost because it would benefit women. Although empowerment arguments are not incompatible with arguments claiming that the purpose of gender equity in SMTE is to improve livelihood and secure economic growth and development, the arguments I have placed in this category have empowerment as their *main* focus. Such arguments include those claiming that women by being more scientifically literate would have better opportunities to survive in a scientific and technological environment and that they would have more opportunities to participate more actively in decision making. Such arguments are also well represented within the AFCLIST organisation (See chapter 5.3.5).

“Change arguments”

The last set of arguments emerging from the interviews of the AFCLIST group could be categorised as “change arguments”. This category includes arguments claiming that a reason to include more females in science and science education is that women would contribute to the scientific enterprise with something qualitatively *different* than men. These types of arguments are not found in any of AFCLIST's official documents. While several of the interviewees said that they thought females would contribute differently to science than men, only one of the actors interviewed used this as an argument for increased female participation in science education. Several of the actors claimed that women would have a different focus than men; some said that they would get the same results as men but interpret them in a different way. Some actors also claimed that women, because of the way they work, would get more thorough results since girls tend to put more details into their work. Three of the female actors in AFCLIST claimed that women are more practical than males and would thus come up with more practical solutions in technological research.

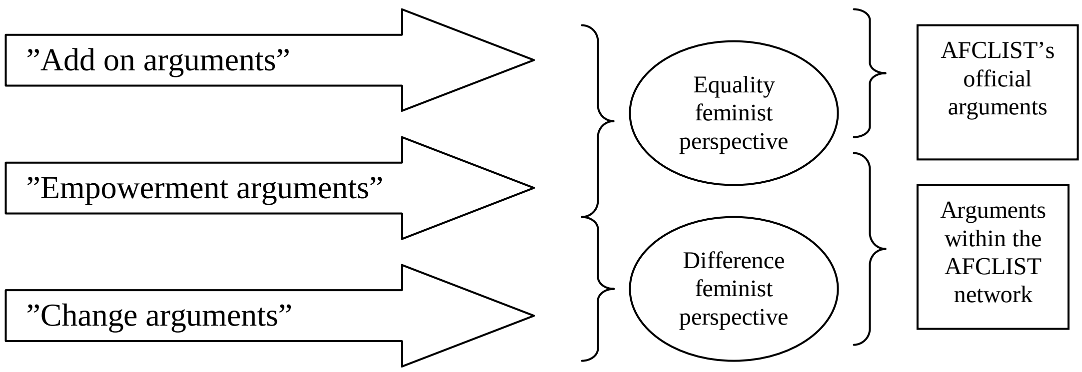
Several of the actors also claim that science carried out by females would be more socially responsible than that of males. December said that this is because women are brought up to be more empathic than men and also because of the nature of the activities women are often involved in: “They nurture nature” (December, 2002).

One actor also said that women by nature are more caring than males and that this would impact positively on their focus in science inquiry.

The understanding of women as contributors to something different to science than males is as my interviews have show, well represented in the argumentation among the actors of AFCLIST, but this is not reflected in written documents and not used as arguments for increased female involvement in SMT and SMTE.

As a result of analysing AFCLIST's arguments for increased female participation in SMT and SMTE, I would therefore argue that AFCLIST officially argues for gender equity in SMTE from an “equality feminist” perspective, while there are several actors within the network that have perspectives that would be more closely to the understandings I have described as representative of “difference feminism” (see figure 5.3).

Figure 5.3: Arguments for increased female participation and performance within AFCLIST.



Consistent throughout all AFCLIST documents and interviews, however, is a notion of gender to impact mainly on the choice of research focus. The actors did not claim that a researcher’s sex/gender would also impact on the actual quality of the knowledge being produced. As one of the AFCLIST actors in the interview said: “A truth is a truth no matter who discovers it” (July, 2002).

5.4.4 Recommendations for change

AFCLIST operates under the principle that all the projects and activities of AFCLIST shall “address gender issues”. As I have shown previously, the AFCLIST documents are not specific in terms of recommendations for how gender issues ought to be addressed.

In my review of the documents written by the AFCLIST secretariat, I find them to be most concerned with removing what is regarded to be the main obstacle - a lack of quality in science education.

Some of the recommendations from AFCLIST would imply a “gender-sensitive” science education, since they focus on accommodating differences in pupils’ abilities and interests in science without asserting that such differences necessarily are the same for pupils of the same sex. Examples of such recommendations found in AFCLIST documents are:

- Pupils could be physically divided based on abilities /level (Mulemwa, 2002)
- Time table should account for poor people (Reddy, 1998).
- Scholarships to poor/special target groups (Reddy, 1998)
- Ensure all subjects are inclusive of male/female, rural/urban experiences and interests (Savage et al., 2001)

Most of the recommendations provided within the official AFCLIST documents would, however, according to my analytical framework, be categorised as “gender-neutral” initiatives since they tend to imply changes that would improve the quality of science teaching for all learners regardless of sex. Most of the official recommendations concern improving the quality of science teaching by developing new ways to teach science in underresourced, large classes. Such recommendations are outlined in table 5.6, and include suggestions such as introducing double shifts for teaching, having more science clubs, adopting curriculum and examination designs that account for the context, and popularising science to increase public awareness about the importance of such subjects.

Curriculum and examinations	Education material	Teacher development /Teaching methods
Examinations should be designed to encourage good practice (Savage & Naidoo, 1998, p. 219) Design curriculum according to the context of large under resourced classrooms (Reddy, 1998, p. 98; Savage et al., 2001, p. 14) Home economics should be made compulsory to both boys and girls throughout Africa (Green, 2001)	More effective use of existing resources (Naidoo & Savage, 1998, p. 215) Textbooks must be revised not to show girls in negative, stereo- typed, passive ways (Nassor, 2001a, p. 9)	Teachers should work double shifts to ensure that all girls attend (Nchesi, 2001, p 88) Science clubs should be a must in all schools (Nchesi, 2001, p. 88) Schools should be encouraged to popularise science through science fairs in the communities (Nassor, 2001b, p. 111) First get science education right, then implement gender equity actions if necessary (Naidoo & Savage, 1998, p. 98) Teachers need to be sensitised and trained on gender issues (to learn that the differences between males and females are only biological) (Nassor, 2001a, p. 9, 2001b, p. 103) In order to improve girls' participation and performance in science and mathematics the interventions should address males and females (Nassor, 2001b, p. 112) Conduct a stimulating and safe learning environment for both boys and girls (Nchesi, 2001, p. 88) Inspiring lectures are important (Reddy, 2001, p. 123) More female science educators are needed to act as role models (Nassor, 2001a, p. 9; Reddy, 1998, p. 98) Teacher training programmes should include language training (Reddy, 1998, p. 98) Teachers need to change to inquiry approaches to learning (Nassor, 2001a, p. 9) Teachers must be innovative and develop ways of teaching suitable for the context (Naidoo & Savage 1998, p. 214)

Table 5.6: Gender-neutral recommendations within AFCLIST.

The recommendations in the publications written by the AFCLIST secretariat represent a gender-neutral approach to gender equity in science education, since they build on the assumption that the same science education can be made equally relevant for boys and girls. None of the official recommendations assume males and females to be different in their engagement in science education. The gender specific obstacles are mainly focused on removing discriminatory factors in science classrooms and sensitising teachers on females' equal ability to succeed in science. Several of the AFCLIST interviewees and the gender articles written by AFCLIST actors recommend employing more female science teachers to act as role models for girls.

While I regard most of the documents written and presented as "the AFCLIST view" as rather consistent in terms of recommending changes within a gender-neutral frame, other understandings and recommendations are made by other actors associated with AFCLIST that are not consistent.

Several of the recommendations I have located in the gender papers written by members of the AFCLIST network reflect an understanding of males and females as different in terms of how they learn and engage in science education. It is argued in these papers that these sex-based differences need to be accounted for in order to achieve gender equity in science classrooms. These recommendations are outlined in table 5.7, and would represent what I have described as characteristic to a "female-friendly" science education.

Recommendations within a female-friendly science education would put emphasis on planning education to accommodate research documenting sex-based differences in how males and females learn science. Such recommendations found in the AFCLIST documents and interviews are outlined in table 5.7:

Curriculum and examinations	Education material	Teacher development /Teaching methods
Girls perform better in essay tests therefore more essay tests should be used (Erinosho, 2002, p. 118)		SMT teachers are gender insensitive and ill-equipped in the psychology of girls (Erinosho, 2002, p.119) Boys' interests are around control/construction and technical activities, while girls are more attracted to nature and domestic subjects, health related and academic subjects (Erinosho, 2002, p. 118) Girls are found to be more predisposed for co-operative, collaborative, and group work environment (Erinosho, 2002, p.121) Girls like active problem solving, contextualised- and problem centred approach including games, field trips, role play, discussion, case study etc (Erinosho, 2002, p.121) The learning difficulties of girls in SMT and the various gender differences in their experiences must be identified with a view to ascertaining appropriate teaching approaches to SMT (Erinosho, 2002, p. 120)

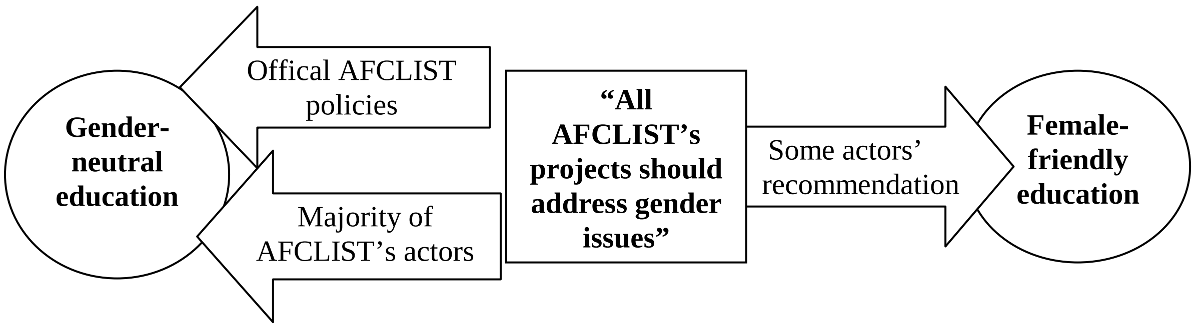
Table 5.7: Female-friendly recommendations within AFCLIST.

There are also recommendations within the AFCLIST documents to separate pupils physically based on their sex when teaching science. There are obvious differences in the recommendations made by the different actors regarding physical separation of pupils based on their sex. While one actor recommends single sex science schools for girls, another actor recommends single sex science teaching in co-educational schools. A third actor recommends that science should be taught in groups based on level, not on sex. One of the actors interviewed said that more research is needed to come up with "girl-friendly teaching methods".

I regard the recommendations found both among the various actors as well as within the gender publications published through AFCLIST to represent contradictory understandings of the official AFCLIST perspective. The official understanding of AFCLIST as it is formulated through documents and by the members of the secretariat, seems to be that increased quality education for all is the main tool to improved female participation and performance in science.

Figure 5.4 shows how the recommendations provided by the AFCLIST secretariat regarding how gender equity in science education could be achieved would hence, according to my analysis imply a “gender-neutral” approach to gender equity in science education.

Figure 5.4: Implications of the recommendations from AFCLIST of how science education should be changed to secure gender equity.



The recommendations given from some of the members of the AFCLIST network would however imply a science education that could be characterized as “female-friendly”. Science education reform projects operating under the premise that males and females are equal in their approach to science, would be expected to have a different focus than projects operating under the premise that males and females are different. AFCLIST’s official analysis of the weaknesses within science education represents an equality feminist understanding in that it explains discriminating attitudes in science education as approaches which treat males and females differently. If one does however take the perceptions of several of the actors in the AFCLIST network seriously, namely that females, because of their upbringing, would contribute with something *different* and positive to science, then it would be required to reorganise science education in order to accommodate these differences. Perhaps quality education, according to this understanding, would look slightly different from the quality education described by AFCLIST.

5.4.5 Conclusions

With some exceptions, most of the recommendations from AFCLIST reflect an understanding of male and female pupils as not very different in their approach to science education. AFCLIST as an initiative tends to see factors affecting both girls and boys equally as the most crucial to address in order to increase gender equity in science and science education. There are examples of “difference feminist” perspectives only in a couple of the articles on gender issues published through AFCLIST, all written by the same author. I would therefore position AFCLIST within an equality feminist understanding. I have interpreted the overall recommendations from AFCLIST to be representative of a gender-neutral education. Education initiatives reflecting such perspectives would hence, like AFCLIST, not emphasize the differences between male and female pupils, but focus on improving the education for all regardless of their sex.

Through my analysis of AFCLIST I have found no critique of scientific knowledge for being androcentric and influenced by its mainly male developers. My impression is that actors within AFCLIST do not regard scientific knowledge as gender biased. Their focus is to develop high quality science education and through this make this body of knowledge accessible to a majority of pupils in sub-Saharan Africa. AFCLIST does not provide any recommendations as to how the nature of science should be taught and reflected in science education. Because of their unproblematic perception of science knowledge, they would not be expected to promote a science education that challenges the nature of science. Seen in relation to figure 2.4, AFCLIST can therefore be seen to reflect a majority of equality feminist perspectives in recommendations for how science education should be organised to increase gender equity as well as in their (absence) of recommendations to how the nature of science should be presented.

Although my overall analysis of AFCLIST reveals mostly equality feminist perspectives, other understandings are also present among the AFCLIST actors. My analysis of AFCLIST indicates that there is a need within AFCLIST to be more explicit in terms of defining what the organisation means by “addressing gender issues” in order to develop more consistent gender initiatives. My understanding is that there has been little focus on gender within AFCLIST. The initiatives that have been carried out to “address gender issues” seem to be planned without a sound theoretical foundation. Gender-neutral initiatives have been criticised for not sufficiently addressing the needs of all marginalised groups. My study of AFCLIST indicates that such critique could also be raised against AFCLIST.

6. Contrasting FEMSA's and AFCLIST's approaches to gender equity

6.1 Introduction

The point of departure for this research journey has been to use feminist theory to see whether it can add a new perspective to understanding different approaches to secure gender equity in science education. I have used this theoretical discourse to analyse how two initiatives in sub-Saharan Africa work towards increased gender equity in science education.

In the two previous chapters I have used the theoretical framework derived from feminist theory to analyse FEMSA and AFCLIST individually. In this chapter, I discuss some of the distinct features of the two cases in relation to each other. The purpose of this analysis is to tease out and discuss some central features that can be helpful in order to visualise similarities and differences in FEMSA and AFCLIST's approaches to gender equity in science education.

A comparative analysis of FEMSA and AFCLIST was carried out subsequent to the discussions between FEMSA and AFCLIST after FEMSA was established in 1995. FEMSA and AFCLIST then felt a need to outline the similarities and differences between the two initiatives. The purpose of doing this was to avoid competition for funding. By showing the differences between the two initiatives they wanted to visualise how each project played its own important role in terms of improving science education at the African continent. The "position paper" (AFCLIST, 1995) that resulted from this process, focuses mainly on organisational differences between FEMSA and AFCLIST. The main differences outlined in this paper include:

- AFCLIST's main focus is to improve science education regardless of gender while FEMSA targets girls in particular.
- FEMSA believes change is best achieved through strong organisational presence in member countries organised around national centres and national action plans. AFCLIST believes that systemic change is better achieved from within national systems through a critical mass of skilled science educators.

- FEMSA focuses more than AFCLIST on mathematics while AFCLIST focuses more on technology.
- FEMSA has more full time staff than AFCLIST.
- FEMSA focuses all activities on the mainstream education system, while AFCLIST focuses on activities also outside of the educational system.
- FEMSA has, through the link with ADEA, better access to donor organisations and ministries of education than AFCLIST has.

In my analysis of the two cases, I focus mainly on other aspects of the two initiatives than the differences outlined in the position paper. I focus particularly on differences and similarities in FEMSA and AFCLIST's objectives and missions, their identification of obstacles and target groups, their leadership and choice of personnel and the relationship between research and action within the two initiatives. I also discuss similarities and differences in the two initiatives' recommendations for change and how they have organised their work to secure gender equity in science education. I end this chapter by a brief discussion of why I consider FEMSA to be a female-friendly project while I consider AFCLIST to be a gender-neutral initiative.

6.2 Objectives, mission and arguments for change

Both FEMSA and AFCLIST were implemented in order to change science education systems. FEMSA has a clearly defined and expressed goal that is presented using identical formulations throughout its written documentation:

> *The over all goal of FEMSA is to "improve the participation and performance of girls in Science, Mathematics and Technology (SMT) subjects at primary and secondary school levels" (http://www.fawe.org/femsa/Defaultold.htm).*

AFCLIST most often describes its overall goal using the expression "Mission". The AFCLIST mission (although formulated a bit differently in different documents) is to:

> *Develop the base for strong science and technology culture among young people in Africa. Involvement in this culture provides youth opportunities to participate actively in democratising the educational process and society, as well* as providing a base for *development of higher level human resources in science and technology" (AFCLIST, 2003).*

For FEMSA, increased female participation and performance in science education is the aim that is formulated in their objectives. For AFCLIST, working towards increased gender equity is seen a means to approach AFCLIST's mission *"to contribute to the social, economic and political transformation of sub-Saharan Africa"* (AFCLIST, 2003). In one AFCLIST document it is stated that AFCLIST builds on theoreticians like Paulo Freire and Angela Davis (Savage et al., 2001, p. 16)[50]. The organisation also emphasises the important role high quality science education might play for the development of democracies (AFCLIST, 2000). Through its policies AFCLIST formulates a wish for political change and transformation of sub-Saharan Africa.

Neither FEMSA's nor AFCLISTS's documents focus on discussing what the two initiatives wish to achieve by having more females involved in SMT and SMTE. AFCLIST expresses what they want to accomplish by changing science education without separating what they want to achieve by having more *females* involved in science education from what they want to achieve by having more *pupils* engaged. Throughout the documentation written by members of the AFCLIST secretariat it is expressed that AFCLIST's overall aim is to develop a science education suited to educate learners who are able to contribute and change the social and economic development of countries in Africa. AFCLIST gives directions to what type of teaching and learning methods the initiative wishes to promote. The reference to Freire indicates a desire to promote critical education. In its documents AFCLIST also repeatedly argues that they believe inquiry science education is best suited to develop critical and creative citizens capable of contributing to the transformation of society, democracy building and increased economic and social development in sub-Saharan Africa.

The initiatives carried out by FEMSA are developed to achieve the aim of increased female participation and performance in SMTE without making explicit through their objective what they expect to accomplish by this goal. In some of the documents the expected benefits of female education for social and economic welfare is mentioned, but these discussions are not given much place in the FEMSA documents. Even though the interviews of the country Coordinators show that they have different perspectives regarding what they

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[50] While Freire is most known for his development of critical pedagogy and the writing of "The Pedagogy of the Oppressed" (Freire, 1968/1970), Davis is a renowned philosopher who gained international attention when she was fired from her position at UCLA because of her membership in the Communist Party in USA. Davis understands theory and praxis as dialectically linked, she rejects theory as abstract, ahistorical and decontextual and argues that synthesizing theory, community and critical coalition politics is key to revolutionary change (Code, 2002).

want to achieve by recruiting more females to science, FEMSA in its formulation of objectives and goals does not express explicitly their visions for a transformed society beyond the goal of better participation and performance of girls in SMT subjects in primary and secondary school. As discussed in chapter 4, the formulation of FEMSA's objectives does not imply any particular methods. According to the objective, any method contributing to increased female participation and performance in SMTE would be plausible.

In my interviews with the actors engaged in AFCLIST and FEMSA, similar arguments were pushed forward to explain why more females should be given the possibility to engage and succeed in science. Most of the arguments are in the categories I have defined as "add on" arguments. Such arguments comprise arguments that represents the perspective that having more females engaged in science would be beneficial because it is important for increased development that more people are engaged in science. These types of arguments focus on the benefit to the society of having more scientifically literate people. Such benefits can be improved livelihood in families, and the benefit to the broader society by having a larger scientific literate work force. "Add on" arguments constitute most of the arguments raised for the benefit of increased female participation and performance in SMT and SMTE in both initiatives. "Add on" arguments do not include arguments representing the perception that women could advance a different science or technology than men. I have labelled the arguments that represent the perspective that females would contribute with something different than males to science "Change arguments". These types of arguments are also present in both initiatives, however less dominating than the "add on" type of arguments. Limited critical attitudes are expressed in any of the two initiatives against science inquiry, and no claim of scientific inquiry as androcentric is made by actors in any of the two initiatives. Since both initiatives seems satisfied with science the way it is currently developed, claiming that females will change science is perhaps not seen as an important outcome. There are, however, examples in both initiatives of actors claiming that women would engage in scientific inquiry in a different way. One actor from AFCLIST said he believed women would bring in more details in scientific research, some argued that women would interpret results in a different way than males, and some argued that women would be more concerned about the ethics of scientific inquiry.

Some of the actors also argued for increased female participation and performance from an "empowerment" perspective claiming that being scientifically literate would in different ways benefit women. My main understanding of the argumentation raised by the various actors within the two initiatives is still that the emphasis is on the benefit to society of having *more scientifically* literate females, not because they would be able to contribute with something *different* to the development and priorities in scientific inquiry.

Seen in relation to the analytical framework developed in chapter 2, the objectives of the two projects reflect no desire to redress gender bias in scientific inquiry. The objectives of both projects are to make the body of scientific knowledge available and relevant to more people in sub-Saharan Africa. Their understanding of why and how this should be done, who should be targeted and how, does however vary between the two initiatives.

The overall goal of FEMSA is to achieve gender equality in science and mathematics education. The formulation of FEMSA's goals and objectives should make it easier to evaluate the success of FEMSA than to evaluate AFCLIST on the basis of its mission. As I have shown in chapter 4 it has, however, proven impossible to evaluate the success of the quantitative goals of FEMSA due to the lack of quantitative, gender segregated data both prior to the implementation of the project and also after FEMSA as a project was ended. After AFCLIST became independent from RF, there has been no external evaluation measuring the success of AFCLIST.

6.3 Identification of obstacles

AFCLIST: Obstacles were identified by African science educators, FEMSA: obstacles were identified by own research

After AFCLIST became disconnected from Rockefeller Foundation, AFCLIST initiated a conference of 150 renowned science educators, mostly from countries in sub-Saharan Africa (ASTE 1995). The challenges identified by these science educators have formed the understanding of the challenges which AFCLIST has later organised its work to address.

FEMSA on the other hand was initiated by donors to address underrepresentation and underperformance of females in SMTE. The obstacles for female participation and performance in SMTE were identified based on research carried out in the project's first phase.

The documents presenting the challenges the two initiatives aim to address, appear very different. The report from ASTE 95 consists of 13 chapters, written by science educators from throughout Africa. The first 12 chapters deal with different aspects of science education, and report on research and literature studies carried out by the various presenters. The 13th chapter of the book is written by the director of AFCLIST. In this chapter he summarises the main issues discussed at the conference and considers how AFCLIST can move to address the challenges identified. All the chapters are based on research both from an African as well as from an international arena. They are written for an academic audience, but with recommendations to policymakers and teachers as well as to academic research institutions.

The obstacles, on which FEMSA bases its interventions to address, were all identified through the project's first phase, the research phase. The obstacles were identified mainly through interviews with and questionnaires filled in by different actors within the educational system. These actors were pupils and parents, teachers and school principals. The presentations of the findings from FEMSA's research are presented in the 16 Dissemination Reports produced after FEMSA's first phase (see chapter 4). The Dissemination Reports differ from AFCLIST's report as they are based solely on empirical material from their own research. No reference is made to relevant African or international research, and recommendations are presented as they appeared in the interviews and questionnaires, without being qualified and discussed professionally.

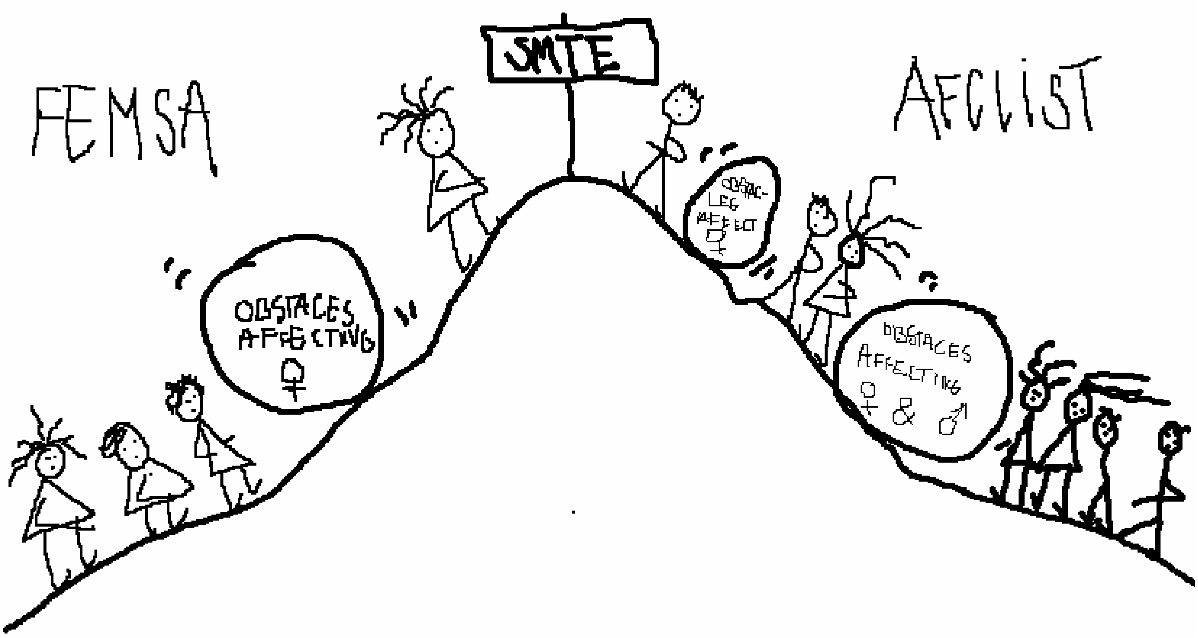
Although FEMSA reflects a perception of females and males as different in their engagement in science, they do not refer to any literature documenting such differences. Instead they carried out their own research aiming to identify what were girls' "strengths and weaknesses" in science education. The findings from this research were presented as one of FEMSA's main findings.

I see the presentations of obstacles as characteristic for the way the two initiatives have chosen to work. While AFCLIST tries to collect already existing evidence, FEMSA chose to develop a new research process to collect the evidence needed for action and did not refer to any other research carried out previously on similar issues. AFCLIST in other words tries to identify findings that have already been undertaken, discuss and make these findings visible for a broader context while FEMSA started from scratch.

FEMSA: sex as critical factor, AFCLIST: Poverty

As shown in the description of the cases, AFCLIST sees lack of quality education as the main challenge for science education in sub-Saharan Africa. AFCLIST argues that before dealing with gender specific obstacles, factors caused by poverty that affect all pupils in poor contexts need to be addressed. AFCLIST’s descriptions of what obstacles cause female underparticipation and underperformance in SMT and SMTE therefore emphasise the factors that affect pupils in poor countries without focusing particularly on the factors that affect girls.

Fig. 6.1: AFCLIST and FEMSA’s analysis of obstacles to female participation and performance in SMTE. While FEMSA discusses only obstacles affecting females, AFCLIST considers that the majority of obstacles that have a negative effect on girls, also to impact negatively on boys. AFCLIST, however, acknowledges that girls are faced with an additional set of obstacles as compared to the boys.



FEMSA on the other hand was initiated for the purpose of identifying and addressing obstacles that have a negative impact on female participation and performance. The obstacles to female participation and performance are presented in the FEMSA documents as affecting females without also being analysed in terms of their possible effect on males. AFCLIST as an initiative emphasises and focuses on removing the obstacles to participation and performance in science education that affect males and females equally. Apart from statements made in a couple of papers written by AFCLIST actors, this initiative does not reflect understandings of males and females being any different in their engagement in science education and hence do not seem to presume that most of the problems pupils experience in science classrooms affect girls and boys differently. AFCLIST is quite consistent in its claim that obstacles to increased participation and performance in science education are caused by factors external to the girls. AFCLIST therefore can be seen to reflect equality feminist perspectives in its analysis of obstacles to female participation and performance to science education. FEMSA with its focus on factors affecting females, its reference to girls' special difficulties, and its research on girls' strengths and weaknesses, in my opinion reflects perceptions that males and females are different in their engagement in science education. I therefore regard FEMSA as a project to reflect difference feminist perspectives in this regard, although some of the Coordinators have expressed the opposite perception.

AFCLIST AND FEMSA do not see science as problematic

In none of the two initiatives have I found any attempt to raise any feminist critique against science. My understanding is that the two initiatives regard science to be a crucial tool to development, a tool that must be made available to the majority of the African population. More scientifically literate people is seen to benefit the population at an individual and a societal level. While the emphasis of AFCLIST is to make this body of knowledge relevant to the public by improving the quality of science education, the main focus of FEMSA has been to find ways of having more females engaged in science education.

Sandra Harding (1992) argues that without challenging the andocentric practices and policies implicit in scientific research practice and politics there is no point in recruiting more females to science. If one does not believe that females will contribute to something different and qualitatively better to scientific research she asserts there is no reason to recruit more people to this enterprise. Harding expresses critical attitudes towards scientific knowledge and claims that this knowledge is developed to serve the need of the ruling class. She wants more females and other oppressed groups to be involved in science research to challenge the oppressive practices within scientific research practice. Her argument is that without challenging the practices and the focus within scientific and technological research, recruiting more female scientists will not do any good. Similar perspectives are not reflected by actors in FEMSA and AFCLIST. Their focus is on scientific research as a positive activity that will benefit societies in Africa if it was made available to the public.

The research phase of FEMSA showed that several of the people interviewed tended to see science as an enterprise as masculine (see chapter 3). This finding was not by the FEMSA actors analysed in relation to feminist literature explaining female underrepresentation in SMT from similar understandings. By FEMSA understandings of science as masculine domain were regarded as misconceptions that could be removed by “sensitisation”.

It is my understanding that actors within FEMSA and AFCLIST have a strong faith in the potential of scientific methods to eliminate biases and produce objective knowledge. In spite of the fact that several of the actors in both initiatives argue that they believe females would contribute with something different than males to scientific inquiry, none of the actors raises any critique against scientific knowledge for being biased and influenced by the sex/gender of the scientist.

6.4 Recommendations and approaches to gender equity

6.4.1 Leadership

Both FEMSA and AFCLIST have been organised by a strong and influential secretariat consisting of men. The secretariat writes documents that represent the initiative using expressions such as “AFCLIST thinks”, “FEMSA believes” and so forth. My study of the two initiatives indicates that the perspectives described to be representative for the two groups are in both initiatives more representative of the opinions of the secretariats than of the entire group. Not unexpectedly the background of the members of the secretariat, and their personal experiences and agendas are reflected in the descriptions of the initiatives. While the descriptions of FEMSA never refer to other research on the area, the writings of AFCLIST appear more academic and are most often positioned according to other research relating to the topics they are addressing.

Based on my study of the two initiatives I would argue that the secretariat of AFCLIST tries to add value to the various initiatives carried out throughout the network by placing them within a broader theoretical framework. The FEMSA secretariat, on the other hand, seems to have tried to add value to the work carried out in the various FEMSA countries by simplifying the findings and developing easy, manageable solutions, often to very complex problems.

The secretariat of AFCLIST also seems to have a stronger agenda in terms of what type of interventions they want to support than what the case is with FEMSA. At the meetings I have attended organised by AFCLIST, the secretariat, who always chair the meetings, openly try to influence the actors with their perspectives to what type of educational praxis they wish for the actors to promote. In spite of critical discussions at these meetings, and a secretariat always open to discuss, it is my understanding that the AFCLIST secretariat has strong influence in this group and is highly respected by the actors. Since I have attended fewer FEMSA than AFCLIST meetings and therefore base my understanding mostly on minutes and meetings and interviews, I will not argue strongly that the situation has been different in FEMSA. Several of the people that have participated at FEMSA meetings have said that these meetings were mainly characterised by the various actors reporting on their findings. According to my informants, time was very seldom allocated for critical and professional discussions relating to the issues FEMSA addressed. The different traditions of critical engagement were clearly demonstrated at the joint AFCLIST/FEMSA gender workshop in Nairobi in 2001. While the members of AFCLIST critically engaged academically in each others presentations, it was requested by the FEMSA secretariat that comments made to the presentations should be less critical. I understand this event to be an illustration of AFCLIST, as compared to FEMSA, as a project much more grounded in an intellectual and academic tradition where critical discourse is considered to be “part of the game”.

6.4.2 Selection of personnel

My study of FEMSA and AFCLIST indicates that both initiatives have chosen their personnel assuming that sex is a factor relevant for action. I base this claim on both initiatives’ emphasis on using female personnel as an instrument in addressing gender inequalities in science education. In its documents about gender equity AFCLIST presents gender equality in boards and administration as one of its main efforts carried out to secure gender equity while FEMSA regarded sex, not competence on gender issues, to be a more critical factor for the Country Coordinators.

According to my interviews of the actors in AFCLIST I have found no evidence that the female science educators were more concerned about gender issues in science education than their male counterparts. Simeone de Beauvoir in “The other Sex” writes that

> *In a time when women are starting to take part in the shaping of the world, this world still belongs to men (de Beauvoir, 1953, p. 15).*

Common to all the female actors interviewed for this study is that they have been able to succeed in a world that “belongs to men”. I believe that in order to succeed in this world on equal terms as men it is required to adjust to the rules made by men. Perhaps the pioneering women that manage to adjust to these rules are the ones who are atypical in the sense of not being affected by the oppression having negative impact on other females in their context. But the qualifications required to succeed on equal terms as men in their masculine world are perhaps not the same qualifications required to bring femininity into science and science education and to know how best to address gender issues within science education. The pioneers are, however, crucial in order to visualise for younger women and men that it is possible for women to succeed in fields traditionally dominated by men.

It is my understanding that none of the female actors in any of the two initiatives were selected to the central positions of the two initiatives because they had a record of engaging in science and/or science education in a *different* way than males. They were selected because they were able to succeed on *equal* terms as males. At the same time they are expected to contribute with new ideas and perspectives to how gender issues might be addressed in science education. AFCLIST has not formulated explicitly its purpose of using female actors as agents to secure gender equity in science education. FEMSA claim that female Country Coordinators were chosen, to be able to act as role-models.

6.4.3 Relationship between research and practice

The process of FEMSA has been to move from a two-year research phase to a four-year action and implementing phase and was supposed to end up in a third mainstreaming phase.

The research phase outlined the constraints faced by girls in science education and came up with recommendations towards how these obstacles could be combated. In the second phase the project moved from research to action through implementing the recommendations in schools within 11 countries throughout sub-Sahara Africa. The third phase should focus on mainstreaming the initiatives into each country’s education system (O’Connor, 2002b).

The main focus of AFCLIST is not to start new projects but to identify projects and individuals that are already engaged in innovative projects and support to them in developing and publishing their work. Theory building, research, and action are seen as circular activities.

Instead of starting new projects AFCLIST identifies local initiatives that have already proven to work. Through these initiatives, AFCLIST tries to establish a critical mass of skilled science educators who can impact the broader education system.

The publications made available from FEMSA are mainly publications with reference to the whole project. The FEMSA actors have produced very few research articles[51] and other publications that have been made available to the public. The first phase of FEMSA resulted in the production off 16 Dissemination Reports describing the experiences from the project. Similar reports should have been produced to document the findings from the second phase of the project (O'Bura et al., 2000). This was however not done. AFCLIST as a network have more individual publications, and put more emphasis on publishing and disseminating their experiences. Both initiatives have produced education materials targeting children and teachers.

6.4.4 FEMSA: a female-friendly approach, AFCLIST: a gender- neutral approach

Both FEMSA and AFCLIST see gender inequity in science education as a problem and have developed strategies for how such gender inequity should be reduced. AFCLIST sees all pupils in poor African societies as marginalised because of poverty and limited ability to achieve a good quality education. Obstacles affecting all pupils regardless of their sex are seen as major hindrances that need to be addressed before dealing with even further marginalised groups of pupils such as girls. AFCLIST's approach to gender equity is therefore to address quality in science education in general. Besides working towards increased quality education for all pupils, AFCLIST's strategy is to apply as a guiding principle that all projects shall address gender issues.

It seems like AFCLIST's focus on factors affecting all pupils regardless of their sex have taken focus away from the additional factors that only affect girls. In spite of the guiding principle of addressing gender issues in all projects my study indicates that few projects have done this in a serious way. On the other hand FEMSA's exclusive focus on females seems to have taken focus away from negative factors also affecting males. Evaluators of FEMSA have therefore accused some of FEMSA's initiatives of being discriminatory towards boys.

[51] The only two articles published by FEMSA actors that I am aware of are: Mulemwa (2000) and O'Connor (2001).

While AFCLIST has failed to account sufficiently for the obstacles that particularly affect females, FEMSA's exclusive focus on girls seems to have caused ignorance towards other marginalised groups in science education. The projects therefore in different ways tend to ignore variations within groups of people constituting each target group. While obstacles affecting females as a group have not been given the desired focus within the project that bases its understanding of obstacles first and foremost on factors caused by poverty, obstacles affecting other people than the target group of females might be overlooked within projects focusing solely on girls.

By defining all pupils in poor, underresourced schools in sub-Saharan Africa as marginalised, AFCLIST has not given priority to one group of pupils over another. They have tried to accommodate the particular underrepresentation and underperformance of females in SMT education by integrating gender issues into all levels of the organisation, a so called "gender mainstreaming" approach[52]. A central question regarding gender mainstreaming is whether such an approach is sufficient in order to secure that gender issues are taken adequately care of (Moser, 1993). My study indicates that for the case of AFCLIST the guiding principle stating that all projects should address gender issues has not been satisfactory to secure that gender issues have been dealt with seriously within the various parts of the organisation. Reeves and Baden (2000) point to the importance for gender mainstreaming projects of building capacity on gender within the organisation. One solution can be to have a special gender unit that has particular responsibility for gender issues and that makes sure that gender aspects are sufficiently mainstreamed within the broader organisation. AFCLIST wished to establish such a gender unit by setting up a gender node (Naidoo & Savage, 1998). It seems like establishing such a noted could strengthen AFCLIST's work towards increased gender equity.

FEMSA, in contrast to AFCLIST, applied strategies to focus exclusively on females. All initiatives from FEMSA have been planned particularly to accommodate this group. Evaluators of FEMSA have argued that FEMSA through this method has disregarded marginalised groups across this division

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52 "Gender mainstreaming" is by the Institute of Development Studies at the University of Sussex defined as: "An organisational strategy to bring a gender perspective into all aspects of an institution's policy and activities, through building gender capacity and accountability" (Reeves & Baden, 2000, p. 12). Gender mainstreaming was also used as a term by FEMSA to describe the main focus of the project's third phase: To mainstream the experiences from FEMSA into the education policies of each participating FEMSA country. As written in chapter four this phase of FEMSA has not yet taken place.

(O-saki & Bunwaree, 2003). They argued that in some countries FEMSA's exclusive focus on females had ignored boys with special educational needs in favour of females with a lot of resources. Similarly female pupils that perform well may feel stigmatised by a project committed to identifying and addressing girls' "special problems". In this way, projects planned to redress some inequities can actually end up stigmatising other marginalised groups. Similarly projects that seek to challenge stereotypes regarding what females can and cannot do may actually create new stereotypic understandings of what it means to be a female.

> *(…) the search for pedagogies that are suitable for girls often boils down to trying to identify the essential nature of girlhood (Kenway & Gough, 1998, p. 18).*

Such critique has been raised against gender-neutral and female-friendly science education initiatives. My study shows that similar critique can also be levelled against FEMSA and AFCLIST.

7. Conclusions, critique and reflections

Science, mathematics and technology education constitute the areas of the educational system where girls are most marginalised compared to boys in a majority of the poorest countries of the world. This is also the area of the education system where much of the knowledge needed to break out of poverty could be learned. This study emerged from a realisation of the important role science and science education can potentially play to reduce poverty and increase development. Curiosity about the key to increased female participation and performance in science education has also motivated the study.

Norway has contributed economically to some of the major initiatives aiming at including more pupils in science education in sub-Saharan Africa. Through my dissertation I got the opportunity to learn more about how these initiatives work towards gender equity in science education.

I end this dissertation by briefly discussing whether I consider my research journey to have answered my research questions. I provide a critique of my study and elaborate over some of the complications that I have been faced with along the way. I close this chapter with some personal reflections and recommendations at the end of my research journey.

7.1 Conclusion

7.1.1 How does the academic discourse about feminism, females and science impact science education initiatives targeting girls?

My initial research question was whether the academic discourse about feminism, females and science, in particular feminist critiques of science, influences science education initiatives in Africa which target girls. After my first interviews, I realised that feminist critiques of science were rarely read by the actors in charge of the two major science education projects in Africa and therefore could not be seen to have had any impact on these initiatives. Also general literature written about females and science education seemed barely read, particularly by the actors in FEMSA.

One of the interviewees from FEMSA explained that a reason why literature on feminist critique of science had not impacted on their work was that there were more pressing needs that needed to be addressed in order to include more females in science education than looking for hidden masculinities in scientific knowledge. Another interviewee from FEMSA said that Africans, being “passengers in the world” could not be critical towards knowledge that could possibly bring progress and development to the continent. One of my interviewees from AFCLIST claimed that initiatives like FEMSA and AFCLIST are not guided by one particular set of theories, but have developed on the basis of several theories and experiences.

I thought that an additional reason to why feminist critique is not read and used by actors working towards gender equity in science education might be that it can be difficult to see what relevance feminist critique of science can possibly have for such initiatives. I decided to change my focus to study whether feminist critiques of science could be a relevant point of departure for reflecting on various explanations to gender inequity in science. I also wanted to examine the relevance of this literature to better understand different approaches to gender equity in science education. By doing this I have attempted to demystify feminist theories and critique of science and explore their possible relevance to initiatives dealing with gender issues in science education.

My focus therefore changed from initially aiming to study whether a selected set of theories guided initiatives like FEMSA and AFCLIST, to study these initiatives through the lens of a theoretical framework derived from a selected set of theories.

7.1.2 Can feminist theories and critiques of science be used to analyse and develop science education initiatives which address gender issues?

The second research question guiding my study was whether feminist theories and critiques of science could be used to analyse and develop science education initiatives aiming at gender equity. By addressing this question I wanted to explore whether such theories could be useful to analyse science education initiative in a way that could add new insight to the understanding and further development of such initiatives. To answer this question I developed an analytical framework derived from feminist critiques of science that showed three distinct approaches to gender equity in science education. I made use of this analytical framework to conduct an analysis of two science education initiatives in sub-Saharan Africa.

The analytical framework suggests that different perceptions about how a person's sex/gender impacts on how he/she engages in science education should imply different approaches to achieving gender equity in science education. In my study of AFCLIST and FEMSA's approaches to gender equity in science education, I have therefore tried to identify what perceptions about sex/gender are reflected through the two initiatives. My study shows firstly that none of the two initiatives I have analysed as cases were planned based on a unified understanding of how sex/gender might impact on engagement in science and science education. Secondly my study shows that contradictory recommendations exist within each initiative to how gender equity should be approached. My analytical framework has made it possible to unravel such inconsistencies within the two initiatives. It has also proven useful to reflect and clarify different understandings of what we can expect to achieve by involving more females in science inquiry. The analysis has also shown that the answer we give to this question actually entails very different implications for how we should design science education projects to approach gender equity.

In my analysis of the two initiatives, I have analysed interviews and documents to illuminate what perceptions are reflected as to how sex/gender impacts on pupils' engagement in science education. I have done this at a relatively detailed level, analysing the initiatives at a sentence level, and teased out contradictions in statements made by individuals. By carrying out an analysis at such a detailed level of a group of individuals, one will always find contradictory statements. This has been the case also in FEMSA and AFCLIST. Both FEMSA and AFCLIST are initiatives carried out by independent and well educated scientists and science educators. These actors do not have one unified perception about the issues raised in this thesis. Within both initiatives there are therefore examples of recommendations that reflect a variety of perceptions of how sex/gender can be seen to impact males' and females' engagement in science inquiry as well as in science education. Due to the disagreements and contradictory opinions implicit in FEMSA and AFCLIST of how gender inequity in science education should be addressed it might be argued that treating these initiatives as singular cases, each representing one approach to gender equity, is impossible.

I acknowledge the contradictions implicit in each initiative, and the fact that my analysis of the cases will be my understanding, and not necessarily the true representation of their approaches to gender equity. Acknowledging these limitations, I have still found it plausible to treat the two initiatives as cases and describe the typical features of each initiative's approach to gender equity. In order to do this, I have had to look for characteristics of how the initiatives work at a general level. My way of doing that has been to focus on the empirical material that presents the initiatives as such. This means that the voices of the secretariat claiming that "AFCLIST means" and "FEMSA thinks" and so forth have been given more weight in my overall analysis of the two initiatives' general approach to gender equity than the voices of the individual actors. This means that some of the voices of actors involved in the two initiatives that represents contradictory understandings compared to what I, based on my analysis of the cases, have found to represent the position of the case as such might have got lost in my general description and analysis of the case.

Based on this realisation I would argue that if the analytical framework should be used to analyse and plan similar initiatives in the future, it might be used at a less detailed level than I have used it in this dissertation. By using it at a less detailed level, I think the analytical framework can still be drawn on to raise the consciousness of people working with gender issues in science in terms of what perceptions about the relationship between gender and science they operate within. Hopefully the description of different approaches to gender equity can also be found valuable to become more consistent in terms of the relations between objectives and means when similar initiatives are planned in the future.

Through this thesis I have shown that feminist critique of science can be *used* to analyse science education initiatives addressing gender issues. Whether it has been *useful* and whether it will be useful when developing initiatives addressing gender issues in science education, I think has to be judged by other than me.

7.1.3 How do two African science education initiatives supported by Norwegian aid address gender issues?

The third research question in my study has been to study how African science education in initiatives supported by Norwegian aid address gender equity. The two initiatives chosen as cases were AFCLIST and FEMSA. These initiatives were chosen since they represent two major efforts to transform science education in sub-Saharan Africa and since they are the only initiatives focusing exclusively on science education that are supported through Norwegian aid. Based on the theoretical framework developed in chapter 2, I positioned my two cases within a female-friendly (FEMSA) and a gender-neutral (AFCLIST) approach to gender equity in science education. In chapter 4 and 5 I have explained my analysis of how FEMSA and AFCLIST address gender issues.

The main aspects that I have found to separate the two initiatives' approach to gender equity in science education have been discussed in chapter 6. These aspects can be summarised in the following table:

ASPECTS	FEMSA	AFCLIST
Objective	Quantitative: Increased female participation and performance in SMTE Gender equity in science education is the goal	Qualitative: Systemic change through increased quality in SMTE Gender equity in science education is a means to reach the goal
Mission	Development, apolitical, uncritical	Development, change, political, critical
Methods	Do not prescribe particular methods	Promote inquiry /critical science education
Target Group	Female pupils	All pupils
Selection of personnel	Female science educators with an interest in girls and SMTE	Innovative science educators. Aim is equal number of males and females in boards and administration
	No attempt to recruit female scientists/science educators who have a record of engaging in science/ science education in a different way than males	
Relation between research and action	Three well defined phases: From research to action	Research and action as circular activities
On what basis are initiatives planned?	Own empirical research in phase 1	ASTE 95 + theory
Leadership	Practical / pragmatic / simplifying	Theoretical/ academic/ theorising

<table>
<tr><td rowspan="5">Understanding of obstacles to female participation and performance in SMTE and SMT</td><td colspan="2">No critique of science raised</td></tr>
<tr><td>Sex as main analytical factor</td><td>Poverty as main analytical factor</td></tr>
<tr><td>Emphasis on factors affecting females</td><td>Emphasis on factors affecting males and females</td></tr>
<tr><td>Focus on differences in males and females approach to science education</td><td>Focus on similarities in males and females approach to science education</td></tr>
<tr><td colspan="2">- but exceptions within both initiatives</td></tr>
<tr><td rowspan="2">Argumentation for increased female participation and performance in policies</td><td colspan="2">No explicit argumentation for why increased female participation and performance is wanted is formulated in objectives of initiatives</td></tr>
<tr><td>FEMSA does not discuss this in its objectives and policies</td><td>AFCLIST argue for increased general participation in SMTE</td></tr>
<tr><td>Recommendations for change</td><td>Female - friendly science education</td><td>Gender - neutral science education</td></tr>
</table>

Table 7.1: How do two African science education initiatives supported by Norwegian aid address gender issues.

The objective of FEMSA is quantitative in the sense of focusing on increasing the number of females in science and mathematics education, without being explicit about what type of science education they want to develop in order to reach the aim. In AFCLIST's objectives what type of transformed society they would like science education to contribute to, and what type of science education should be developed to reach this goal is expressed clearly. AFCLIST in that way appear to be more political and critical in their approach than FEMSA does. While FEMSA sees gender equity in science education as an end, AFCLIST regard gender equity as a means to reach their goal of a high quality science education.

A major difference in how the two initiatives approach gender equity is that FEMSA focuses in particular on female pupils while AFCLIST targets girls and boys equally. AFCLIST expresses that they regard gender equity best to be achieved by a general improvement of the quality of science education, while FEMSA regards it crucial to develop particular initiatives targeting girls. AFCLIST does not regard sex to be a major influencing factor on pupils' learning situation in sub-Saharan Africa. FEMSA operates with two categories of pupils – males and females. This initiative has chosen to emphasise and focus on one group over the other, namely girls. They argue that their pilot study revealed that the variations within the group of females they investigated in the four pilot countries were marginal. Therefore they considered their identification of obstacles to female participation and their recommendations for change to be valid for the total group of female pupils across the 12 nations they operated. While AFCLIST might be accused of creating a stereotyped picture of what it means to be a pupil in an African classroom, FEMSA can be accused of creating a stereotypy of what it is like to be a female pupil in sub-Saharan Africa and designing the project to accommodate this image.

While FEMSA used only female Country Coordinators to drive the project, AFCLIST wants to have equal numbers of males and females in boards and administration. While they have succeeded in this goal in their boards, the secretariat of AFCLIST still consists of men only. Besides the benefit of having female role models, none of the two initiatives are explicit about what they expect to achieve by using female personnel to run the initiatives. None of the two initiatives have appointed female actors that have a record of engaging in science and/or science education in a different way than males.

FEMSA was a project consisting of three predefined phases (As noted in chapter four, only two phases were carried out). In 2001, FEMSA was taken over by FAWE, and seems not to have been taken much further after that. AFCLIST was started as a project under Rockefeller Foundation but has later been turned into an independent initiative organised as an NGO. While AFCLIST builds on previous research, FEMSA has been developed based mainly on the investigations carried out by the project in its first phase. The documents produced by FEMSA do not refer to research beyond what has been carried out by the project itself and there has been no attempt to publish the findings in an academic format. Most writings from AFCLIST are positioned in relation to national and international science education literature.

Neither FEMSA nor AFCLIST express any critique against science. FEMSA expresses obstacles to participation and performance in science mainly according to how such obstacles affect females, while AFCLIST emphasises hindrances affecting males and females equally. Through the project's documents FEMSA emphasises differences in how males and females experience science education while AFCLIST focuses on similarities in girls' and boys' experiences in science class.

Even though the individuals in both initiatives express many reasons for why they regard gender equity in science education to be important, none of the initiatives have formulated this explicitly in their objectives and policies.

In spite of some inconsistencies, I regard FEMSA to represent what I, in my theoretical framework, have labelled a female-friendly science education, while I regard AFCLIST to represent a gender-neutral approach to gender equity in science education.

My understanding is that some of the inconsistencies in terms of what perceptions about sex/gender are reflected in the two initiatives have resulted in some contradictory and unclear recommendations by FEMSA and AFCLIST regarding how gender issues should be addressed. Clarifying what understanding of the impact of sex/gender on science and science education the initiatives are grounded in, would, in my opinion make it possible to plan more targeted initiatives and formulate clearer recommendations as to how gender equity in science education should be achieved.

7.2 Critique and challenges

Applying feminist critique of science as a foundation to analyse science education initiatives has been an exploratory task. My research journey has therefore not been without challenges. In this section I will express some of the challenges I have been faced with. I will also discuss some of the critique I see that can be raised towards the feminist critiques of science and the use of such literature for analytical purposes.

7.2.1 Criticising feminist critiques of science

Applicable mainly to biological sciences?

Feminist critics discuss the interplay between science and the scientist. Several of the feminist critics I have reviewed for this thesis have shown how the sex/gender of the researcher has impacted on the research product. Most of these feminist critics have visualised this genderedness within biological sciences where sex is often used as a factor for analysis. Visualising genderedness within scientific knowledge where sex is not a natural factor for analysis, like physics and chemistry is less common. Critique might therefore be raised against feminist critiques of science for only being applicable to biological sciences. Keller (2003) argues that more work is needed to illustrate andocentric biases within natural sciences other than the biological.

Too much focus on the scientific product, too little on the processes?

While andocentric biases might be more apparent in the biological knowledge than in other sciences, the processes and priorities within such fields can still be influenced by individuals and economic priorities. Helen Longino (1990) accuses feminist critics of science for being preoccupied discussing the impact of sex/gender on the scientific content and being ignorant to the important role of the scientific processes. She argues that a narrow understanding of what it means to be a woman combined with a too narrow perspective of how individuals' impact scientific research processes can constrain our potential to impact research practice:

> *By focusing on science as a practice rather than content, as process rather than product, we can reach the idea of feminist science through that of doing science as a feminist (Longino, 1990, p. 188).*

Several understandings exist of what it means to engage in scientific inquiry as feminist and whether there is such a thing as feminist science inquiry. The description of feminine methodologies and research processes also varies among different feminist writers. Of common features that I have found to describe feminist processes in scientific research is the preference for qualitative research over quantitative, inclination of participatory research over non-participatory, the use of reflexive methodologies where the researcher gets into a dialogue with the research object, and a desire to challenge and change existing power structures and so forth. Some of these characteristics are expressed in Rosser's (1990) work as characteristic for female scientists. My impression is that later feminist critics of science inspired by postmodern thinking tend to use several of the same characteristics previously used to describe *female* science inquiry to represent *feminist* science inquiry. My understanding is that the continued use of the term "feminist", a word that is so closely related to femininity and females makes our understanding of the differences of meanings unclear. The ability of engaging in science as a feminist therefore, in my opinion, continues to be understood by many as something restricted to females.

Is andocentric bias in process and content really the issue?

One of my interviewees argued that there were more pressing issues to deal with in science education in sub-Saharan Africa than too look for hidden masculinities in scientific knowledge. As long as this body of knowledge is useful to advance economic and social development, there is no space for critique. It could be argued that the chances for a more socially responsible science could better be achieved by targeting research priorities than research practice. Seen from a development point of view it seems obvious that priorities within the sciences are ruled by economic interests. In 1998 the 28 OECD countries, according to UNDP, spent $520 billion on research and development – more than the combined economic output of the world's 30 poorest countries. In these countries more than 60% of research and development are carried out by the private sector with a correspondingly smaller role for public sector research (UNDP, 2001, p. 3). UNDP asserts that research priorities that have neglected the needs of poor people. According to UNDP the global spending on health research was in 1998 $70 billion, but just 300 million was dedicated to vaccines for HIV/AIDS and about $100 million to malaria research. Of 1223 new drugs marketed worldwide between 1975 and 1996, only 13 were developed to treat tropical diseases. It might therefore be legitimate to ask whether the most important task for science educators concerned about bias in natural sciences is to make explicit androcentricm in scientific processes and products, or whether it is more important to make explicit for the students the politics and economics that influence what knowledge we actually develop (and not develop) about the world.

Feminists criticise science, not science education

My interviews of actors within AFCLIST and FEMSA revealed that feminist critique of science was not widely read among this group. Neither did any of them seem to raise any critique of science for being masculine and preoccupied with issues of relevance mainly for males. Besides arguing that the situation they operated within required a different focus than to criticise science, some claimed they were not in the position of criticising knowledge that was developed by others and used by them.

I think that an additional reason explaining why this literature was not familiar to my interviewees is that not much feminist critique of science has been written for an audience of scientists and science educators. Feminist critique of science is written, I believe, mostly for other feminist critics of science and not for the people actually involved in science and science education. If the feminist critiques of science want to impact and change scientific research practice, I believe it is imperative to impact future scientists. To do this, the ideas developed by feminist critics of science should be made available to science educators and science students. I think that Howes (2002) as cited in chapter 2, is right in her claim that in order for this knowledge to make an impact there is a need for work that brings science education and feminist theory together.

7.2.2 Making use of feminist critique of science to analyse "real projects"

Some years after I had taken the course on feminist philosophy of science, I coincidently fell in with one of the lecturers of the course. It turned out that she remembered me from the course since, as she said, "you were the student who wanted to use feminist philosophy of science to analyse real projects!"

As written in chapter 2, few feminist critics of science and science educators inspired by feminist critics of science tend to have used this theoretical discourse for analytical purposes. The people who have utilised feminist theory as a resource in science education, have used this mainly to position themselves, and to outline the implications of their positions for gender and science education reform.

One challenge in using this theoretical body of knowledge for this particular purpose has been to understand and get an overview of the major feminist theories and critiques of science. I am not going to claim that I have an overview of this literature. In fact the more I read of this discourse – or more correctly – the more I read of these numerous discourses- the more I realise how little of this body of knowledge I actually have insights into. Since a major part of this literature is written for an audience other than science educators, it presumes that the reader has a certain background in the philosophy of science. This has for me made some of the readings hard to approach. On the other hand it might be legitimate to assume that I am not the only one who finds some of this literature difficult to grasp. I would claim that much of this literature is not easily available. As a person with a background in science, I also have a tendency to look for definitions and clear answers. This is certainly not characteristic for this body of knowledge. On the contrary much of this literature is written as a critique of simplified answers. It uses many words, it uses many labels, and disagrees with the labels set by others. In my attempt to understand this complicated body of knowledge, I might have misinterpreted some theoreticians. I underline that my presentation of the various feminist theoreticians represents my interpretations of their writings and acknowledge that some of them might not feel at home in the categories I have placed them within.

7.2.3 Creating categories that makes sense

> *When we establish a considered classification, when we say that a cat and a dog resemble each other less than two greyhounds do, even if both are tame or embalmed, even if both are frenzied even if both have just broken the water pitcher, what is the ground on which we are able to establish the validity of this classification with complete certainty? (Focault, 1971/1994, p. xix)*

Michel Foucault (1971/1994) in “The order of things” provides a perspective on how no categories are given by nature. He argues that every development of categories is marked by the background and presuppositions of the person who develops the categories.

And creating categories representing various approaches to gender equity in science education has in fact for me been problematic. In order to create categories I have had to typify. To separate one category from another, I have focused on the contrasts between the different positions. Most likely several positions could be detected in between my identified typologies. I will therefore not insist that my mapping of the terrain is *the* mapping of it.

As written in chapter 2, this thesis has not been an attempt to identify *all* possible approaches to gender equity, but to visualise that there do in fact exist different ways to approach gender equity in science education. By characterising some distinct approaches, I have also wanted to emphasise the importance of being explicit about what assumptions about how sex/gender impacts science and science education the initiatives are based upon. Without being explicit about what understanding of sex/gender and its impact on science one assumes, an initiative can easily provide contradictory recommendations to how change should occur. My analysis has uncovered such contradictory recommendations in FEMSA as well as in AFCLIST.

7.2.4 Using predefined categories – have I found (only) what I was looking for?

The categories developed through the theoretical part of the thesis were applied in the empirical part to analyse how FEMSA and AFCLIST address gender issues. The categories in the theoretical framework were modified and reworked as I worked with the empirical material.

The use of predefined theoretical lenses in qualitative research is questioned in methodological literature. Within grounded theory for example, the researcher should approach the empirical material without previously designed categories in order not to be constrained by trying to fit the empirical answers into an already established grid of predefined answers. Theory is to be derived/ grounded in the empirical material (Glaser & Strauss, 1967; Strauss & Corbin, 1998). I did much of my theoretical review previous to my empirical work with the cases. Because of this it could be argued that my previous knowledge provided lenses that limited what I saw through my empirical study of the cases. At the same time it would have been impossible for me to study the cases without any previous knowledge about the field I was to study. Even though I had read much theory before conducting my interviews I will argue that the way my study has evolved it has not been a deductive study since I have not used my empirical data to test a hypothesis drawn from a certain theory. Instead my research strategy has been more like the strategy explained by Glaser & Strauss (1967, p. 253) using existing theory as a source for new theory to: "line up what one takes as theoretically possible or probable with what one is finding in the field". Merriam (1998) argues that a study without theory is impossible.

> *Qualitative research is designed to inductively build rather than to test concepts, hypothesis and theories. Because of this characteristic, many believe mistakenly that theory has no place in a qualitative study. Actually it would be difficult to imagine a study without a theoretical or (a term that can be used interchangeably) conceptual framework (Merriam, 1998, p. 45).*

He argues that the theoretical framework reflects the researcher's disciplinary orientation and that it "is the lens throughout which you view the world" (p. 45). Merriam argue that "the trick is to make this framework explicit".

In this dissertation I have tried to make my framework explicit. Still, when using predefined categories in the empirical analysis, one may be accused of only finding what one is looking for, and not understanding what the initiatives are really about. Most likely my analysis of FEMSA and AFCLIST would have looked different if I had used a grounded theory approach. My project has, however, not only been an attempt to understand how two science education initiatives work towards gender equity in science education. It has also been an attempt to explore whether feminist critique of science could possibly be used to better understand such initiatives. In order to reach my goal, a grounded theory approach was hence not applicable. The task set for my project was to carry out the empirical case study to see whether the theoretical framework could be utilised to analyse such initiatives.

7.2.5 Using feminist theory – have I done justice to my cases?

I have positioned the two cases according to my description of a gender-neutral, female- friendly and gender-sensitive science education. None of the initiatives I have analysed as cases for this thesis have been guided by the theories used to develop my analytical framework. It could therefore be argued that my analysis of the two initiatives has not been made on the premises of the two initiatives, but on my own predefined understanding of what they should have done.

I acknowledge that by applying a framework for analysis that was derived from feminist critiques of science to analyse AFCLIST and FEMSA, I might have lost sight of other important dimensions of the two initiatives. By being explicit about the fact that the analysis is carried out from one particular perspective and that I do not claim that this perspective is the only legitimate perspective of which to view the cases from, I hope that I have managed to do justice to my cases and the individuals representing each initiative.

7.2.6 Limitations to qualitative research

Lack of rigour and clarity

Case studies applying a qualitative approach, as all qualitative research, have been criticised for lack of rigour and clarity. This involves problems of a poorly conceptualised theoretical framework and investigator's bias (Yin, 2003). In a case study approach the researcher is the main instrument in the collection and design of the study as well as in the process of analysing the data collected. The large quantities of data collected forces the researcher to focus on some issues, and thus base this selection on subjective criteria. Although the subjectivity of the researcher is more explicit in a qualitative than a quantitative research design, Yin (2003) argues that bias can also occur in quantitative studies, for instance in the design of a questionnaire. In qualitative research it is left primarily to the researcher to deal with procedural bias.

The fact that research develops and changes in direct meetings with the people of who one research, and that the researcher herself is the main instrument, makes personal biases and subjectivity impossible to avoid. A qualitative research study, (like all research) will therefore always be influenced by the person who reports on the study. Being open about this influence is in my opinion imperative to secure validity of research. I have, however, found it challenging to balance how much of "me" should be allowed to come through in the text. The result, I believe, of this balance has been that the degree to which my voice comes through has varied throughout the different sections of this text. Perhaps I could have been more consistent about this than I have managed to be.

Another issue that I have found challenging for my study in particular has been my unequal access to information about my two cases. The fact that so much uncertainty has been connected to FEMSA's destiny since 2001 has complicated my access to proper data from this study. It might be discussed whether my access to data about FEMSA has been too limited and that it might have been better to exclude the initiative from my study. When I still decided to include FEMSA as a case, this was because FEMSA represents a major initiative to approaching gender equity in science education in sub-Saharan Africa. I therefore considered the benefits of including FEMSA to be higher than the weaknesses caused by the limitations of data access.

Case study research is time consuming and requires a lot of resources

Qualitative research is often accused of being time consuming and requiring a lot of resources (Creswell, 1998; Nisbet & Watt, 1978; Peiszle-Goetz & Le Comte, 1991). The researcher most often commits to extensive time in the field in order to get access to the "insider perspective". The researcher also needs to engage in time-consuming processes of data analysis – the ambitious task of sorting through large amounts of data and reducing them to a few themes or categories. Yin (2003, p. 10) argues that since case studies do not imply one particular research method, and it is therefore not required for a case study researcher to spend much time in "the field" it need not take much time. My case study included fieldwork and interviews. This made my study vulnerable to the above mentioned critique. I do however believe that much of what made my study time consuming also had to do with my limited experience as a researcher. Carrying out this project was also a learning experience where I had to learn about the different phases of a case study along the way. I believe that the experiences from this study will make my next research project less time consuming simply because I will be able to plan the study better.

Case studies are not generalisable

A common concern about case studies is that they provide little basis for scientific generalisations (Burton, 2000; Yin, 2003). Stake responds to this critique claiming that “the purpose of a case report is not to represent the world, but to represent the case” (Stake, 2000, p. 448). Yin (2003, p. 10) argues that “case studies, like experiments, are generalisable to theoretical propositions and not to populations or to universe”. The purpose of my case study is not to determine how all science education initiatives in Africa work to address gender issues. The purpose is to use the two cases as examples of two distinct ways of how gender issues in science education are being addressed by initiatives in sub-Saharan Africa and in that way generate theoretical propositions about different ways of addressing gender issues in science education.

7.3 Personal reflections and some recommendations at the end of a research journey

My ambitions with this work has not been to find *the one* approach to reach gender equity in science education but to visualise the complexity of this challenge, and show the variety of possible pathways that might be possible to follow towards that end.

One recommendation that can be made on the basis of my study is that in order to plan science education initiatives suitable to obtain gender equity, it is important to be explicit about what understanding of the impact of gender on science and science education the initiative is grounded within.

Another point that has emerged through my study is the importance of consistency between objectives and methods for such initiatives.

When it comes to the question of which of the approaches described here is best suited to reach gender equity in science education, my answer to that would be my own personal perspective since I have not studied the impact of my two cases.

It does, however, seem beyond any doubt that the expectations for FEMSA when the project was planned have not been fulfilled. FEMSA was to gather information about what was causing gender inequity in science education in sub-Saharan Africa and recommend changes that could be mainstreamed into the educational systems in the countries where the project operated. Furthermore FEMSA was to establish a resource base that could be used as an up to date resource base to work towards increased female participation and performance in sub-Saharan Africa. The fact that FEMSA's web pages have not been updated in more than three years, and that it is impossible to get hold of information that it is claimed has been produced by the project, indicates that this goal has not been reached. So does the fact that several of the previous FEMSA schools according to the evaluation undertaken in 2003 were not even aware of having been involved in FEMSA.

I believe that weaknesses and contradictions in FEMSA's professional analysis and recommendations have caused some of FEMSA's problems. A variety of more organisational factors do however also seem to have contributed to limit the success of FEMSA. Such factors range from an unwillingness, and perhaps even incompetence by central actors within FEMSA to engage critically in professional discussions, personal conflicts between FEMSA and FAWE staff, fights for positions and a not enough well thought through project design.

It is my understanding that FEMSA's perceived "monopoly" on dealing with gender issues in science education in sub-Saharan Africa has also prevented other initiatives from working explicitly with gender equity. Correspondence between FEMSA and AFCLIST and their donors, indicate that AFCLIST's proposal to develop a node on gender issues was actively barred by individuals from FAWE and FEMSA because gender issues was seen as FEMSA's domain.

Whether AFCLIST would have had more success than FEMSA working towards gender equity in science education if they had managed to establish such a node is impossible to say. AFCLIST's approach to build initiatives around resource people and their already established projects seems to be a better way to organise such initiatives. On the other hand my visits to the various AFCLIST nodes have shown that the AFCLIST actors are also occupied with a lot of other, often more pressing issues than AFCLIST work. Most of the members of the AFCLIST network are engaged in AFCLIST on a voluntarily basis next to a permanent job. The work that should be done for AFCLIST is therefore easily is pushed aside. In my analysis of AFCLIST and FEMSA I have focused on their recommendations to how gender equity should be approached. An evaluation of the actual impact of AFCLIST's work might look different due to for example the limited time available for the AFCLIST actors to be engaged in AFCLIST work.

My own perspective after studying FEMSA and AFCLIST's approaches to gender equity in science education is that teasing out particular target groups is important in order to give sufficient attention to all marginalised groups within an educational system. It is, however, my understanding that two categories defined solely on the basis of biological sex are insufficient in order to grasp all marginalised groups. I think we need a more sophisticated categorisation of target groups than male versus female in order to secure gender equity in science education.

Acknowledging that biological differences in most contexts have major implications for how girls and boys develop as individuals, I still believe that placing too much emphasis on these differences might take our focus away from other variations that perhaps will impact more on how people engage in science and science education than their biological sex. Gaskell, Hepburn and Robeck (1998, p. 873) writes that: "gender equity is not a simple issue of dealing with females and males, because identity does not come in neat packages". I would argue for a separation between our understanding of how sex versus gender impact people's engagement in science and science education. Acknowledging the important role sex most often plays in the shaping of gender, I still believe it is crucial to be open for other sides of a person's identity that impacts on her/his experience and interest in science than only the part that relates to the individual's sex. Perhaps it is also a prerequisite in order to have more realistic expectations to what we can achieve by educating more female scientists.

Brickhouse et al. (2000, p. 457) write that:

> *When teaching girls science and trying to explain why it is that they are not doing well in science we need to know more than that they are girls. We need to know what girls they are.*

It can be easy to design education projects that account for differences in males' and females' approaches to science education that are not sufficiently validated. Such initiatives can, in my opinion, be limiting by constraining female characteristics and preserving stereotyped understandings of what it means to be female.

Although girls and boys come to school with a gender that is most often highly influenced by their sex, I believe that schools should enable pupils to explore multiple and perhaps new identities without being constrained by presuppositions about their sex. Education initiatives approaching gender equity should in my opinion make sure not to create organisational structures that constrain diversity and ignore marginalised groups. I am not arguing that knowing the sex of the pupils we seek to reach is irrelevant in the planning of approaches to gender equity in science education. It is simply not sufficient information in order to know how initiatives should be planned.

Similarly, knowing the sex of a person in charge of a gender initiative is in my opinion far from sufficient information to know what we can expect from the outcome of such initiatives. I adhere to understandings presented within feminist postmodern theories arguing that women are too diverse to generate a single cognitive framework. What is commonly seen as feminine qualities are not and should not be reserved to females. Several of my interviewees claimed that increased performance of females within science would impact ethical aspects of the research process placing more emphasis on care. They claimed that female scientist would be more empathic, and be more concerned about utilising science for the sake of good, rather than science for its own sake. Similar perspectives are also reflected by difference feminists like Gilligan (1982), Harding (1993) and Rosser (1990). I would argue that the values described by difference feminists and some of my interviewees to be representative for females, are more characteristic for what we have come to define as feminine characters. Based on this notion I would raise the question of whether our arguments for increased female participation in science and our aspiration for gender equality on boards and in administrations, reflects more a yearning for feminine values rather than for more females.

Throughout this thesis I have tried to find out whether feminist theories might be of use in understanding different approaches to how gender inequity in science education might be addressed. Although feminist critics of science do not provide clear answers to what causes gender inequity in science education and how this situation might be changed, this discourse open for these issues to be raised. Perhaps this body of knowledge can make us science educators raise some questions that can help us to better understand the complexity of questions connected to why and how gender equity in science education could be attained, and a stronger basis to better understand different approaches to reach such equity.

My motivation for doing this study has been that I am concerned about the gender inequality in science education and science research, but also that I believe that scientific and technological knowledge can be powerful tools for development. If it can be made available and relevant to the public, including females, I believe it could be a great instrument in the fight against poverty and the development of nations and individuals.

I believe this is the same motivation that has guided the implementers and contributors to both FEMSA and AFCLIST. Because I have experienced the level of enthusiasm, efforts and hard work that has been put into this work by both initiatives, it has sometimes been hard for me to write about the two initiatives in a critical way. I hope that this thesis can be seen more as a contribution to their work and an attempt to contribute to the same goal of finding new ways to improve science education and make the body of knowledge available to the majority.

The United Nation's Millennium Goals provide a shared vision of a much improved world by 2015 where extreme poverty is cut in half, child mortality is greatly reduced, women are more empowered and gender disparities are illuminated in all levels of the educational system. These goals are ambitious and they set ambitious goals for projects working to secure gender equity in science education since this is the area of the educational system where gender differences in most countries are greatest. I hope my attempt to clarify different approaches to gender equity in science education can be a contribution to the ambitious shared goal of more equity in science and science education.

Some people prefer going on pre planned journeys. Use agencies that organise everything prior to their departure. Some prefer travelling with a guide. Or follow the travel agency's instructions slavish.

That way of travelling never appealed to me. I like journeys with unexpected events. I enjoy bumpy roads and unfamiliar terrain. I can get frustrated. I often get homesick and long to go back home. I sometimes regret my choice of destination and wish that my aspiration for the unexpected was less developed.

Yet I never regret the journeys I take. When I return back home.

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7. Teachers' attitudes to the study of science, mathematics and technical subjects by girls in secondary schools.

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