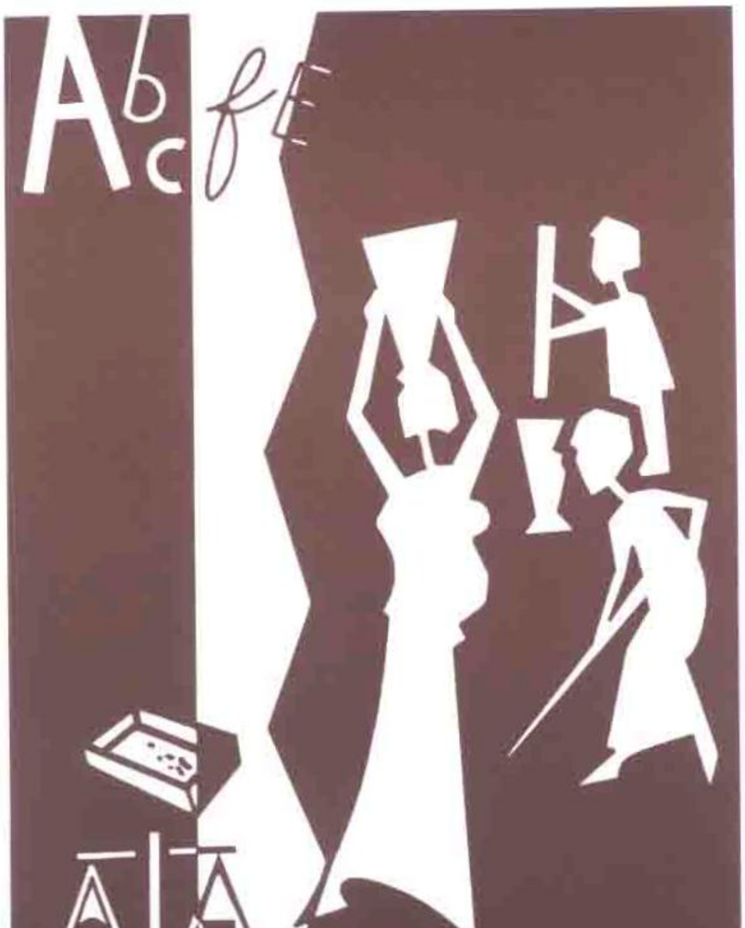
EDUCATION OF WOMEN IN AFRICA

AFRICAN GIRLS AND THE SCHOOL SCIENCE AND TECHNOLOGY CURRICULA

Alphonsine BOUYA



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AND
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PREFACE

To promote gender equality and the improvement of women's status has been a constant preoccupation for UNESCO. The Third Medium Term Plan (1990-1995) lays emphasis on women's participation which is a sine qua non for successful development. Attention is first of all given to education for women and girls, key of their participation, on an equal footing in all aspects of economic, social and cultural life. In other respects, the fight against physical and moral violence practised on women, the contribution of women in the media and in the safeguard of heritage are as many fields of action in which UNESCO has been steadfastly involved during these past years.

These are all the more reasons why UNESCO's Regional Office for Education n Africa (BREDA) has published a number of texts written on the occasion of activities carried out in this priority field of Action.

Most of the Authors are women : African women of different nationalities involved at various levels in the development of their countries. This is already a choice : to give the floor to the academic world, the world of research, the political world in order to make them express an African and "female" point of view. Moreover, these women aim, through their action, at highlighting and enhancing the precious, but all too often unknown role of their sisters: the millions of women and girls committed day after day to the fight to ensure a better life to their families and themselves, to affirm their right to education, to improve through their participation at the grassroots level, the standard of living of their communities.

In publishing this series, the Regional Office aims at enhancing the dissemination of knowledge and information on the real situation of African women in particular in the educational sector. The obstacles encountered, the failures endured and the successes achieved are just as many milestones towards real equality and the valorization of difference.

And yet it is not first a matter of knowing and understanding. These texts are intended to be working documents which contain orientations for action.

Indeed even today, women are among those left on the scrap heap, the most important group in the world. The question is how can the world self-develop without its other half ?

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INTRODUCTION

The World Conference on Education for All held in Jomtien in 1990 and the 42nd session of the International Conference on Education (1990) recognized as priority of priorities the improvement of the quality of education for girls and the elimination of stereotypes and prejudices harmful to the education of girls.

In 1989, the Convention on the Rights of the Child and the World Summit on Children underlined the importance of the education of girls in improving the status of women as well as the recognition of their role in development.

In Africa, practically all countries subscribe to the principles of the United Nations and UNESCO in particular, on equality of opportunities in education and employment as well as on the elimination of discrimination and injustice based on sex.

Nonetheless, the question as to whether in the short and long term, the application of these principles will be effective and/or yield results in a particularly stubborn, recalcitrant and difficult socio-cultural context still remains unresolved.

Thus, this study proposes to analyze and shed more light on the constraints and factors which impede girls' access to scientific and technological education.

It is only through a better understanding of these constraints and factors that appropriate ways and means could be devised to improve the situation which, if not checked, will ultimately lead to the exclusion of more than half of the African population (in Africa women account for 55 to 60 per cent of the overall population), thereby constituting a major obstacle to the development of the continent.

This paper will focus on the following issues:

1) Which are the three aspects of a curriculum? The first chapter examines the official or programmed curriculum, the curriculum presently in use and the goals achieved.
2) Which are the areas of interest of girls in the sciences, mathematics and technology in the official curricula?
3) What is the level of female acceptability in relation to practices in the classroom in the teaching and learning of the sciences and technology?
4) What are the results of girls in the sciences and technology?
5) What should be done to encourage more girls in the sciences and technology?

The structure of the paper as presented suggests an array of statistics and figures. It will therefore be appropriate at this juncture to indicate that the study aims in particular, at tackling the issues by placing emphasis on the psychological, socio-cultural and socio-educational factors which affect girls in the teaching of the sciences and technology in Africa. This does not exclude the use of certain figures to support our arguments.

We decided to base our study in Francophone Africa with special reference to Senegal, which is our permanent place of residence. The situation in Francophone Africa is almost the same everywhere, and the influence of the French colonial heritage continues to prevail, in a very special way. Whereas in Anglophone Africa, the trend of educational policies seem to favour women and to reduce, no matter how small, the disparities between men and women, boys and girls in schools, in francophone Africa everything is done as if the cultural colonial heritage and African cultural norms are linked in a kind of marriage and union in which it is hard to contemplate divorce.

The specific case of sex discrimination should provide international cooperation, and in particular, North-South cooperation. with a fertile ground to prove their mettle and a rare opportunity to bring about change.

But as with all other areas, Africa remains the usual major consumer in spite of itself. In the field of education, it turns out to be both consumptive and conservative.

Nonetheless, since society is in perpetual evolution, in constant movement, education should consequently be adapted to the society in order to make human beings able to properly manage and master their living environment.

Mastery of the living environment or development demands the participation of everyone, men, women; it calls for solid basic education in all fields: literary, scientific and technological. Continued maintenance of barriers and obstacles to women's access to scientific and technological education therefore amounts to limiting the participation of women in the development of the African continent. We will examine these obstacles.

THE THREE ASPECTS OF A CURRICULUM

To quote professor Obanya (1992), "*the school can well be one of the likely agencies for the act and process of education, but education can do without the school*"; it is no less true that the school remains the most appropriate place for the acquisition of general cognitive skills such as reading, writing, arithmetic and the learning of scientific principles.

In Africa, one of the major defects of the school system is its inability to respond to the demands of the continent's development. African governments through the various Ministries of National Education, draw up national school curricula. Such curricula ensure continuity in the acquisition of knowledge according to the grades and ages of the pupils.

We can thus distinguish three aspects or faces in a curriculum. The curriculum is defined as the sum total of activities tied to the school system, certificates and formal and non-formal educational (school) activities of the individual.

Therefore, the three aspects or faces of the curriculum are:

a) the official or prescribed curriculum;
b) the curriculum used;
c) the achieved curriculum.

The Official Curriculum

The official curriculum is therefore that which is spelt out by an official or governmental organ. Their principal objective is the transmission through teaching or the acquisition by learners, of knowledge, skills and attitudes which are capable of ensuring or facilitating the participation of all in the economic, social and cultural life of the continent.

In a way, it has to do with arming the citizens with the means to participate in intellectual and material activity for their individual growth and for the development of their country and continent.

In the first level or primary education in Francophone Africa, the following subjects invariably appear on the time-table: spelling, reading, grammar, conjugation, vocabulary, oral and written composition, mental exercises (scientific and manual), poetry, etc. These are taught during the first two or three years of primary school.

During the first and second years of the middle school, mathematics classes become more difficult; for the pupils it is no longer a question of working on simple addition, substraction, multiplication or division but calculations which form part of the more complex problems that require understanding, thought and a certain level of logic.

It is during the last years of primary school that natural sciences, also called nature study, is introduced. The pupils then go on to the study of matter, its various forms and states, the human body, how it functions and is taken care of, diseases and their causes, domestic and wild animals, carnivorous, herbivorous and insectivorous animals, vertebrates and invertebrates, the mollusks, insects, herbs and plants, etc.

The first year of the primary school is considered as the initiation class while the second year is seen as a class for the expansion and revision of knowledge.

At this stage of learning, school attendance cannot really be differentiated. In 1988, the rate of primary school enrolment for girls was 59 per cent while total enrolment stood at 67 per cent in sub-Saharan Africa as a whole. For some Francophone countries, primary school enrolment in 1990 was as follows.

TABLE 1: First Level Education. Gross Enrolment Ratios (%), 1990

Countries	MF	F
BENIN	67	45
BURUNDI	73	66
CAMEROON	103	95
CENTRAL AFRICAN REP.	68	52
CHAD	57	35
COTE D'IVOIRE	69	58
SENEGAL	58	49
ZAIRE	76	64

Source: UNESCO, *World Education Report 1993*

As can be observed from the table, primary school enrolment percentage for girls are on the whole acceptable except in a few countries like Senegal, Benin and Chad.

Specialization begins at the secondary school level. Subjects such as physics, chemistry and biology are introduced. In mathematics, algebra and theorems are included in the syllabus. With such new disciplines one begins to notice the differences and the gap between boys and girls in the process of learning as well as in school orientation. The gap grows wider as the pupils move up the secondary school ladder and becomes established as from the latter years in the high school.

In countries like Senegal, the fifth year of the secondary school cycle is like a common platform or crossroads when children decide on their final options for such disciplines as literary, economics, or the sciences. In such other countries as Congo, the choice of subject takes place during the last year of the junior secondary school, that is at the end of the third year of secondary education. The pupils are then made to choose between the series A (literary), B (economics), C (mathematics) or D (natural sciences) At the end of the junior secondary school, the pupils write an examination prescribed by the General Middle School Examination Board (Brevet d'Etudes Moyennes Generales) in Congo. In Senegal, the examination is known as the Middle School Certificate (Brevet d'Etudes Moyennes) or BFEM. The scores obtained by the pupils during the school year and those obtained in the tests will determine their areas of specialization. It should be noted that the subjects remain the same in the syllabus. Rather, it is the importance accorded in teaching them that varies. The weight attached to each subject can be assessed from their occurrence on the time-table and the in depth manner in which the core subjects are taught. The orientation and grouping of pupils in series A, B, C or D determines the type of certificate they will study for and subsequently, the kind of trade or profession they will aspire to.

While in Senegal initiation to technology begins in the third or fourth year of the secondary school since the 1976-77 school year, in some countries pupils are not given the opportunity to take courses in technology until they enter high school. They are asked to choose between grammar schools or technical colleges where technological subjects such as electricity, mechanics or carpentry, etc., are taught.

Analysis of the Senegalese primary and secondary school curricula does not show any gender bias with respect to content. In textbooks, however one can still find innuendoes connected with sex differentiation in social and professional activities.

On skimming through a standard 5 textbook of arithmetics, we found, for instance, that certain terms refer to the traditional dichotomy of girls and boys, of men and women. Although efforts and progress have been made, there are still some textbooks which convey sexist images not easily detectable at first sight but nonetheless present.

Although there is no sex differentiation as such in the presentation of official science and technology curricula, these contain, however, elements that may drive girls to reject these subjects which are, to some extent associated with the idea of physical strength, and therefore inaccessible a priori to women.

The Curriculum Used

The issue here is to assess how effectively the teacher covers the official curriculum.

Opinion is unanimous with regards to the overloading of the school syllabus both in the primary and secondary schools in Francophone Africa. Also the preoccupation of the teacher who is given such a syllabus is to cover it at the end of the school year. While the desire to complete the syllabus is legitimate, or even indispensable for the examination year, and almost suitable for the literary disciplines, it seems to be more difficult for the science and technology teacher to cover the curriculum for various reasons.

First, the educational system inherited by Francophone countries gives preference to theory rather than practice. However, it is obvious that for the teaching of science and technology to be effective, it should of necessity include the practical aspect support by experiments. One of the obstacles which makes it impossible for teachers to cover their syllabuses is the lack of material for experiments. Very few schools in Francophone Africa are endowed with laboratories, rooms for practical work or tools for the practical aspects of learning.

At this juncture, an illustration of this phenomenon is required: according to rules currently in force, the aim of mathematics education at the third year of secondary school is to make students understand the meaning of demonstration and to be able to conduct it. Premisses should therefore be carefully stated if this aim is to be achieved. At the end of the school year, it is expected that "*geometry, which is derived from experiment, should be taken by students as a genuine mathematical theory, after treating certain topics (axioms), others are obtained by inference (theorems)*". It is "*imperative for the conduct of the various experiments and practicals using drawing tools to precede the statement of axioms as well as reasoning*" (*Le Pédagogue*, May 1984).

Inadequate training for teachers themselves, worn-out tools when they are available, the non-mastery of scientific and technological vocabulary by the teachers, should also be taken into account. Some people have tried to down-play the myriad handicaps by pedling the idea according to which technology and its teaching should reflect the milieu and the living environment of the individual. While this assertion remains valid, it should not exclude the importance of the mastery of scientific vocabulary, more so as the languages of teaching in Africa are foreign. It is true that educational reforms in African countries have brought about the introduction of the practical aspects linked to agricultural production, among others, to try to adjust learning to the realities of the countries concerned.

The large majority of these practical aspects are to be found in gardening, cattle rearing, the fight against locust invasion, sinking of wells, etc. But these practices are rather more developed in rural areas whereas a majority of the secondary schools and colleges are located in the urban areas.

In urban areas, where emphasis is placed on the so-called modern technology, the shortage of materials for experiments is acute. And since the materials are often lacking, teachers are contented with theoretical and descriptive teaching, of course leaving aside some lessons which require practical experience. When such materials are available, in other words, when they are imported, the problem of maintenance, lack of spare parts or other numerous problems come to the fore. Since science and technology are subject to constant change, it stands to reason that scientific vocabulary evolves as well, or even changes. Refresher courses for teachers to acquaint them with the new vocabularies then become necessary. Unfortunately, the current situation in Africa is such that few teachers keep a tab on developments in science and technology and the various facets of knowledge linked to these two disciplines.

We thought we were cracking a joke when we asked 10 secondary school teachers the meaning of AIDS. Only two out of the 10 were able to give the right answer. Only one teacher was able to define mortality as the frequency of deaths in a given population. And when one realizes that today the problem of AIDS (Acquired Immune-Deficiency Syndrome) and issues related to population studies (mortality, morbidity, pregnancy, fertility), are current in Africa, one begins to appreciate the magnitude of the problem posed by lack of scientific knowledge; one also realizes why some subjects on the time-table are either not properly handled or simply ignored by teachers.

This may seem overstated. Yet, it is based on the idea that any teacher, whether in science, mathematics, technology or even in arts subjects should possess a minimum of general and scientific knowledge enabling him/her to easily ship from one subject to another, from a theoretical standpoint at least. Hence the need for a pluridisciplinary training of teachers and the position of information on an on-going basis. A teacher should, as a rule, be a well-educated person; however, education at a certain level goes beyond subject specialization. Confining the teacher's knowledge to one single subject amounts to reducing opportunities for students to gain general and scientific knowledge conducive to the emergence of individuals of great personal worth. Informing teachers requires the collaboration of all those concerned and great efforts. Admittedly, this involves the availability of financial means and, it is at this level that stress must be laid on the contribution of all those concerned: governments, parents, private and public institutions, etc. Information is not just statement of curricula. It entails the specification of their purpose, refresher courses, the updating of knowledge and a steady epistemological renewal.

The document dealing with the presentation of general mid-level education in Senegal (see *Le pédagogue*, May 1984) goes on to state that: "*the various components of the curriculum are tightly interdependent and should be addressed in close connection with one another. Ideas in the first section should, in particular, be utilized in studying all of the others, which will thus provide motivation and application*".

Further this document reads as follows: "*teachers are free to determine the sequence of the various sections of the curriculum. The importance of each of these sections, along with the amount of time to devote to them are not proportional to the length of their wording*".

While the first passage mentioned urges teachers to keep up strictly with the curriculum and through it foster a gradual assimilation of courses by students and finally promote the emergence of logical and rational thinking among learners, the second passage gives teachers the possibility not to address certain lessons in the curriculum; this situation is at the origin of certain "gaps" both in the acquisition of knowledge by learners and in their reasoning.

Addressing the curriculum in a sequence that differs from the initial one may well bring about other outcomes than those expected.

Assessing the Curriculum Achieved

It is at the end of the third and seventh years that one can assess how much of the content of the official curriculum was imparted.

It is also at the end of these classes that one can ascertain whether the measures adopted by governments to check all forms of sex discrimination in education have been accomplished. Primarily because they are examination classes, secondly it is at these levels that pupils decide on which of the disciplines -literary, technology or the sciences - they plan to specialize in.

According to a study conducted by the United Nations (1991), there are 30 female students in every 100 students in Africa even in disciplines where women appear to dominate in other continents (Humanities and social sciences, etc); in agriculture and forestry, only one out of every five students happens to be female and less than 30 per cent of students in the other science-related disciplines are female.

In a school in Dakar (Senegal), reputed for the quality of its education and well publicized campaign for equality in education, the figures obtained in the final class of the (A, B, C, D) series, revealed the following.

TABLE 2: Distribution of students in Upper-Six Forms by subject area and Curriculum in a School in Dakar

	Senegalese Curriculum		**French Curriculum**	
	F	MF	F	MF
Upper-six form A	21	29	6	9
Upper-six form B	10	27	13	28
Upper-six form C	8	23	0	11
Upper-six form D	13	36	5	12

We note here that the distinction between the "French curriculum" and the "Senegalese curriculum" is not based on the level of teaching of the sciences but with regards to history and geography. In the Senegalese curriculum, more of African and Senegalese history and geography are taught while emphasis is placed on European history and the geography of France in the French syllabus.

These figures show a tendency for literary disciplines among the girls and the little interest they have in the sciences. It is interesting to note that no girl was enrolled in upper-six C of the French syllabus. The reason given for this by the girls interviewed was that the history of Europe and the geography of France was of no use to them. They also said that the mathematics taught in this class was more complex. However, the second reason is not valid because the content of the mathematics syllabus in both cases was the same.

During the year 1990, the number of girls enrolled at the tertiary level was distributed as follows, in a sample of African institutions.

TABLE 3: **Distribution Of Girls At The Tertiary Level of Education**

Countries	Natural Sciences and Engineering	Medical Sciences	Agronomy	Social Sciences	Others
BENIN	11.2	3.5	0.5	80.5	4.3
C.A.R	3.1	53.7	0.0	36.8	6.4
CONGO	3.5	3.9	2.5	73.6	16.5
MALI	1.3	15.5	18.8	44.0	20.4
NIGER	5.8	16.4	1.5	54.2	22.1
SENEGAL	14.4	24.1	0.4	57.5	3.6
TOGO	2.4	10.9	1.6	76.0	9.1

Source: UNESCO, *Statistical Yearbook 1993*

An analysis of these data shows the small number of girls who study the sciences. Except Mali, which recorded 18.8% in agriculture, the other countries recorded percentages of between zero and 5. This situation is serious for a continent where agriculture plays a major role and where food self-sufficiency remains one of the main priorities if not the most important.

It has been acknowledged that the progress of humanity in general and development in particular are determined by the mastery of science and technology. At the same time, everyone proclaims the involvement of women in the development of the African continent. In other words, Africa's development will be determined by the mastery of science and technology by women. And as long as women remain a minority in this domain, it will be difficult for Africa to achieve sustainable development.

The teaching of science and technology should engender among girls (and boys as well), the development of the analytical faculty towards all the phenomenal manifestations of nature, the environment and society. Such education should inculcate among female students respect for scientific and technical trades and professions, and above all, the desire to acquire skills and work habits necessary for their individual growth and development as well as the progress of their countries.

Nonetheless, the syllabus in use has led to defection on the part of girls. The results obtained from the teaching of science and technology fall short of expectation and does not meet the needs of African societies.

The values of the analytical spirit, intellectual curiosity, critical sense, scientific objectivity, etc. which one should expect from the study of the sciences and technology are often lacking among a good number of girls who benefitted from this kind of education, as a result of the superficial nature of teaching methods on the one hand, and on the other, the lack of experimental instruments. With regards to scientific knowledge in the real sense, they remain superficial and disappear with time for lack of renewal. The spirit of creativity is practically absent among a large number of girls who study science.

The role of the teacher is crucial in the assessment of educational achievement. Apart from cultural barriers and the perception of science in the society, (absence of a scientific culture), the attitude of the teacher counts a lot in the performance of female students in science and technology disciplines. There is a problem of teaching methods. But the teacher is part of a society, and in this case, the African society where one cannot hide the influence of culture on the perception of women and science.

Furthermore, one notices a kind of timidity and lack of confidence among girls in science and technology classes which can result in school failure.

During our investigation for this study, we came across a young woman who abandoned her pharmacy programme in the second year of university to learn sewing. The only reason she gave us was that she was no longer able to take lectures because she had forgotten the formulae and that "they were becoming more difficult".

Hence, one observes differences in cognitive behaviour between men and women, boys and girls in the face of what we would call the problem of the science discipline. However, attitude relates to milieu and consequently culture and education. It cannot be said that African cultures have changed so much today as to spur girls to venture into the domains of science and technology.

Thus, we have the case where the number of girls tends to diminish as they advance to higher education, especially, in the fields of science and technology.

To be noted also are the following: the lack of an enabling scientific culture, which results in girls' lack of concern for or misunderstanding of scientific phenomena and events as well as the technology background, even when they perform well in science and technology subjects. Although they show interest for science subjects, many girls are not ready to buy a document (book, journal) or an experimentation instrument that would cost them CFA 10,000, whereas they would easily spend CFA 50,000 on a dress.

AREAS OF INTEREST TO GIRLS IN THE SCIENCE AND TECHNOLOGY SYLLABUS

As the title suggests, this chapter aims at finding an answer to the question: What is of interest to girls in the sciences and technology in the official syllabus. In other worlds, which are their areas of interest?

In order to provide answers to this question, we visited various public schools in Dakar (Senegal). As we indicated earlier, the sciences we are concerned with in the Francophone educational system is what Jose Mariano Gago terms "the most international sciences", in other words, natural sciences like physics, chemistry or biology to which we would of course add mathematics.

At the primary school level, mathematics does not raise any major problems (addition, arithmetic and geometry). Both boys and girls almost make the same grades with the boys having a slight edge when it comes to mental sums. In form one the girls understood problems and were able to apply theorems. It is as from forms four and five that the girls began to fall back because mathematics seemed to become more abstract. It must be noted that the introduction of the so-called modern mathematics did not help matters.

Since it is almost impossible to talk of congenital or biologic, or even atavistic weaknesses whatsoever in girls for science disciplines or mathematics, the causes of their defection and deficiency in these disciplines should be found somewhere in the psychological domain. This explains the importance of knowing the areas of interest of girls.

The first observation is that the sciences as they are presented in the school syllabuses do not respond to the needs of girls who rather want the subject to be taught in a more concrete way. The girls do not understand why they are asked to cram chemistry and physics formulae which they do not require in everyday life. The various formulae, along with mathematics theorems, constitute a mine field for the students who do not see their relevance and usefulness. A group of secondary school girls owned up to having once asked a nearby shopkeeper for H^2O (the chemical formula for water) and Na Cl (formula for salt). The poor man knew nothing about the items. And he was very honest about it. This joke, which rather appears like a laughing matter really carries a lot of significance. It simply goes to prove what we said much earlier, that the students do not appreciate scientific formulae of which they do not see the necessity and do not even understand why they are asked to memorize them. This notwithstanding, the fact that the girls asked for H20 and NaCl is an interesting symbol which could be linked to the role reserved for women in the society. In fact, water and salt are used for cooking and, as everyone knows, cooking is one of the domestic responsibilities of women.

This jest also brings out into the open the problem of formula memorization. As a rule, chemistry, physics and mathematics formulae should not but be the result of a process; in addition, they should be rediscovered through reasoning. Unfortunately, it turns out that there is lack of reference to formulae in reasoning and, by and large, students resort to memorization.

As for teachers, they put forward the idea that memorization is not a sine qua non. However as can be read in the presentation of the third year of secondary school curriculum: "*Ionic interpretation will be avoided, the focus being exclusively on the equation-result:* $HCl + NaOH + H^2O = Heat$." Is it not true that the mere presentation of equations-results favours memorization without any understanding by students of the phenomena? Moreover, experience has shown that evaluation methods regarding students' advance in the learning process require that they should memorize instead of reasoning. It is clear that a student who cannot accurately reproduce the symbol of zinc or lead in a written or oral assessment will never obtain a good mark. This is due to the fact that science and mathematics teaching still gives priority to memorization.

Our investigation also revealed that girls show interest in biology and medicine. Their interest in biology derives from the fact that it enables them to understand living things, especially the body and how it functions. This underscores the much deeper issue of the female identity. The choice of medical sciences (medicine, pharmacy, etc) can be explained by a kind of concern for others, the desire to put one's talent at the service of others. In the final analysis, this choice can also be traced to the role and status of women in African societies. On the contrary, the girls we spoke to are not interested in physics. This total lack of interest in the subject can be explained by the apparent belief among girls that they are incapable of grasping the laws of physics and technology, which, for them, relate to force and the use of muscular power.

Nonetheless, "*the teaching of science and mathematics are deeply rooted in the belief that they are useful disciplines and that methods and attitudes which they inculcate contribute to the well being and prosperity of everyone.*" (Jacobsen 1991). This conviction, unfortunately, is absent in the minds of many African girls as much as in the minds of those who produce the school syllabuses and of some teachers.

If the sciences can sometimes, and for those who opt for them, be perceived as one of the roads to highly paid professions and integration into productive life, technology, especially when accompanied by the qualifier "appropriate" is perceived by girls as backward, a return to the old ways, to peasant life. Simply because this term was introduced in Francophone Africa alongside the so-called rural development.

As for mathematics, the subject really appears not to be of any interest to students who consider it to be very difficult. Female students hate mathematics because it serves as a filter for the selection of the best. Considered as a tool of selection, mathematics appears to constitute a big obstacle in the orientation of girls toward the sciences and in the choice of their future profession.

In concluding this chapter, we would say that girls show very little interest in the sciences, mathematics and technology, a situation which accounts for their tendency to rather opt for the literary disciplines.

GIRLS' RECEPTION OF SCIENCE AND TECHNOLOGY TEACHING

This section deals with three major issues:

1) Who teaches mathematics, the sciences and technology?
2) How are they taught?
3) Are the subjects taught appropriate to the interests and expectations of girls?

Women's Participation in the Teaching of Science and Technology

The problems of women in sciences subjects appear at the top and bottom rungs of the educational system.

On consulting the UNESCO World Education Report (1993), we were able to extract the following percentages for certain countries for the years 1980 and 1990.

TABLE 4: **Statistics of female teachers at the primary and secondary levels**

Countries	First level		Second level	
	1980	1990	1980	1990
BENIN	23	25	-	-
BURKINA FASO	20	27	-	-
BURUNDI	47	46	20	21
CAMEROON	20	30	20	22
CENTR. AFRIC. REP.	25	26	16	-
CONGO	26	33	8	-
COTE-D'IVOIRE	15	-	-	-
GABON	27	-	24	-
MALI	20	23	-	14
MAURITANIA	9	18	8	10
NIGER	30	33	21	17
SENEGAL	24	26	-	16

Source: UNESCO, *World Education Report 1993*

These figures which fall below the overall average relates to general education. If we were more specific in highlighting each discipline, it is obvious that the involvement of women in the teaching of science, mathematics and technology would be almost nil.

This only confirms what we have been saying all along, that the problems encountered by women are to be found at both ends of the educational system. The same situation prevails upstream where the enrollment of girls in the sciences remains very low. This means that the teaching of the sciences, mathematics and technology is mainly carried out by male teachers.

This situation can later become an inhibiting factor for girls to gain access to science and technology education. In fact, it clearly explains why very few women qualify as teachers of science, mathematics and technology, thereby making them conclude that these disciplines are the sole preserve of the masculine sex.

Science and technology education should be oriented toward finding practical solutions to problems confronting the community. It is not certain that this kind of education can cater to the specific needs and problems of girls and women since the courses are taught by men, in spite of the officially expressed desire by African leaders. When one considers other socio-cultural factors, one would easily guess the kind of results that would be obtained.

Teachers' Attitudes

Every system of education depends on a number of factors for its success: the idea and concept established, the way in which these ideas and concepts are perceived and applied by teachers and students, and the way in which both teachers and students perceive the disciplines, etc.

The teaching and learning of mathematics, science and technology in Francophone Africa is surrounded with a kind of mystery not unrelated to the problems attached to the disciplines. Students consciously or unconsciously develop fear which is sustained by teachers when faced with problems in mathematics. Either by commission or omission,or sometimes in an attempt to ridicule students, teachers end up creating permanent obstacles in the mind of students while trying to make them understand the sciences. The example of the "the age of the captain" serves as a perfect illustration.

The examples we have chosen took place about five years ago in a college in Brazzaville in Congo. Right from the first day of the mathematics class, the teacher tried to make fun by asking the students to solve the following problems:

First problem: "In a boat, there are 45 goats and 35 sheep. What is the age of the captain?"

Second problem: "In a class there are four rows of eight benches. How old is the teacher?"

Third question: "A shepherd has three dogs and 120 sheep. How old is the shepherd?"

Whether it was meant to be a joke or not, this teacher crated a barrier in the minds of the students who spent the full hour the class lasted trying to solve the senseless and idiotic questions. None of them was able to discover the stupid nature of the questions, and the reason is to be found in what the children themselves think of the teacher.

Paulo Freire (1970) in *Pedagogy of the Oppressed*, enumerated the kind of relations maintained by some teachers in under-developed countries:

a) The teacher teaches, and the pupils are taught.
b) The teacher knows everything, the pupils know nothing.
c) The teacher talks, and the pupils listen attentively.
d) The teacher thinks, and the pupils are thought.
e) The teacher is the subject of the learning process, the pupils are mere objects.

When education is conceived as mere transmission of knowledge it becomes a process of defining and assigning roles. Knowledge emanates from the teacher who positions himself like a transmitter beamed toward the pupils who are receivers. While the teacher plays the active role, the pupil is assigned the passive role. This is the case with the teaching of science, mathematics and technology.

The pupils see the teacher as a sage, one who possesses the truth. Also, in the case of the age of the captain and the shepherd, the pupils were unable to notice the incoherence or the nonsense of the questions. They passively absorbed them and even went ahead in search of answers to the questions, because pointing out the incoherence of the questions would amount to challenging the omniscience of the teacher.

This raises the question as to whether pupils in such a situation actually learn.

Apart from the peculiar nature of science and technology, there is also the question of how the teacher is seen from outside. The science and technology teacher is portrayed as austere, severe and strict, he is dehumanized in the minds of the children who see in him a kind of formula machine. The teacher particularly, of mathematics, "terrorizes" the pupils. This is because of the selective nature of the discipline. Also, the best pupils are those who obtain high grades in mathematics, physics and chemistry or biology. However, they too fear the science teacher.

Girls' Interests

Since our investigation revealed that girls' interests are determined by socio-cultural pressures and more oriented toward the roles traditionally reserved for women, the future science and technology teacher should, as a result, take this aspect into consideration and focus on removing this barrier.

Within the overall context of the question of African development, science and technology should be applied to the problems of hunger and the environment. In other words, promotion of the teaching of science and technology should be based on the realities of the continent and integrated into the principles of development.

Education in Africa continues to be subject to the discriminatory influence of our societies toward women. In science education, for example, references are drawn from international male scholars and inventors. But information on international female scholars and "inventors" are nowhere to be found. One of the most striking examples is that of Pierre and Marie Curie. Our investigation shows that very few girls, including those enrolled in the C (mathematics) and D (natural sciences) know anything about Marie Curie. Few among those in series A (Humanities) and B (Economics), had heard of Simone de Beauvoir, Maryse Conde or Hannah Arendt, among many others. On the contrary, everyone knew Pierre Curie and Jean Paul Sartre.

Thus, in addition to the discriminatory reference which Africa inherited from colonization, its sexist educational system undermines the achievements of women in science and technology.

Some people have suggested that science and technology education for girls should focus on aspects related to health, nutrition and home economics, etc. But will such restriction not mean launching girls in a vicious cycle that will be difficult to break, in this case, the traditional role of women?

In non-formal educational institutions which cater for professional and "technical" training, for young girls, the courses taught centre around the "techniques" of sewing, embroidery and secretariat work. A tour of professional training institutes in Dakar revealed girls' new interest in informatics. We would have had cause to rejoice had it not been that all the girls enrolled just in order to know to type and correct texts and in some cases, to study what is often termed "public" or "commercial" relations. Can it then be said that these institutions, in spite of their declared good intentions are helping in promoting girls' access to science and technology education?

Our view is that the only solution is to adapt science and technology education to the needs of girls and those of our developing countries. If girls should conquer the domains of science and technology through education and training, one must accept that the discriminatory barriers, stereotypes and other prejudices should be broken to ensure girls access to the sciences in recognition of their real and not imagined or imposed needs.

GIRLS' PERFORMANCE IN MATHEMATICS, SCIENCE AND TECHNOLOGY

Studies carried out in Europe and in France in particular (Christian Baudelot and Roger Establet, *Allez les Filles*, Editions du Seuil, 1992) showed that girls are better than boys in course work. This has also been observed in Africa; when all the necessary conditions are available (this is the case in some rich families), the girls perform better than the boys.

In junior classes in private or public schools, few girls repeat classes, for example. At the secondary school level, many of them reach forms three and four. One of the reasons why girls abandon school in these classes is either because of marriage or because the parents are no longer able to bear the financial burden of their education.

While the girls in the private schools continue their studies, the problem for them arises in the public schools. This is not due to any congenital or biological incapability whatsoever, but rather because, in less wealthy families, the girls are often required to do domestic work which leaves them with little or no time to devote to class work.

An examination of the results of girls in science subjects showed that there were no major differences. In a secondary school in Dakar, scores for girls in the lower-six C varied between 12 and 14 over 20 while the best score for the class got 15/20. In an upper-six D class which we visited, the five girls in the class recorded scores ranging between 12 and 15.5/20 and the best score was 16/20. In form four, girls scored as much as 17/20 in physics, 14/20 in chemistry, 18/20 in the natural sciences and 16/20 in mathematics. According to the teachers, girls were at the top of this particular class.

This simple glance at the scores of some girls in science subjects proves that under certain circumstances, girls are capable of understanding science subjects and take courses in the sciences.

Further studies in Europe and North America have shown that coeducational schools present obstacles in the enrolment of girls in science and technology disciplines. In fact, there is a tendency for girls to perform better in sciences and technology when enrolled in single-sex schools. Several reasons have been advanced: distraction by and toward boys which leads to lack of concentration, the desire by the girls to attract attention to themselves (seduction), the tendency for girls to be "taken care of" by the boys and to exhibit their weaknesses, the tendency to "give up" in the face of difficulties, lack of self-confidence, etc. This shows that somehow, the coeducational school system has not solved the problems it was supposed to solve and that, rather than foster the intellectual growth of girls, it could become an obstacle to their development.

In Senegal, where single-sex schools exist, such as the Military Academy in Saint-Louis, John F. Kennedy and Mariama Bâ secondary schools in Dakar, the author of this paper set out to check this phenomenon.

Mariama Bâ school was established in 1978. It takes in outstanding girls at the conclusion of primary school from all regions of the country. Age at admission varies between 10 and 14. Studies last 7 years, on a full board basis. Total intake capacity is 196 each year and concerns the whole secondary cycle. All is therefore set, in accordance with what has been said above, for girls to perform well.

An interview with the school's deputy head, who is a woman, along with the analysis of girls' scores militate against this idea.

TABLE 5: **Performances of Girls in Sciences at Mariama Bâ, a Single-Sex School in Dakar**

	Lower-six C		Upper-six C	
Subjects	Highest scores	Lowest scores	Highest scores	Lowest scores
Mathematics	13.87	11	12	9.6
Physics	13.75	9.85	11.4	8.4
Natural Sciences	13	10.4	16	12.5
Chemistry	11.5	9.75	12	10.5

At BFEM (GCE) examination, Mariama Bâ recorded a 100% success in 1990 and 80% success at Baccalaureat (A-levels).

TABLE 6: **Performances of Girls in Sciences at Collège Sacré Coeur, a Coeducational School in Dakar**

	Form 5 C		Upper-six D		Form 4	
Subjects	Highest scores	Lowest scores	Highest scores	Lowest scores	Highest scores	Lowest scores
Mathematics	15	6	16	8	16	2.5
Physics	14	3.5	15.5	6.5	17	3.75
Natural Sciences	16	7.5	17	5.75	18	8
Chemistry	13	4	14	2.5	14	1.5

At Adama Ndiaye CEM (Lower Secondary School) in Dakar, where there is a mixing of girls and boys, we were able to take down the following scores obtained by girls in two classes chosen at random.

TABLE 7: **Performances of Girls at Adama Ndiaye CEM (Lower Secondary School), a Coeducational School in Dakar**

	Form 3		Form 4	
Subjects	Highest scores	Lowest scores	Highest scores	Lowest scores
Mathematics	16	5	13	2.5
Physics	19.5	7	19	1.5
Natural Sciences	17	3	12	4
Chemistry	15	2	16	3.5

Our sample is not representative of the overall situation of Senegalese schools. One can note, however, that as far as highest scores are concerned, Mariama Bâ School does not perform better than the other schools, the gap between scores is not important. In contrast, the gap is important when we look at lowest scores: at Mariama Bâ school, these are between 8.4 and 11 (it must be recalled that 11 is already an acceptable score), whereas in coeducational schools, they are between 1.5 and 8, which mean either repetition or expulsion. When they have to choose between coeducational and single-sex schools girls prefer the former. For example, at CEM Adama Ndiaye, out of 30 girls who were to follow courses at Lycée John F. Kennedy, only six accepted. The others preferred coeducational schools. It seems that girls run away from the so-called womanish mind which implies pettiness, unhealthy competition (which differs from competitiveness), gossiping, quarreling and competition based on clothing. In addition, girls share the view that male teachers are more tolerant than their female counterparts and that boys are more understanding with respect to their errors in the classroom. The latter views, however, are not shared by all girls.

To the concept of mixed school we prefer that of coeducational school: the former implies an aggregation of both girls and boys and an imbalance in enrolment by sex, whereas the latter concerns educational establishments where there is a balance in the representation by sex, the same training, teaching and education, without any distinction.

An interesting achievement was recorded at a non-formal education centre, the Liberté Centre at Dieuppeul in Dakar by an African NGO called, the African International Volunteers Cooperation Association (ACIVA). During school holidays, the Liberté Centre of ACIVA organizes training workshops on new and appropriate technology. During these workshops, girls undertake bricklaying (reconstruction of disused school buildings) and digging and repairing wells, without qualms. They also learn to repair carts, in short, to undertake such tasks often described as masculine. The results obtained by the centre were encouraging in the sense that at the end of these workshops, a change of attitudes and behaviour was noticed among the girls. They become more independent in accomplishing their daily tasks. The development of a certain sense of responsibility, initiative and creativity has also been observed.

The conclusion to be drawn from the ACIVA Liberté Centre experience is that applied technological education among girls enables them to develop attitudes and behaviour toward greater autonomy, better management of their lives, the tendency to cater for themselves and a step toward breaking sexist barriers.

The acquisition of scientific knowledge helps in the development of the feminine personality by enhancing self-assurance and self-confidence.

Finally, the application of acquired technological and scientific knowledge changes women's perception of themselves as well as life and the society and enhances the development of the human being.

TOWARDS PROMOTING THE INVOLVEMENT OF GIRLS IN SCIENCE AND TECHNOLOGY

The big problem with critical analysis is always "what to do?". When a critical issue is not thoroughly analyzed, it becomes difficult to suggest solutions. But it is not enough to analyze, much less criticize. The more important thing is seek out and propose concrete solutions to improve the situation or the phenomenon in question.

Based on our critical analysis, the first action that should be undertaken is to break the barriers created by stereotypes and the prejudices to which girls fall victim and which constitute the main obstacle for them to benefit from science and technology education.

Girls see themselves in the discriminatory image forced on them by social reality. Consequently, there is need to discard this image and replace it with another one which enhances the development and strength of women.

Science is not a discipline from nowhere evolving in the blues. It derives support and takes root in human societies and cultures. The teaching of science in Africa should, as a result, be married only to values which are positive and favourable to women (without discriminating against men) in order to effectively convey and transmit them to future generations. It is so that Africa can be endowed with a scientific culture.

Among the cultural values that can be derived from scientific activities are precision, intellectual probity, the quest for discovery, scientific curiosity, systematic observation, etc. These values should be used as examples during science, mathematics and technology classes and should be explained to girls based on concrete facts and specific examples of women who have excelled in the field.

People often speak of "feminine curiosity". Although this is often given a derogatory meaning, it could still be beneficial to transform such feminine curiosity into scientific curiosity, to encourage the participation of girls in science and technology.

Paulo Freire (1970) spoke of "cognitive self-discrimination" among oppressed people. We found the practice of self-discrimination prevalent among African girls. At the intellectual level, to be precise, many African girls under-estimate themselves and as a result, consider themselves incapable of studying science, mathematics and technology. This type of self-discrimination does not have any scientific foundation. They are only embellished in ideologies and cultural practices. Therefore, it becomes necessary to bring girls to accept that they are as capable as boys to undertake studies in the sciences.

Home training should also play a major role in the effort to re-orient and liberate the scientific mind in girls. Parents should appreciate the importance of science education for their daughters and relieve them from domestic chores so as to give them sufficient time to devote learning. A change in the perception and attitude of parents and members of the family is necessary and indispensable.

Besides home training, there is also need to tackle the problems of teachers themselves. Opportunities for refresher courses and or re-orientation programmes in the sciences should be offered to female teachers. In addition, student teachers should be encouraged to choose science and technology related topics in the thesis they submit at the end of their course. The practice which we observed at the College of Education in Dakar whereby only topics related to the cultural practices in one community or the other are treated should be discouraged. In principle, preparing a thesis of any kind demands consultation of a number of works and books on the subject being treated. If the topic chosen by the student is science-oriented, he or she will be forced to consult scientific documents. The process can help open his mind to the appreciation of science and later lead the future teacher to re-assess his orientation or the simple desire to further acquaint himself with the sciences and technology.

Teachers should also change their attitude towards girls in science classes. Presenting mathematics, the sciences and technology as difficult subjects is a negative attitude that should be checked. Such attitude on the part of teachers totally discourages the greatest ambitions let alone the already low motivation among female students.

It should be understood that a teacher, whether a specialist in mathematics, the sciences or otherwise, is a human being after all. As such, he should not present himself or allow pupils to see him as a kind of a formulae machine or as an inaccessible super human.

Teaching should not be perceived as mere transmission of knowledge from one active pole (the teacher) to the passive pole (the pupil). Teaching is communication before all else. Not a one-way but multi-channel communication. The essence of science education is to enable pupils to understand and integrate what they are taught. Understanding is not mere accumulation. It calls for a two-way movement between the teacher and the pupils to the point of complete assimilation or to the point where the pupil begins to imbibe the subject.

The lecture method is certainly not the best way to establish effective communication between the teacher and the pupil.

For girls to get a grasp of science and technology, the discipline must be adapted to their real needs, and above all, practical work should go hand-in-hand with theory in such a way that it meets the expectations of the girls, enkindle in them interest in science and technology and assures them of the ease with which the subjects can be understood.

Understanding of language of science and technology requires a solid educational background. In this regard, pupils should receive a solid foundation right from the very first classes of the primary school.

Teachers should sensitize and promote the spirit of hard work and perseverance in learning among girls and ensure that discriminatory tendencies should not prevail in the classroom. For example, allowing pupils to burst into prolonged laughter when a girl commits an error.

Since to err is human, the teacher should never focus his attention and those of other pupils on the error committed. On the contrary, he should, by way of clearer and in depth explanation, correct the error and provide a remedy.

Finally, teachers should avoid any allusion to the weakness of the opposite sex in the classroom as well as to the status and traditional role imposed on them by society.

Women's performance and achievements in the field of science, mathematics and technology exist, but remain minimal. This is why consideration should be given to improve on them.

A better approach in efforts to improve these performances and accomplishments will be to begin right from the pre-primary level. For example, in the nursery schools there is need to ensure that girls and boys have equal access to the same games and toys. Care must also be taken to ensure that discriminatory tendencies do not exist in the play grounds. This is because it is sometimes and also at the pre-primary school that exclusive tendencies take root.

A reconsideration of the idea of opening more coeducational schools in certain regions may perhaps not be a totally negative approach. This is not because there is need to return to the old system of denominational schools, but rather to have a handy model to prove the ability of girls to perform better.

The relevance of science and technology should be recognized and explained to girls, if not the importance of education in general. More and more girls from poor homes and the rural areas believe they do not need to spend several years in school, much less in studying science in order to succeed in life. They support their argument by referring to the success of "Mama Benz" or to "Business Women." Thus the boom in the informal sector also helps to propagate this notion. This points to the need for educators to prove the relevance of education among and for young girls.

Finally, to improve the achievements and performances in science and technology, parents and educators should cooperate, work together to explain and bring their girls to accept that they can always excel and do better. Encouragement from educators (parents and teachers) at this level in this domain cannot but be of benefit to the girls.

CONCLUSION

One is at pains to round up this study which has hardly begun as there is a lot still to be said on the subject.

Nonetheless, we nurse the feeling of having achieved our objective because this work aimed at highlighting the psychological, socio-cultural and socio-educational factors which affect girls in science and technology school curricula in Francophone Africa.

We have therefore made an attempt to prove, with supporting figures, that in spite of official policies and declarations, science, technology and mathematics education is still restricted.

Apart from the socio-cultural factors, and the influence of tradition, which spares no African educational system, we have also tried to pinpoint other factors inherent in the school system itself. These include the small number of female teachers in the sciences, the magisterial method of teaching, lack of tools for practical work and the attitude and behaviour of teachers, etc.

Among the psychological factors, we have noted such barriers as self-censure, cognitive self-discrimination, lack of self confidence, little or lack of assurance which can be devastating for girls.

At the socio-cultural level, social pressure and the place and role of women in African societies. The attitudes and behaviour of parents also constitute stumbling blocks for girls to gain access to the study of science, mathematics and technology.

However, the world is constantly changing and, Africa should not be left out. If Africa hopes to meet the multiple challenges it faces, it should integrate women in all its activities no matter how small. This has to be so because Africa's future depends on the effective participation of women in development. And to ensure that women's participation is neither superficial nor artificial, there is need for an educational system which integrates all women, an educational system bereft of discrimination, without barriers, prejudices or stereotypes; since education remains the basis of the entire social life and lasting development.

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