

WOMEN ON THE MARGINS OF THE MAURITIUA LABOUR MARKET –A VIEW FROM A ‘CYBER ISLAND’ TO BE!

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Introduction

The situation with regard to the participation of girls and women in Science, Mathematics and Technology (SMT) was summed up in the report of the UNESCO World conference on Science in Budapest in 1999. The report indicates that forums on ‘Women, Science and Technology’ organized by UNESCO in Latin America, Europe, Asia, the Mediterranean countries, Africa and the Arab countries showed that in all countries, albeit to varying degrees, participation by women in scientific and technological developments was still far below that of men, especially in the fields of original research and decision making related to science and technology policies. On a world-wide scale, science - and even more technology - is still a man’s business. This situation is no longer acceptable. It is economically unacceptable because of the waste of human resources that it entails; it is humanly unacceptable since it prevents half the population from taking part in building the world. It is intellectually unacceptable as it deprives scientific and technological research of ideas and methods, in other words of creativity. Furthermore, it mortgages the future since it nullifies any prospect of a general mobilization in support of science in the service of a lasting peace and sustainable development. Peace and sustainable development are dependent not only on internal dynamics and policies that are formulated locally but also on external dynamics. We are all very aware to what extent our continent- Africa, is ravaged by conflicts and how the absence of peace impacts on people’s lives. When we talk of peace however, we often think of it as absence of war but peace may also be threatened when social conditions worsen, inequalities grow to intolerable levels and people’s livelihoods are threatened. In fact, the International Peace Research Institute draws our attention to the fact that poverty is the major source of various forms of conflicts. Poverty is the major scourge of this century. As globalisation spreads itself further, poverty seems to be on the increase. Poverty is a violation of fundamental human rights and the feminization of poverty across the globe highlights the fact that women’s rights as human rights are impinged upon. Mauritius too is experiencing poverty and now that unemployment has already reached double digit figure, with women being disproportionately represented amongst the unemployed, some segments of Mauritian society are finding it harder to strike a livelihood.

Africa's slow integration in the global economy

Africa is often treated as a monolithic, homogeneous block but the reality is that it is very diverse and plural. Cultural, linguistic and ethnic diversities exist. The one common legacy however is that of colonialism and slavery in various parts. Although decolonised, Africa remains highly economically dependent. Some argue that new forms of colonialism have made themselves felt with SAPS and more recently with NEPAD since the latter is premised on what I call the unholy trinity of liberalization, privatization and deregulation. Various initiatives have been taken to get the continent out of its quagmire but little seems to have been achieved on the ground. Whether NEPAD the latest initiative supposedly owned by Africans will be successful in bringing about positive change is a question that surfaces up. What will be the fate of women during the course of these developments is also a question that needs to be posed. The continent is ravaged by various ills, the HIV aids pandemic is rampant. The increasing numbers of AIDS orphans are changing family structures in a very significant manner and pose new challenges for the survival of communities and for social policies. Chronic hunger, malnutrition, conflicts illicit arm trading and human trafficking are widespread in many countries. In addition to these, many African countries are still heavily indebted and aid dependent. The continent represents a very small share of world trade, accounting for less than 2% of world trade. Unlike other developing countries, Africa's average output per capita on constant prices was lower at the end of the 1990s than 30 years before and in some countries had fallen by more than 50 per cent. 3 decades ago, African countries were specialized in primary products and highly trade dependent. But Africa missed out on industrial expansion and now runs the risk of being excluded from the global information revolution. And the situation runs the risk of deteriorating if Africa continues to marginalize its women by formulating policies which are thought to be gender neutral but which in fact continue to be gender blind. Africa's development challenges go beyond the question of low incomes, falling trade shares, low savings and slow growth. They also include high inequality, uneven access to resources, social exclusion and insecurity and it is a well-established fact that women are the worst victims. The sad reality however is that if women continue to be marginalized, the continent's development itself is threatened. The UNDP dictum that there is an urgent need to engender development to prevent the endangering of development is very pertinent here. The above sounds like a rather pessimistic picture of the continent. This is not done with

the intention of pursuing the Afro pessimism that we often see around us but instead to draw attention to some of the realities that we are confronted with as well as to find ways and means to move forward. Advancing in a context of growing 'inequalisation' and having to fight the history of unequal exchange that the continent is subjected to is no easy task. Investments in science and technology will certainly contribute to promoting development.

The few success stories of Africa

Although it lies on the periphery of the Indian Ocean and is geographically detached from the continent, Mauritius is part of Africa. It is a full-fledged member of the SADC, of the African Union as well as many other regional organizations and bodies. Slightly more than 30% of its population came as slaves from Africa but connections with the African continent have remained rather thin. On the other hand, the descendants of Indian indentured labourers from India have always wanted to retain ties and links with their 'homeland. Mauritius and Botswana are perhaps the 2 most cited examples of 'success' on the continent. The World Bank and many other organizations often refer to these countries as 'models' to be emulated. It is true that both countries have made great strides in economic performance and have contributed to a general improvement in the quality of life within their borders but their women citizens still lag behind. Mauritius had done so well in the 1980s and early 1990s that it won itself the name of the African Tiger and has become a Newly Industrialised Country (NIC) but unlike NICs such as Singapore, Korea and Taiwan, Mauritius has a very small % of its population going on tertiary education. It is about 5% as compared to 15% to 20% in the NIC countries. Needless to say that enrolments at tertiary level remain rather low in most African countries and coupled with that, many of them suffer from 'brain drain'. Mauritius and Botswana are also the 2 countries which have done very well on literacy and primary schooling enrolment. Whilst many other countries are very far from meeting the millennium development goals of Education for All, all Mauritian boys and girls have access to schooling.

Having equal access however does not mean equality of outcomes and more importantly the outcomes are differentiated on the labour market thus impacting on the Gender development index and the Gender empowerment measure. The Mauritius Research Council study (2000:iv) on Science and Technology notes "Although Mauritius scores reasonably well in international comparison for gender equality, recent studies in poverty and exclusion have shown that there are marked social

differences among Mauritian women due to cultural and historical factors. Besides there are numerous areas of social and economic life where women are poorly represented – especially in secondary and tertiary education, technical and science-based profession, public life and industry. The questions that therefore need to be posed are: Can the Mauritian “success story” be maintained – What are the factors contributing to this success? What has been the role and place of women in this success? What does the future hold in store for them and to what extent are women integrated in science and technology.

Women – critical factors in the Mauritius success story

At independence in 1968, Mauritius was on the verge of disaster. It faced massive unemployment, severe balance of payments deficit, a rapidly expanding population, huge debt problem and soaring unemployment but in less than a decade, Mauritius made great strides and became known as the ‘tiger’ of the Indian Ocean. A number of factors have contributed to the Mauritian success story but the fact that women are critical factors in this success is often occulted. The existence of a national bourgeoisie and the availability of local capital played a key role in the diversification process of the Mauritian economy. Soon after independence, the government realized that it was not possible to rely on a sugar monocrop economy and the idea of an export processing zone was introduced. The shift from the sugar bowl island to the textile island was possible since large numbers of women who were previously employed in the private sphere of unpaid reproductive work joined the formal labour market. In large numbers, Mauritian women turned the wheels of the EPZ factories. These women often had a triple burden and juggled between their domestic chores and the various demands of factory work. The EPZ needed a fairly literate pool of labour but more importantly it needed a well trained, adaptable, disciplined, dexterous and punctual labour. **The Master Plan of education** (1991:29) captures this very well: “A major achievement of the system has been that it has provided the greater part of the manpower requirements for the first stage of Mauritian industrialization.” But now that the country speaks of transiting to an information based system a net economy, the human capital remains inadequately trained. Other factors such as SAPS with a human face- (the country’s resistance to the IMF/World bank conditionalities) the strong welfare state, the best loser system also played a critical role.

The Mauritian welfare state has been heavily influenced by Fabianism and has been consolidated throughout the years. The *Vision 2020* report (1996:5) states that: ‘Some people marvel that we have achieved so much economic success despite the burden of our welfare state. It can well be argued that in reality it was the other way round. We achieved economic success because of the strength of our welfare system...’ Central to the country’s social scaffolding is the relatively large portion of the budget that goes to social expenditure. The latter absorbs about 40% of government spending today. And in spite of the various pressures to downsize the welfare state, the Mauritian governments have remained committed to it. Until today, Mauritius provides free health, free education and old age noncontributory pensions to all its citizens irrespective of gender, ethnicity and race. In addition to this, there exists some form of social aid, subsidized low cost housing and subsidies on rice and flour. Like many other countries, Mauritius also had to undergo the structural programmes commonly known as the Washington consensus but unlike many other countries, Mauritius resisted the IMF/World Bank conditionality of abolishing free education, free health and subsidies on food. Free education has had unintended benefits on women and girls. This had led to their empowerment but now that the labour market is shedding them off in large numbers and the newly emerging sectors demand skills which they often do not possess, various forms of ‘disempowerment’ make themselves felt. The Best Loser system is also regarded as a critical factor contributing to the country’s stability. To reduce tensions and fears of the different communal/ethnic groups, the British, while discussing the modalities of independence in Mauritius, introduced the Best Loser system in 1967 general elections so that each ethnic group is represented in Parliament. The proposals that emerged continue to shape Mauritian elections today. Single member constituencies were scrapped on the grounds that they tended to overrepresent the Hindu community. They are replaced by 20 constituencies with 3 members each. In addition eight seats were to be allocated after the elections to the ‘best losers’ representing communities under-represented in Parliament. Mukonoweshuro (1991) and the World Development Report (1997) as well as many others draw attention to how this best loser system ensured the representation and recognition of each ethnic group. This however does not mean that all Mauritian citizens are receiving an equal treatment. Gender as a category is ignored. The Task Force instituted by the Ministry of Women’s Rights a few years ago produced a report entitled **Women in Mauritius** (2001). The report notes: “Women are in minority in parliament despite the fact that they compose the majority

of the electorate.” Gender inclusiveness was certainly not attempted by the ‘best loser’ system. Since women in Mauritius remain largely invisible in the decision making process and positions, women’s concerns and interests are not adequately represented at policy levels. Sandra Harding well known for her various contributions on ‘gender science and technology’ (1998) in fact argues: “Gender diversity in policy makers enhances the quality of decision making in science and technology. To stress the importance of women’s perceptions and analyses, especially around issues that affect them most, is simply to point out that allowing for different view points can have immense value in scientific and technological work.’ Although Mauritius boasts itself of being a democracy, very little space is created to allow for a diversity of views from a gender perspective. Mauritius has ratified the SADC convention regarding the 30% representation of women in parliament but very little has been done so far to achieve this goal.

Mauritian labour market tilted towards males

Mauritius continues to be a highly patriarchal society with various forms of male biases. The labour market is one sector where the ‘male bias’ is highly prevalent. The Mauritian labour market is tilted towards males. ‘Male bias’ is a term that was initially used by Diane Elson in her seminal work entitled ‘Male Bias’. The latter refers to the idea that policies are shaped and formulated in such a manner that men are the ‘winners’. Male bias is a world wide phenomenon but in some countries it is more pronounced than others. An analysis of the evolution of the Mauritius labour market highlights the extent to which ‘male bias’ prevails in Mauritian society. In an attempt to address the heavy unemployment problem of the 70s, the government initiated the ‘Travail Pour Tous’ (Work for All) programme - a public scheme which created some 20000 rather unproductive kinds of jobs for males. The discourse was work for all but the ‘all’ excluded female citizens. This scheme designed specially for men, reflected and reinforced the government’s view that males are the breadwinners. In stark contrast, much concern has been expressed about the gender imbalance in employment patterns in the EPZs. The policy attempt to correct for this supposedly discriminatory situation against men is an important indicator of the anxiety generated by the impact of adjustment on employment patterns. The census 1983 on economic activity (Vol. 4: 17), for example, writes:

“The creation of the textile and wearing apparel industries (which have not only provided relatively low wages to females, possibly to the detriment of males, but have

even attracted women who would otherwise be inactive, into the labour market to compete for jobs. The recent abolition of differential wages for men and women in the EPZ has enhanced the chances of male employment in textile industries and will ultimately lead to a more equitable sex wise distribution of jobs in the manufacturing sector.”

The term ‘inactive’ conveys the idea that the reproductive and unpaid labour of women is not regarded as labour. The need for a more ‘equitable sex wise distribution of jobs’ does not seem to be of concern in the case of women but becomes a policy concern when male unemployment is being addressed. The issue therefore is not so much gender equity between men and women as access to a range of occupations is concerned, but anxiety about the role of men as ‘breadwinners’. Subsidy towards training costs was also advocated for males. Professor Lim Fat, an academic at the University, who is also regarded as one of ‘visionaries’ regarding the setting up of the EPZ argued that ‘increasing government subsidy towards training costs to 75% for male trainees only would induce the subsequent employment of more male labour, where unemployment is more acute.” (PROSI, 1985). Subsidising training costs for males only highlights the exclusionary mechanisms that are at work. Women are therefore disadvantaged. In fact women have remained highly ‘invisible’ in the training sector and now that they are being shed off in large numbers from the EPZ, attempts are being made to retool some of them but the various training schemes being offered remain dispersed and more ‘token’ like. Women do not form a homogenous block. Class and ethnicity permeate gender. One may be tempted to believe that higher class and status women with higher levels of education are at par with men when it comes to employment on the labour market but this is not true. The country may have gone some way in increasing the numbers of female scientists and engineers but subtle discriminatory mechanisms persist as highlighted by the UNDP study (1997) on education and training. This study had in fact given a ‘voice’ to some of the graduates in science and engineering. The narratives of these women are very telling regarding the extent to which ‘male biases’ exist on the Mauritian labour market.

The Mauritius Research Council (2000) study on Science and Technology also notes “...Apart from reticence due to cultural reasons, it would appear that women face much resistance from employers as regards recruiting females in industry as scientists.” (p. vi)

Women therefore are victims of diverse forms of 'male bias', the vast majority of women continue to be pooled in the most marginal, low status, low skilled and low paid positions.

Unemployment has in fact always been much more acute amongst females than males. The percentage of women employed in the formal labour market is around 35% as compared to male employment which is around 70%. With the heavy delocalization of industries from the EPZ as well as the import of foreign labour, the percentage of female unemployment has gone up. It is currently at 11.3% compared to males which is 4% (Central statistics office, 1999). Gender and the question of the cyber/intelligent network island Becoming a cyber/intelligent network island demands various forms of investment and more importantly, it demands investing in science and technology oriented human capital but Mauritius continues to lag behind in terms of science and technology. Wignaraja and Lall (1998) in a study carried out in Mauritius for the Commonwealth Secretariat argue: "Mauritius currently faces shortages of skills that would enable the economy to move to and keep up with international technological best practice in its industries. The causes lie in insufficient general and specialised education and training which in turn are the results of limited opportunities for secondary and higher education, in particular scientific and technological education, and the relatively low quality of the output of most of the institutions." The rather poor enrolment rates in scientific and technical disciplines make it difficult to believe that Mauritius can become a high tech, information based economy. The budget speech (Ministry of Finance, 1998) also recognizes the science and technology poverty prevailing in Mauritius. The University of Technology has been set up but whether this is enough to fill in the gaps and whether the curricula being offered is in line with the requirements of industry is something that remain undocumented and under researched. Munbodh (1987) also draws attention to the poor representation of girls in the technical sector and some form of positive discrimination may be called for. The persisting gender bias of the system causes a large portion of female economic potential to be under utilized.; but this issue continues to be largely ignored. Various reports and documents speak about the need to avoid 'wastage'; yet very few note the specific gender dimension of this wastage. The Mauritius Employers Federation report (MEF, 1997) is one of the few which indicates that there are more females with secondary and tertiary qualifications who are unemployed than males. This seems to suggest that either females are discriminated against by employers on the labour market or that the skills and

qualifications required by the newly emerging labour market are those that females do not possess. Traditionally feminine subjects find less space in the modern labour market. At a time when the country speaks about moving to a net economy, a cyber island, girls remain heavily underrepresented in fields that are appropriate for such a niche. (Bunwaree, 1997,1999).

The search for the cyber/network island- the new niche

The search and the efforts being made in order to transit to a cyber network island are in full swing so as to make information and communication technology the fifth pillar of the economy after sugar, textile, tourism and financial services. The government has for a number of years realized that the economy is facing a number of challenges and unless it intensifies its efforts to create a new niche, the small, isolated vulnerable island state of Mauritius runs the risk of being marginalized but what it does not realize however is that unless its human capital is treated and trained in a gender equitable manner, the country will continue to waste a large section of its human resources. The major challenges that the country currently faces are the dismantling of the multifibre agreement in 2005 and the loss of protected markets. The erosion of cheap labour - its only comparative advantage and the relocation of industries to cheaper sites of production is another major problem. Over-dependence on one or 2 products and the failure of diversifying the EPZ products is also problematical. Markets had been diversified but products not sufficiently so. The loss of FDI to other countries in the region especially post Apartheid South Africa which has become a major player is also something that the country is having to grapple with. The sustainability of the EPZ is also influenced by the level of Foreign Direct Investment. The initial spurt of FDI that fuelled the boom is tapering off. The annual growth rate of FDI inflows were 49.5% over the period 1985-1990, the figure for 1991-1997 was only 13.9% (World Investment Report, 1997).

FDI, the net economy and the human capital

The Africa Competitiveness Report speaks of Mauritius as having a very low optimism index. If the latter does not improve, capital will be attracted to other destinations. Mauritian politicians are busy developing strategies to attract FDI to the country. The Minister of Finance at a recent meeting to discuss the 'investment policy review' drew attention to the insufficient incentives offered to attract FDI and came up with a number of proposals, whilst the minister of Industry emphasized the role that

FDI will play in moving the country to a net economy (*Le Mauricien*, 25 Nov 2000). This paper however argues that moving the country to a net economy is not only dependent on FDI and the right kind of infrastructure but that human capital plays a crucial role. The island's vision is to become a regional IT or 'dotcom hub' and kickstart its flagging economy, hit hard by fierce competition and the removal of preferential access to European markets for sugar exports and textiles alluded to above. In a paper entitled "Software strategies in developing countries" Richard Heeks argues that: "IT will be a cornerstone of every national economy in the 21st century and the sooner developing countries recognize this, the better.... But not just any IT will do... Trying to copy Microsoft as a major package producer will bring all pain and no gain." According to some, it is what is termed as 'smart exports' which are critical and Mauritius, according to some people is taking a three pronged smart export road. First, it hopes to export IT services by attracting Indian and other international firms to set up call centers, back office operations and programming centers. Second, Mauritius will build on its unique domestic strengths- French is widely spoken throughout the island and this will be useful in creating software packages for French language markets in Africa, Europe and Canada and thirdly, Mauritius hopes to become a regional center for manufacture of computer hardware. In November 2001, Prime Minister Jugnauth at the launch of the cyber city project in Port Louis stated that: "We have set ourselves the task of putting Mauritius on the digital map." But whether we will be able to successfully do so is the question that we wish to pose here. As pointed out above the poverty of science and technology needs to be tackled urgently. The emphasis is now on the mental rather than the manual and if the young people of Mauritius are not sufficiently attracted to the scientific and technological disciplines, the brains that are required to transit to a cyber-island will be lacking. On the other hand, the country may decide to import foreign labour from Bangalore for instance - the 'Silicon Valley' of India but that may have other severe economic and social implications.

Conclusion and recommendations

Unless efforts are made to utilize the country's human resources in a gender equitable manner, the country's intention of becoming a 'cyber' island may just remain a dream. There is a need to rethink the conventional understanding of the history, philosophy, and social relations of science and technology. And in this context, centers of learning such as schools and sites of knowledge production and

consumption such as universities as well as research institutions become crucial. To add value to this rethinking, there is an urgent need for more research that draws upon feminist methodologies and theories, so that the often veiled mechanisms of discrimination can be exposed and these findings can feed into policy making. Many countries, including Mauritius continue to experience important gaps between policy makers and researchers. Building bridges between them is necessary and urgent. This can be done by dissemination of findings, more advocacy work and giving a voice to local scholars through publications. Pushing for the advancement of girls in science and technology also calls for a more effective sharing of experiences and learning from best practices. Organisations such as FAWE and GASAT itself as well as UNESCO, the Commonwealth Secretariat (just to name a few) have a very important role to play. Given the fact that Mauritius is also part of the Francophone countries, contacts should also be made with the relevant partners. Regional cooperation blocks such as SADC and ECOWAS especially the Human Resource Development (HRD) sector of SADC can contribute to the promotion of science and technology for girls. In short, pulling women and girls from the margins to the center requires holistic strategies. Relevant stakeholders should synergize and work together so that societies can be transformed and women find their rightful place in a world that is increasingly dominated by the market as well as science and technology. Several task forces have been set up to monitor the Science Action plan but unless these task forces and monitoring groups are infused with gender planning and analysis techniques as well as with an understanding of gender sensitive budgets, resources will continue to be inequitably allocated. There is also a need for a feminist critique of the science action plan so that appropriate measures can be taken to ensure an optimal use of resources. It is not sufficient to ask the questions : What kind of science should be taught, how it should be taught and who should be teaching. These are pertinent questions but more importantly the question 'How to make that science gender sensitive, gender responsive and gender relevant' should also be asked and addressed. The so-called 'gender neutrality' of various plans need to be analysed and addressed urgently, otherwise the shift to a cyber island may just remain a dream. In addition to this, the human condition on the island may deteriorate since all the traditional engines of growth are practically out of steam!

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ENGINEERS WITHOUT FRONTIERS

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Introduction

Today, around a billion people in the world lack access to clean water, 2.4 billion do not have access to sanitation, and 2 billion live without electricity ^[1]. These conditions affect the health and productivity of individuals, and in turn, the economy and social development of societies. Because women are most frequently the caregivers, social stewards, and primarily responsible for use of resources such as water and domestic power, they are potentially the greatest beneficiaries of improved living conditions. Involving women in problem identification and designing solutions can lead to greater empowerment of women in developing communities, as well as ensuring successful solutions.

A growing community of engineers believes technology can be an effective tool for development. However, these socially conscious engineers believe that technology is only as good as it is locally sustainable, economically compatible, culturally accepted, and indigenously implemented. This philosophy is the foundation of Engineers Without Frontiers (EWF-USA), www.ewf-usa.org.

"Engineers Without Frontiers addresses engineering-based challenges of developing communities through partnerships that foster cultural, educational, and technical exchange."

EWF-USA is a national non-profit organization headquartered in Ithaca, New York, and supported by Cornell University. From this setting, EWF-USA is developing chapters around the country. At Cornell, the local chapter advisors have developed an academic course that will have direct and lasting impact on the engineering curriculum. EWF-USA promotes this curriculum development at all affiliated campuses, which now include seven of the top ten engineering programs in the United States. Inculcating social and cultural consciousness into the engineering curriculum can help transform engineering education in the US, making technical education and professions more appealing to the growing and vital population of non-traditional students, especially women and ethnic minorities. EWF-USA appeals particularly to the humanitarian values of non-traditional students, who often list "giving back to society" as a defining value and professional goal.

Motivation

In its 2001 report on human development^[1], the United Nations Development Programme (UNDP) recognized the importance of harnessing technology to improve the lives of people in developing countries. The 20th century saw unprecedented gains in eradicating poverty primarily from technological breakthroughs. Today, digital, genetic, and molecular innovations have the potential to transform lives on a global scale. But as technology is transferred to various cultures at different stages of development, it must bend itself to local values, and blend itself into local practice. Improving health and nutrition, sharing knowledge, stimulating economic growth and empowering people to participate in their communities – all these goals can be reached, but only when the problems are defined at the local level and the solutions are tempered to fit into the social fabric. This means ensuring women are included in the process of defining the challenges and crafting the solutions. This blending of technology and respectful, inclusive social exchange is the niche of EWF-USA, which seeks to share and learn, rather than impose methodology.

Transforming Engineering Education: reaffirming social and ethical responsibility

There is no question among professionals that engineering has a direct and vital impact on improving the quality of life. Fundamental to the *Engineering Code of Ethics*^[2] is the responsibility to hold paramount the safety, health, and welfare of the public.

EWF courses provide an opportunity to situate engineering education in a social context. This is especially important for students from “high-context culture” groups.^[3] High-context culture groups – a term originating in the field of intercultural communication -- process streams of information surrounding an event, situation or interaction in order to derive meaning from the context in which it occurs. Women and minorities in the US, who tend to seek opportunities to help people and “give back to” communities, constitute such groups. EWF courses appeal to non-traditional students in engineering by being sensitive to these values.

The EWF course at Cornell University was developed in the department of Civil and Environmental Engineering (CEE). It is open to students at all levels, from all fields. The course is co-instructed by two CEE faculty members who also serve as EWF-Cornell’s faculty advisors. Students may register for the course up to four times for academic credit, allowing long-term engagement in a project. The coursework, in its

pilot offering (Spring 2003), had both lecture/classroom and laboratory/project components. Teams of students elected to work on two different projects. One was a partnership with a central New York community to design technology to improve access to public library resources for patrons with visual and other disabilities. Another was a collaboration with the NGO, *Water for People*, to design project management templates as they worked to provide communities in South and Central America greater access to water. The semester course had an enrollment of 22 students, 15 of them women, from a variety of fields, and ranging in experience from first year to graduate students. The course is real-life engineering, blending multiculturalism with technology; problem-solving complicated by real-life constraints. It is experiential learning, training students in a deeper appreciation of cultures, values, global issues and complexities.

The expanding number of EWF chapters on academic campuses creates a network of young people with a shared value -- social responsibility for global service. Such ethics-based educational experiences have been limited within technical curricula in past decades. EWF-USA seeks to make such experiences part of the mainstream of engineering education, reaffirming its roots in social responsibility.

Optimizing the Youth Factor: creative thinking, social values, low tech solutions

Students play a fundamental role in EWF-USA. Thanks primarily to the activism of student leaders, EWF-USA grew in one year from approximately 40 to 400 members, 83% of them students. Student leaders have raised awareness of international development issues among their peers, coordinated lectures and workshops, hosted speakers, and worked with faculty advisors to shape the course. Students engaged in EWF learn to build relationships with faculty and professional mentors, and apply their growing base of classroom knowledge directly to real world needs. And because the primary challenges in developing communities often require innovative contextual solutions rather than sophisticated technology, students are well suited to the task, drawing upon their abundant creativity, problem-solving skills, personal values, and boundless energy.

These student-initiated groups have been strengthened by support from dedicated faculty and administrative staff. At the Cornell chapter, faculty and administrative staff partners have helped with organizational guidance, securing office space, serving on the advisory board, and connecting the college-based chapter with needed

University services (risk management, international student travel, etc.) Support from faculty and staff is also providing a strong academic foundation for the development of EWF projects.

EWF Partnerships: expanding the scope of development agencies

There are many development agencies with considerable experience and local talent. However, there are few programs that engage students in the practical application of engineering through service-oriented projects. Based on a model program developed by the Canadian *Engineers Without Borders-Ingénieurs Sans Frontières (EWB-ISF)*^[4] the EWF-USA Internship Program provides opportunities for engineering students and recent graduates to work with development agencies around the world. This partnership not only increases the capacity of the project partner organizations, it fosters the cultural respect and sensitivity of the student volunteers; a potentially life-changing experience.

Through the Internship Program, EWF-USA identifies 3- to 6-month work placements with development agencies, recruits students from top engineering institutions, and coordinates the logistics of sending volunteers overseas. Students are selected based on technical fit, demonstrated leadership skills, interest in development issues, and energy. EWF-USA provides pre-departure planning, language and cultural training, and makes a contribution to the volunteers' transportation, insurance, and living expenses.

The success of this program has been evident in the retention of intern host organizations and student participants. Between the EWB-ISF Canada and EWF-USA, over 40 students and recent graduates have participated in the program, working for organizations such as the International Water Management Institute (IWMI), CARE, and the Himalayan Light Foundation. A majority of the alumni return to serve as volunteer leaders within a chapter or in the national organization. High retention among development agencies has likewise resulted in growth of the program. In 2002, IWMI hosted one volunteer intern who researched the groundwater contamination affecting rural villages in India. Her project was part of a larger initiative to reduce the negative impact of urban wastewater on rural livelihoods. In 2003, the organization is hosting six interns at their regional offices around the world.

Structure and Growth

The regional chapter model is common among engineering professional organizations. The Society of Women Engineers, American Society of Civil Engineers, and most other professional engineering groups have a national-regional structure. EWF chapters play a similar role. They provide opportunities to engage students, faculty, and practicing engineers in projects, in partnership with developing communities. Through the chapter model, EWF is gaining widespread support in the United States. Chapters now exist at seven of the top ten engineering institutions. Members are present at over 25 universities, many of which are also developing chapters. Through curriculum development and projects, EWF chapters are transforming engineering into a caring global community, raising awareness of the critical role engineers play in sharing knowledge, expanding humanitarian efforts, and ameliorating inequity.

The primary benefit of the chapter model for students is leadership experience and professional development. The students engage in creation of a start-up organization based on shared values. This experience appears to attract commitment from a disproportionate number from women and minority populations. Currently, 52% of EWF student members are under-represented students.

Vision for the Future

EWF-USA has grown rapidly in its very first year, attracting nearly 400 members with minimal marketing. The marketing effort remains low-key, partly due to limited funds and partly by strategy – rapid growth with limited resources can compromise sustainability. There is constant sharing of strategies and best practices with EWB-ISF Canada and EWB-UK. EWF-USA is developing partnerships with NGOs around the world, strengthening the link between technology and community development, and increasing opportunities for design and implementation of scalable projects. This strategic incrementalism is consistent with EWF-USA's grassroots origin.

Experiential education through community service and teamwork will continue to strengthen the niche for engineers driven by altruism and a desire for social impact. There is considerable potential for worldwide impact through scalable solutions of engineering related community problems. There is also potential for diversifying the engineering field in ways far beyond what has occurred to date. Already, the effects

can be seen in the participation of women. Nationally, in the US, 20% of undergraduate engineering students are female. In the workforce, it is about 10%^[5]. But of the 2500 EWB-ISF members^[4] and 400 EWF-USA members, about 50% are women.

Challenges

The main challenge faced by EWF-USA is one that any new non-profit initiative has to face: financial stability. Chapter and NGO partnership development needs support, as does the identification of project and internship opportunities. Essential to the healthy growth of any organization is administrative stability, integrity, and process development: volunteer coordination, chapter development, travel, marketing, project identification, evaluation, research and implementation, fund-raising, grant writing, and foundation relations. The situation is made more challenging by the fact that providing capital for administrative support, where a new organization experiences the greatest need, is not a funding priority for most donors and foundations.

Why Engineers Without Frontiers?

Diversity, Culture and Pedagogy: The National Academy of Engineering has identified the need for increasing the numbers of non-traditional engineers as a critical issue^[6]. Many leaders in the field believe this can happen only by changing the academic culture of engineering. EWF, incorporated into the fabric of engineering education, can attract and retain non-traditional students. EWF courses in the engineering curriculum add global context to the pedagogy of engineering education, which in turn, will attract a more diverse population of students.

Gender and EWF: EWF-USA is attracting women members in proportions far greater than their representation in the engineering profession. As mentioned earlier, nearly 50% of student members and 33% of professional members are female. In the pilot EWF course at Cornell University 15 of the 22 students were women. We see EWF as means for greater recruitment and retention of women in engineering. EWF is also very conscious of the implications of development projects on gender equity and empowerment.

EWF brings students and faculty together for a common goal, sharing values and efforts toward a greater good. On large campuses where students do not easily

connect with faculty members, this is a great benefit. This is especially important for women who express the need for a supportive community as a key value.

EWF as part of the curriculum is a strong response to the early disengagement experienced by many students who find their passions dampened by an onslaught of foundational math and science courses in the first and second years, with little real-life context. Since attrition of students in engineering is highest at the early stages, EWF projects and coursework can positively influence retention.

Ethics, Professional Development, World Citizenship: The EWF experience helps engineers develop a more sophisticated understanding of global development issues and increased cultural sensitivity. EWF volunteers are challenged to put their skills to use in innovative ways as they work on projects and internships, and as they learn to work within the constraints of a non-profit organization with limited resources. Student leaders gain administrative and management experience; non-profit budgeting and accounting, managing an advisory board, creating meeting schedules/agendas/follow-up, navigating the campus administration and politics, etc. Once students begin working toward a project, they experience the complexities and public relations nuances of creating partnerships and networks with and between chapters, NGOs, governmental agencies, and funding sources. Once on-site, students deal with language and culture differences as they apply their creative problem-solving skills, not to a computer simulation model, but to real situations involving real people. And they have an impact. EWF projects help expand people's choices and enrich their lives. EWF creates another forum for meaningful exchanges leading to greater understanding among people around the world.

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A PATH-ANALYTICAL STUDY OF NIGERIAN HIGH SCHOOL FEMALE SENIORS' CHARACTERISTICS AND THEIR ACADEMIC PERFORMANCE IN BIOLOGY

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ABSTRACT

The recognition of the fact that learners' characteristics, attitude and commitment are paramount to the business of learning, coupled with the urgent need to ultimately lay to rest the problem of female under representation in the field of Science and Technology informed this study which was undertaken to examine the causal effect of Nigerian High School Female Seniors' characteristics and their academic performance in biology. Hence, this study specifically developed and validated a female student model involving causal linkages between characteristics such as school type, cognitive-style, self-concept, home language, study-habit, locus of control and attitude towards biology and their academic performance in biology with a view to promoting gender equity in Science and Technology. The sample comprised two hundred and fifty (250) female high school seniors. Six validated instruments were used to collect the data while path-analysis and multiple-regression analyses were employed for data analysis. The findings of this study documented the more parsimonious model which is effective in predicting female seniors' academic performance in biology. The results further indicated that four (4) out of the seven characteristics have both direct and indirect causal linkages with the criterion variable whereas the remaining three characteristics have only indirect causal linkages. A major implication of this study is that collective efforts on the part of the teachers, parents, curriculum planners, government and society should put in place enabling conditions that would empower girls and encourage them to possess the identified potent characteristics. This will ultimately enhance higher achievement in biology.

INTRODUCTION

The need to encourage females to continually participate, achieve highly and remain in Science and Technology is now a strong one across the globe. This is probably borne out of the fact that women constitute more than half of the World population (UNICEF 1998) and as such it may be morally wrong for development to take place outside this formidable group. It follows that women's contribution to the transformation process cannot be ignored if high level of Science and Technology input is to be achieved. This would in turn have implications for the capacity to produce the sufficient numbers of technical and managerial workers with the skills to meet the needs of modernising the economy (Erinosho 2001).

The issue of girls' under-performance in science is a cause for worry. Researchers such as Erinosho (1993), Mbanjo (1997) and Nasor (1997) have documented lower achievement in girls than their male counterparts. However, Nwanza and Kazima (1999) found that low performance of girls is not entirely a function of general lack of ability. For instance, O'Counor (1998) in an extensive study made this submission.

"Everybody 'knows' girls can't do Mathematics and Science. Teachers 'know' it. Parents 'know' it. And because so often people live up to or down to the expectations of them, the girls themselves bow down to the conventional wisdom and assume that everyone is right and that they really can't excel in these subjects".

In the same vein, Lenga (2001) identified factors preventing high academic performance of girls to include lack of self-esteem, confidence and exposure, their negative attitude towards science, environmental factors and lack of role models.

It is worthy to note that considerable research efforts have been directed towards identifying the remote and immediate causes of women under-representation and under-achievement in the field of Science and Technology. Some of the identified causes include poverty, socio-cultural barriers, student factors, attitudes of parents, insensitive teachers, didactic approaches to teaching Science and Technology, inappropriate and irrelevant syllabuses, poor facilities, lack of equipment and resources, inefficient and unsuitable examinations and lack of role models (Orji 1998; Bilesanmi-Awoderu 2000; O'Connor 2001 and Lenga 2001).

However, this investigator contends that any meaningful and concerted effort to enhance more participation and high achievement in Science and Technology should be sensitive to female seniors' characteristics such as study-habit, cognitive style, self-concept, locus of control, school type, home language and attitude towards biology. This is because these variables have been identified to effectively influence performance in Science and Technology. (Fatubarin 1987; Germann 1988; Macnab and others 1991; Shepardson 1991; Aghadiuna 1992; Bilesanmi-Awoderu 1996; Onafowokan and Okpala 1998 and Bilesanmi-Awoderu 2002).

However, the literature indicates that the earlier studies did not take many of the variables together at the same time in a particular study. Also, data analysis range from t-test through one-way analysis of variance to correlation coefficient. Hence, it is clear that these studies despite their depth and perhaps scope have not been able to determine and establish the sequence, direction and strength of interactions among the female learner characteristics and achievement in biology. In effect, interactions could not be explained in terms of causal linkages in a multivariate analysis.

It is therefore the problem of this study to construct and test an eight-variable model for determining the extent to which some female - seniors' characteristics (study-habit, cognitive style, self-concept, locus of control, school type, home language, and attitude towards biology) provide a causal explanation of the female seniors' academic performance in biology.

Specifically, this study sought to provide answers to the following questions:

1. What is the most meaningful causal model (involving the listed variables) for achievement in biology among female seniors in secondary schools?

2. What is the direction as well as estimate of the strengths of the causal paths of the variables in the model?
3. What are the direct and indirect effects of the variables on biology achievement?
4. What proportion of the total effects are (i) direct and (ii) indirect?

METHODOLOGY

Sampling Procedure and Sample

Using judgemental sampling technique ten equivalent secondary schools were selected from Ogun State, Nigeria. Five of the ten schools were single-sex schools while the rest were mixed schools. From each school, twenty-five female seniors in Senior Secondary School II were randomly selected. In all, two hundred and fifty (250) girls participated in the study.

INSTRUMENTATION

Data collection involved the use of six valid and reliable instruments.

- (i) Study Habits Inventory (SHI) Cronbach alpha value = 0.79.
- (ii) Sigel's Cognitive Style Test (SICOST) Test-retest reliability value = 0.77.
- (iii) Personal Data Inventory (PDI) Cronbach alpha value = 0.87.
- (iv) I-E Locus of Control Scale (I-ELCS) Test-retest reliability coefficient value = 0.83.
- (v) Female Seniors' Attitude Towards Biology Scale (FSATBS) Cronbach Coefficient alpha value = 0.86
- (vi) Achievement Test in Biology (ATB) K-R 20 reliability value = 0.87.

DATA COLLECTION AND ANALYSIS

The investigator, two research assistants and the biology teachers of the selected schools were involved in the process of data collection which lasted for three weeks after due permission had been sought from the school principals. Data analysis employed the two closely related multivariate analytical techniques of multiple regression and path analysis. These two techniques are integral parts of the confirmatory causal modelling.

RESULTS

The hypothesized model (figure 1) which shows the path coefficients and the zero order correlation coefficients (in parenthesis) provides twenty six paths. Using the criteria of significance and meaningfulness, only thirteen out of the twenty-six paths survived. The hypothesized model was therefore trimmed to produce a more parsimonious model (figure 2).

To verify the efficacy of the more parsimonious model, the reproduced correlation coefficient was compared to the original correlation coefficients. From table 1, the discrepancies between the original and the reproduced correlations are considered very small. This is an indication that the pattern of correlation in the observed data are consistent with the new model. The parsimonious model is therefore considered tenable in explaining the causal interaction between the predictor variables and the criterion variable. Figure 2 is thus the most meaningful causal model (involving the predictor variables) for thinking the criterion variable. This is the main result of this study.

The direction of the causal paths of the variables in the model are the paths which are significant and meaningful as well as have a link with the criterion variable (X8). Altogether these paths are twenty-eight (28) in number and the path co-efficient give the estimates of the strengths of the causal paths of the variables in the model.

Out of the significant and meaningful twenty-eight (28) paths, only four (4) are direct while the remaining twenty-four (24) are indirect. The total effect (i.e. direct plus indirect) of all the seven predictor variables are shown in table 2. The proportion of the total effect that is direct and indirect is also evident from the table.

Table 2: Effects of the Seven Predictor Variables on Students' Achievement in Biology

Xj j= 1, 2, 3-7	Variable Description	Total Effect (TE) a	Direct Effect (DE) b	% of DE Relative TE (b/Ta x 100)	Indirect Effect (IE)	% of IE Relative to TE TE (a-b/Ta x 100)
1.	School type	-0.0984	0.1046	7.734	-0.203	-15.01
2.	Home language	0.4454	---	---	0.4454	32.93
3.	Study habit	0.0546	---	---	0.0546	4.04
4.	Cognitive style	0.4236	0.3797	28.08	0.0439	3.25
5.	Self-concept	0.3558	0.3048	22.54	0.0510	3.77
6.	Locus of	0.1561	---	---	0.1561	11.54

	control					
7.	Attitude towards Biology	0.0153	0.2637	19.50	-0.2484	-18.37
	Total	1.3524	1.0528	77.85	0.2996	22.15

Note: Absolute values of the total effect and direct effects are used for computation.

$X_1 = X_8$ = the criterion variable (X8)

$X_j = (1, 2, 3, \dots, 7)$ = Predictor variables (X1 - X7)

DE = Direct Effect = P_{ij} s (where $i = 8, j = 1, -2, \dots, 7$)

P = Path coefficient

TE = Total Effect = r_{ij} s (where r = original correlation coefficient)

Ta = Grand Total of T. E.

DISCUSSION

From the available data of this study, it is evident that 11.53% of the variability in high school female seniors' achievement (X8) is accounted for by all the seven predictor variables when taken together. Also, since the magnitude of beta weights is assumed to be directly proportional to the degree of the effects of the influencing variable, it could be seen from Table 2 that four out of the seven variables that is: Cognitive Style (VAR 4); Self-concept (VAR 5); Attitude towards biology (VAR 7) and School type (VAR 1) have direct causal influence on the female seniors' achievement in biology.

Cognitive style (VAR 4) has the most effective causal influence on the female seniors' achievement in biology. As shown in Table 2, VAR 4 has a path coefficient of 0.3797 significant at 0.05 level and accounts for 31.33% of the total effect of the causal variables on the students' achievement in biology. This result is consistent with some other findings (Barnett, 1974; Fakunle 1988; Aghadiuno 1992 and Bilesanmi-Awoderu 1996) which have shown that cognitive style has significant effect on students' achievement. It therefore follows that biology teachers should present information using a repertoire of strategies that would ultimately empower females and enhance proper cognition development. Self-concept (VAR 5) is the next important variable that has direct causal influence on students' achievement. It has a path co-efficient of 0.3048 and accounts for 26.31% of the total effect. This empirical finding is not unexpected considering the fact that other researchers (Okpala and

Onocha (1988b) Asghar 1994, O'Connor 1998 and Umoinyang (1999) have shown that self-concept had a significant effect on students' achievement.

It thus follows that teachers, guidance counsellors, parents and guardians should endeavour to encourage girls to study science and re-orientate them to develop positive self-concept in order to achieve highly in biology.

The third most important cause of variation in female seniors' achievement is Attitude towards Biology (VAR 7). As shown in Table 2, VAR 7 has a path co-efficient of 0.2637 and accounts for 1.13% of the total effect. This finding supports those of Okpala (1985); Aghadiuno (1992); Umoinyang (1999) and Onafowokan and Okpala (1999). This result lends support to the reported effects of attitude on achievement. For instance, Emina (1986) submitted that attitude towards a subject seems to be the very basis of cognitive development in the subject as well as several other positive correlates of achievement in the subject.

The fourth most important cause of variation in female seniors' achievement is school type (VAR 1). It has a path coefficient of -0.0984 and accounts for -7.276% of the students' achievement. According to this study, school type has a causal direct effect on the students' achievement. This finding is in line with the findings of Erinoshio (1992) and Njoku (1999) whose result documented students' differences in performance based on school type. However, the important point to note here is that teachers in whichever school type should strategise their teaching procedures in such ways that females would be highly encouraged to be investigative, creative and active as against the present situation in which girls are passive and largely ignored in class. However, variables such as Home Language (VAR 2), Locus of Control (VAR 6) and Study habit (VAR 3) show only indirect effect on the criterion variable (VAR 8). In other words, in the presence of the potent characteristics, the direct effect of VARS 2, 6 and 3 would be low and not statistically significant and meaningful.

CONCLUSION

A major finding of this study is that four out of the predictor variables (Cognitive style, self-concept, Attitude towards biology and School type) had both direct and indirect, effects on female seniors' achievement in biology while the remaining three variables (Home Language, Locus of control and Study habit) only had indirect effect. This result documents the relative order of importance of the variables as follows $X_4 > X_5 > X_7 > X_1 > X_2 > X_6 > X_3$.

The implication is that curriculum planners should put in place enabling conditions that would empower girls and encourage them to possess these potent characteristics.

The result should be communicated to the practicing biology teachers through workshops, conferences and seminars so that the potency of the four variables in predicting female seniors' characteristics would be known. This knowledge in effect, would enable the teachers to enhance these variables while teaching and in turn, such is expected to bring about more participation and higher achievement in secondary school girls.

Conclusively, the curriculum developers and science educators should note the various linkages in the parsimonious model (figure 2) since these could provide a strong basis for promoting gender equity and high achievement in Science and Technology.

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Table 1: The Original and the Reproduced Correlation Matrix

	V ₁	V ₂	V ₃	V ₄	V ₅	V ₆	V ₇	V ₈
V ₁	1.000	-0.856	0.2264	-0.1816	-0.0686	0.0855	0.0415	-0.0984
V ₂	0.000	1.000	-0.2035	0.6358	0.3621	0.1512	-0.1685	0.4454
V ₃	0.2259	-0.2034	1.000	0.1564	-0.3550	-0.1284	0.5453	0.0546
V ₄	-0.1816	0.6298	0.1297	1.000	0.2986	0.0679	0.1348	0.4236
V ₅	-0.0598	0.3600	-0.3550	0.2899	1.000	0.3049	-0.0172	0.3558
V ₆	0.855	0.1498	-0.1284	0.0587	0.2999	1.000	-0.2835	0.1561
V ₇	0.0357	-0.1683	0.5453	0.1266	-0.0172	-0.2833	1.000	0.0153
V ₈	-0.0984	0.4453	0.0520	0.3739	0.3585	0.1472	-0.0153	1.000

Annex

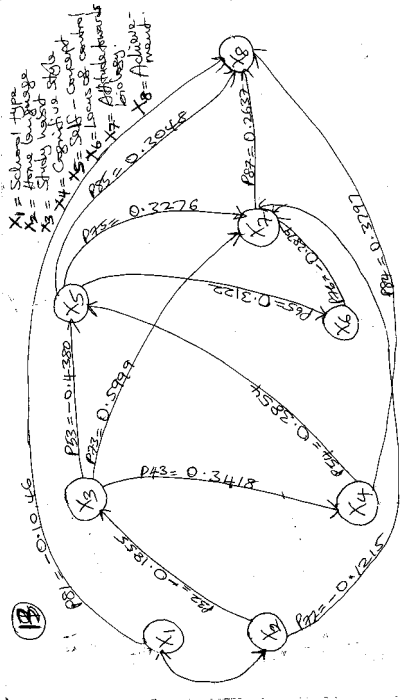


Fig. 2. The New Model for $X_1 - X_8$: A More parsimonious Model.

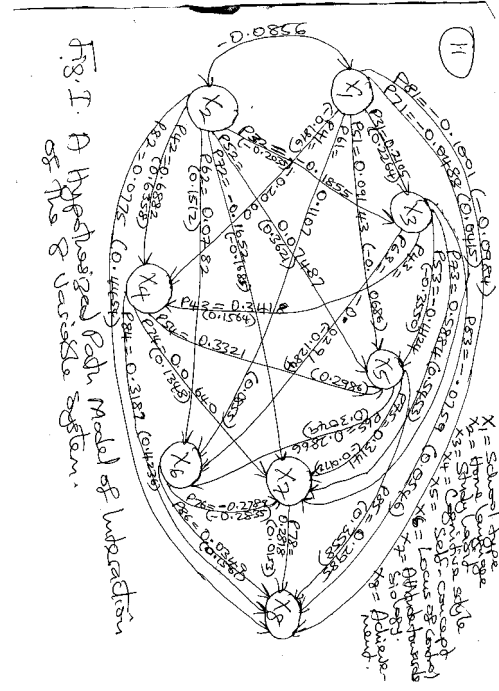


Fig. 1. A Hypothesized Path Model of Interaction of the 8 variable system.

GENDER-RELATED DIFFERENCE ON THE INFLUENCE OF THE PARAOXONASE GLN192ARG POLYMORPHISM ON CORONARY HEART DISEASE IN THE INDO-MAURITIAN POPULATION.

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Abstract:

Serum paraoxonase is an HDL-bound enzyme protecting LDL-cholesterol from oxidation, its encoding gene PON1 is considered to be a potential candidate gene involved in the pathophysiology of atherosclerosis. We studied the association between PON1 Gln192Arg polymorphism and coronary heart disease (CHD) in an Indo-Mauritian population through case-control and family based association studies, using PCR-RFLP techniques in 290 male and 50 female consecutive patients with premature CHD (onset of CHD below 60) who were compared to 125 male and 56 female controls. We also studied for this polymorphism 155 nuclear families (541 individuals), ascertained through an index subject with premature CHD. Allele frequency of the common variant Gln192 allele was higher in CHD female patients compared to female control individuals (64% v/s 49%, $p=0.03$) but was the same in male CHD patients and control individuals (57% v/s 56%, $p=0.84$). We found an excess of homozygous individuals for the Gln192 allele (44% v/s 20%, $p=0.025$) only in female CHD patients. When we grouped individuals with Arg/Arg and Gln/Arg genotypes and compared them to those with the homozygous Gln/Gln genotype, we found a significant interaction between gender and the Gln/Gln genotype on occurrence of CHD phenotype ($p=0.02$). We also found through family studies, in females only, a trend towards preferential transmission of the Gln192 allele to female siblings affected by CHD ($n=65$) compared to transmission of the same allele to unaffected female siblings ($n=182$), $p=0.04$. An interaction was shown between gender and the PON1 Gln192Arg polymorphism on CHD phenotype through case-control studies while family based studies confirmed both association and linkage between the polymorphism and CHD in Indo-Mauritian women.

Introduction:

Coronary Heart Disease (CHD) is a complex disease arising from the interaction between environmental and genetic factors. It is considered to be a major macrovascular complication of type 2 diabetes (T2D) which has achieved very high proportions in Mauritius in all ethnic groups (Dowse et al, 1990). A major risk factor common to both T2D and CHD is the metabolic syndrome or insulin resistance syndrome that could arise from the interaction between behavioral, environmental and genetically determined factors. Several studies support the idea that genes which confer a risk for T2D, and to a lesser extent high blood pressure (HBP), adversely alter the cardiovascular risk profile long before the manifestation of clinical disease (Laakso, 1999; Mitchell et al, 1999; Kareinen et al, 2001). Both CHD and T2D are highly prevalent in Asian Indian populations who lead an urbanised life and those who migrated from India (Mc Keigue et al, 1989; Mc Keigue et al, 1991, Knight et al, 1992; Tan et al, 1999).

We have tried to shed light on the genetic factors underlying susceptibility to CHD and to components of the metabolic syndrome through two complementary study designs. We used a candidate gene approach and an assumption free, unbiased

approach through a genome scan on families with premature CHD (age of onset below 60) belonging to the North-Indian (NI) ethnic group. Position independent and positional candidate genes were chosen if there were reasons to suspect their involvement in the physiopathology of CHD or of the metabolic syndrome. Some candidate gene studies were carried out both in our case-control cohorts and in families selected for the genome scan using family based association studies.

We chose the paraoxonase gene (PON1) as a positional candidate gene given its location in a subchromosomal region (7q36), which is orthologous to a region that had previously shown linkage (Aitman et al, 1997) to several insulin resistance traits in spontaneously hypertensive rats (chromosome 4q). Serum paraoxonase is an HDL-bound enzyme protecting LDL from oxidation. This enzyme protects against oxidative modification of LDL in the artery wall, which is currently thought to be central to the pathogenesis of atherosclerosis. PON1 gene polymorphisms had been previously studied in relation to CHD, with inconsistent results, in several populations. No association was found with CHD in some studies (Herrman et al, 1996; Ombres et al, 1998; Ko et al, 1998; Cascorbi et al, 1999) while some polymorphisms were found to be involved with CHD in others (Aubo et al, 2000; Imai et al, 2000; Sen-Banerjee et al, 2000; Senti et al, 2001).

The contribution of the PON1 Gln192Arg restriction site polymorphism to CHD was assessed through both case-control and family based association tests in North-Eastern Indian (NI) families that had been selected for a whole genome scan.

Population and Methods:

Consecutive CHD patients with age of onset of disease below 60 years were recruited from 2 cardiac outpatient departments of the Ministry of Health. Controls were either recruited from 3 sugar estates, or were spouses recruited in our family studies. Control individuals had no clinical or electrocardiographic evidence of CHD and had a normal glucose metabolism (no T2D, no impaired glucose tolerance (IGT), no impaired fasting glucose (IFG)).

A total of 541 Mauritian individuals belonging to 155 nuclear NI families, whose ancestors migrated from the port of Calcutta to Mauritius, were studied for the PON1 Gln192Arg polymorphism. These families had been initially selected for a genome-wide search for chromosomal regions harboring genes conferring susceptibility to CHD and/or to insulin resistance. Families were ascertained through an index subject with CHD before 52 years and additional sibs with premature CHD or T2D. Apart from available parents and index subjects, all available members of the sibship

affected by CHD or abnormal glucose metabolism (T2D or IGT) were included, as well as one unaffected sibling (preference was given to older “unaffected” members of the sibship). When both parents were unavailable for genotyping, we tried to include at least 4 sibs in the genome scan to allow for estimation of parental genotypes.

We studied family based association between the bi-allelic polymorphism and three phenotypes: CHD, T2D or HBP.

Phenotyping:

Patients, controls, and family members were all submitted to the same research clinic investigations, in a 12 to 14 hours fasting state, after they gave written informed consent.

Insulin and glucose profiles were determined, including a 2 hour oral glucose tolerance test (OGTT) if there was no known T2D. Lipid profile (total cholesterol, HDL cholesterol, triglycerides were assayed, LDL was calculated) as well as serum uric acid, urea and creatinine were assayed. Albuminuria and microalbuminuria (if albuminuria was negative) were determined using dipsticks in first morning urine samples (microalbuminuria tested by Micral II test, Boehringer-Mannheim).

Anthropomorphic measurements (height, weight, waist and hip girths) were recorded, and blood pressure was measured twice in a sitting position, after a minimum of 15 minutes rest. An ECG in the resting state was carried out by nursing officers. Standard questionnaire on personal and family history, medical examination and interpretation of ECG were carried out by a medically qualified practitioner.

PCR-RFLP studies:

PCR reactions were performed with the following primers using a Perkin-Elmer GeneAmp PCR System 9600 (Perkin Elmer Corporation, Norwalk, USA), at an annealing temperature of 60°C, with the following primers (Forward 5' TAT TGT TGC TGT GGG ACC TGA 3' and Reverse 5' CAC GCT AAA CCC AAA TAC ATC TC 3'). PCR reactions were carried out in 20 µl volume with 6 µl Template DNA (10 ng/ µl) and 14 µl of the following mix (1 µl primer mix (both 5' and 3' primers) at 5 µM, 1 µl dNTP at 2.5 mM (Boehringer), 2 µl of Perkin-Elmer Buffer (10 X), 0.2 µl of AmpliTaq Gold polymerase (5 U/µl), 2 µl MgCl₂ at 12.5 mM, and 8 µl H₂O.

After amplification, 15 µl of the PCR product was precipitated with 80 µl cold absolute ethanol overnight at -20 °C. The preparation was submitted to centrifugation

at 3300 rpm for 1 hour at 40C, and allowed to dry before adding a volume of 15 µl of a digestion mix. The digestion mix was composed of 0.5 µl (2 u/ µL) of restriction enzyme AlwI, 1.5 µl of Buffer (10X) and 13 µl H2O. The restriction mix was incubated at 37 °C overnight, digested PCR products were subsequently visualised with Ethidium Bromide staining after migration on a MetPhor gel (Wild-type Gln192 allele yielded 99 bp bands while Arg192 allele yielded 69 and 30 bp bands).

Statistical analyses:

The Chi-squared Test was used for categorical variables and the Kruskal-Wallis Test for quantitative variables in case-control studies, both tests are implemented in Epi-Info Version 6.04 (CDC, Atlanta). In families, statistical analyses were carried out with the Sibship Disequilibrium Test (SDT), a discordant-sibship test, in a software implemented in the Family Based Association Test (FBAT) software (Horvath & Laird, 1998), designed to detect both linkage and association. The SDT does not require parental data but requires discordant sibships with at least one affected and one unaffected sibling ((Horvath et al, 2001).

Results:

Gln192 allele frequencies were similar in male NI controls (0.56) and in male NI CHD patients (0.57). However, a significant difference in allele frequencies was seen in NI women between controls (Gln192 allele frequency: 0.49) and CHD patients (Gln192 allele frequency: 0.64), p<0.03. The homozygous wild-type Gln/Gln genotype was found more often in NI women with CHD than in controls (OR=3.21, 95% CI: 1.24<OR<8.45, p<0.01), as shown in Table 1.

Table 1: Association between PON1 Gln192Arg polymorphism and CHD in the Mauritian population of North-Eastern Indian origin

PON1 Gln192Arg	NI men			NI women		
	CONTROL	CHD	p val	CONTROL	CHD	p val
	n=125	n=290		n=56	n=50	
Gln/Gln	30%	31%	<0.90	20%	44%	<0.025
Gln/Arg	51%	53%		59%	40%	
Arg/Arg	18%	17%		21%	16%	
Gln/Gln v/s two other genotypes			<0.95	OR=3.21		<0.01
				1.24<OR<8.45		

Moreover, an interaction was found between the Gln/Gln genotype and gender for the risk of CHD in the NI group, Chi-square=5.56, $p<0.02$.

The homozygous Gln/Gln genotype was, conversely, associated with higher concentrations of HDL cholesterol in NI women affected by CHD (genotype specific means of HDL cholesterol for Gln/Gln ($n=18$), Gln/Arg ($n=18$), Arg/Arg ($n=8$) were respectively 1.09 ± 0.22 , 0.97 ± 0.24 and 0.87 ± 0.15 mmol/l, $p<0.05$).

No family-based association was found between T2D or HBP and the PON1 Gln192Arg polymorphism. Transmission of the Gln192 allele was similar in male siblings whether they were affected or unaffected by CHD. However a trend was found towards preferential transmission of the Gln192 allele to female siblings affected by CHD ($n=65$) compared to transmission of the same allele to unaffected female siblings ($n=182$), p value=0.04.

Discussion:

It is generally considered that the best candidate genes are those that are located in regions showing linkage to phenotypes under study. PON1 gene in chromosome 7q21.3 was considered to be good positional candidate gene for the metabolic syndrome, given previous results in the spontaneously hypertensive rat where that locus had shown linkage to several insulin resistance traits (Aitman et al, 1997). Background oxidation of LDL plays a role in endothelial dysfunction. Oxidised phospho-lipids from LDL cholesterol activate inflammatory genes and promote the adhesion of monocytes to the endothelium, a key event in early atherosclerotic lesions.

The association found between CHD and Gln192 allele in women in our case-control studies was strongly supported by our family-based association studies (discordant sibship-disequilibrium test) where a preferential transmission of the Gln192 allele was found in female NI siblings affected by CHD but not in male siblings. Results of other studies on association between the PON Gln192Arg polymorphism and CHD have yielded conflicting results so far. Several studies (Bauters et al, 2000; Sen-Banerjee et al, 2000; Senti et al, 2000; Aubo et al, 2000; Imai et al, 2000), but not all (Ko et al, 1998; Cascorbi et al, 1999) have implicated the codon 192 polymorphism in PON1 gene with the risk of CHD. These findings suggest that this polymorphism might not be functional but may be in linkage disequilibrium with a functional mutation in the PON1 gene or in a nearby gene.

Paraoxonase activity, which we did not measure in our study, was described to be lower in individuals with macrovascular disease compared to healthy individuals (Mackness et al, 2001). Ageing is correlated with reduced serum paraoxonase concentrations, which may compromise the protective influence of the enzyme (Levieu et al, 2001). Risk of MI was found to be increased with advancing age, principally among subjects carrying the low-activity Gln/Gln genotype in a Spanish study where PON1 activity was studied in relation to age distribution and the Gln192Arg polymorphism in 280 consecutive MI patients and 396 control subjects (Senti et al, 2001).

Another polymorphism in the PON1 gene promoter, the -107 C/T polymorphism upstream from the PON1 gene, has been shown to be associated with transcription of the PON1 gene and serum PON1 concentrations (James et al, 2000). The TT genotype was associated with significantly lower serum PON concentrations and was over-represented in T2D patients with CHD (TT v/s TC+CC: OR 1.64, 95% CI 1.03-2.61, $p < 0.05$). This association was independent of other risk factors and of the coding region Gln192Arg polymorphism which was also associated with increased risk of CHD (OR=2.12, CI 1.19-3.70). These findings, and our results showing both interaction between the Gln/Gln genotype and gender on CHD, as well as the preferential transmission of the Gln192 allele to women with CHD tend to show that PON1 Gln192Arg polymorphism should not be disregarded, in its own capacity, as a contributing risk factor for CHD, at least in women.

Few studies in humans have explored potential gender differences in the influence of genetic polymorphisms on phenotypes, whereas genetic studies in animals point to differences in phenotypes between gender groups. The importance of PON1 in the pathogenesis of atherosclerosis was underlined by gene targeting studies in animals. PON1 “knock-out” mice were found to be more susceptible to atherosclerosis than their wild-type littermates. HDL cholesterol isolated from PON1 -/- (knock-out for PON1 gene) mice was unable to prevent LDL oxidation in a cell co-culture model of the artery wall (Shih et al, 1998). In the same study, effects of PON1 deficiency on plasma lipoproteins levels were examined in male and female “knock-out” mice of different genotypes. No difference was observed between male mice with different genotypes. However, PON1 +/+ and +/- female mice had increased lipoprotein levels (VLDL cholesterol and Triglyceride) compared to PON1 -/- female mice. These findings point to a gene-gender influence on lipid metabolism for PON1 in mice. Results in “knock-out” mice confirm the role of PON1 as a protective factor against

atherosclerosis through its anti-oxidant properties even if presence of the PON1 gene leads to a more atherogenic lipid profile in female mice. Importantly these experiments show the plausibility of gene-gender influence of the polymorphism. If we speculate that the Gln192 allele is associated with lower paraoxonase activity, then our results in NI CHD female patients are not in contradiction with results in mice that were knocked-out for the PON1 gene. PON1 Gln/Gln genotype in NI women was indeed associated with higher risk of CHD, but it was also associated with a less atherogenic lipid profile in CHD female patients (higher HDL concentrations).

Conclusion:

Both case-control and family based association studies indicated association between the Gln192Arg polymorphism in the PON1 gene and CHD in Mauritian women of North-Eastern Indian origin, but not in male CHD patients. It would seem that the consequences of diminished anti-oxidant activities associated with the Gln192 allele are more important than reverse cholesterol transport in the pathogenesis of atherosclerosis in women.

Acknowledgements:

Dr U.S. Ramjuttun, Dr TK Gunness from the Ministry of Health, Mauritius

Dr S. Francke, Miss L. Corset, Miss C. Lecoœur, Professor P. Froguel from CNRS UPRES A 8090, Lille, France.

Miss A. Hébé, Mrs S. Lee Kwai Yan, Mrs N. Sem Fa, Mrs S. Jankee from SSR Centre for Medical Studies & Research, University of Mauritius, Moka, Mauritius.

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PROBLEM-BASED LEARNING, FEMALE FRIENDLY?

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Abstract

Problem-based and project-oriented learning model has been well applied in Aalborg University for more than twenty years. It succeeds in attracting more and more young people into engineering profession. The emphasis on group work in this module is expected to be attractive to women, since it involves more cooperation and communication. But there has been little research done in gender perspective. This paper states the starting thoughts of my Ph.D. project, which is also part of a national project 'Get A Life, Engineer!' in Denmark. The aim of this study is to understand women's learning experiences in the problem-based and project-oriented learning context, and to probe possibilities of creating a friendly learning environment not only for male but also for female engineering students. The preliminary findings in my first period of empirical work are briefly analyzed in this paper. Besides, this paper is also an attempt to relate my initial thoughts to some theoretical ideas on gender contract, engineering education, learning and power system, and to the proposed methods.

Background

Engineering as a technology-based and career-oriented profession works in a remarkably different way for women from that for men. One of the most commonly-seen indicators of engineering's gendered impacts is the sharp difference in the number of men and women in the participation of engineering education and workplace.

Women's underrepresentation and invisibility in engineering profession has been seen as a problem in many Western countries due to the great need for engineers in general, the potential diversity of values women might bring into this profession, and the issue of gender equality in science, technology and power relations. Thus, various efforts have been made in the western world with an aim of recruiting more female students into engineering curriculum.

In Denmark, despite liberal doctrines of equal opportunity, there continues to be a gap between formal and real equality, especially in the area of women's participation into non-traditional professions. Gender relation in engineering profession has become a less-talked topic in the past years after a long-time struggle without notable success. Having worked at an engineering university in China and having witnessed the Swedish initiatives aiming at recruitment of female engineering students¹, I am interested in looking into the gender relations in engineering education in Denmark

¹ As a sociologist, I have no technical background. However, I used to work as a teaching assistant in an Engineering University in China, helping the students with language study. Through participating in an international program 'Science, Technology, Society' in Roskilde University, Denmark, I experienced the PBL environment as a student. Later, I studied 'Gender and Technology' in Sweden and conducted a research on gender and engineering education in China with the collaboration of western and Chinese theories.

with an outsider's eyes. My Ph.D. research project is part of the national project 'Get A Life, Engineer!' funded by European Union. Together with the other two target groups in the Technical University of Denmark and the Danish Research and Documentation Centre on Gender Equality, the three research projects form an objective of presenting example models that can promote cohesion between work and family life for engineers, and developing the possibilities of creating a fine work/life balance in engineering life. My part of the project will look into gender relations in an engineering educational institution through examining gendered way of learning, with an aim of probing possibilities of increasing gender consciousness at large and making engineering education attractive not only to male but also to female students.

As one of the two engineering universities in Denmark, Aalborg University has been characterized by its curriculum innovation – the introduction of the project-organized and problem-based learning concept (PBL) since its birth in 1974 (Kolmos 1992). The problem and group-based learning style consider both the cognitive and affective factors in the practice of creating an active learning process (Kolmos 1992). This model provides an open learning process for learners, which is build upon learners' experiences and conceptual understanding of science and technology as well as developing interdisciplinary scientific knowledge and technical qualifications (Kolmos 1991). Great success has been achieved in recruiting more young people into engineering education to satisfy the need for engineers in the country.

Aalborg University's PBL model has been supposed to be female friendly as well (Kolmos 1991). However, women's representation remains low and the distribution is uneven, ranging from some few percent in some of the traditional engineering education like Electrical and Electronic Engineering (EE) to about 30%-50% in some of the new educations such as Health Technology (HT) and Architecture and Design (A&D). My research started with the following thoughts: What are the women's experiences in the problem-based and project-oriented learning context? Does this learning environment meet the need of female students? If that, what are the factors leading to the uneven distribution of women in different engineering branches though PBL model is popularly used in this university?

Gendered Way of Learning

There are many different kinds of learning theories, with emphasis on different aspects of learning in relation to different purposes. What I mainly look at in this study is social learning theories which are more focused on the social context for learning.

Learning is no longer simply studied through examining how individuals learn, but is rather put into certain social dimension or context – through participation, practice, communication, language, symbolism and so on - which is of great importance to the learning process (Lave & Wenger 1991, Wenger 1998, Jarvis et al 1998). For Lave and Wenger (1991), knowledge is neither separable from context, nor independent of it, but a way of being in the world, where agent, activity, and world mutually constitute each other. Through attaching the importance of ‘communities of practice’ in learning, Wenger (1998) puts four deeply interconnecting and mutually defining components in the process of learning and knowing: meaning – learning as experience; community - learning as belonging; practice – learning as doing; identity – learning as belonging. Learning is an integral part of our everyday lives, and it is part of our participation in our communities and organizations.

Jarvis, Holford, and Griffin (1998) also notes another way of thinking about the social context of learning, which lies in the social purposes for which people learn – to advance the interests of a particular group, such as an excluded social minority, or a community; or to raise the level of awareness and consciousness of a particular section of society. Then, to support those who want to learn but have been ignored in the learning process because of being the minority, it is necessary to create a warm and motivating climate of learning.

All the thoughts about social learning theories emphasize the importance of learning environment. These can be gathered together and be related to school learning since as a social activity it involves social relations between teachers and learners, and between learners themselves in the process of education. Problem-based and project-oriented learning with emphasis on the collaboration in the group work thus demands a high level of cooperation and communication among group members and the build-up of a friendly learning environment for all the individuals in each small community or organization. Besides, the teacher-student relations (especially their contact in the process of supervising) still play a significant role in the achievement of learning from

both the cognitive and affective points of view, though there is reduced amount of hours for traditional lectures.

Cultural factors have been taken into consideration in the theories of social learning, since what and how people learn is likely to be different in different cultural and social contexts. Cultural differences in the background of group members in PBL have brought about barriers to collaboration, which has started to attract the attention of educators. Yet there is little voice in gender perspective in either the above-mentioned social learning theories or PBL context, no matter from the perspective of women as a large social group in the society or women as a minority in engineering education.

Taking the perspective of psychology, Carol Gilligan (1982) writes about women's way of developing. Different from men, who are believed by many writers to grow progressively more independent in their relationships with others, Gilligan discovers that women find their identity within their relationships with others. She argues that much of the precious literature has drawn conclusions about people in general from research based only on males, but women develop and learn in different ways from men.

Engineering education in terms of gender contracts system

As many feminists (Cockburn 1983, 1985, Hacker 1989, Wajcman 1991, 2000, Sundin 1997) have argued, the social relation between gender and technology is closely connected with power. Men's domination over technology is an important source of their power, thus technology is defined as masculine and masculinity is defined in terms of technology. Femininity as an opposition is defined as technological incompetence, because in each culture, femininity is set against masculinity; womanliness is just the opposite way to manliness (Harding 1986).

Swedish historian Hirdman (1990) points out that there is a power in the social construction of men-women relations to sustain the social structure – men are the norm of the society since they are the power holders, whereas women are by and large the exceptions of the mainstream. Following Habermas, Hirdman distinguishes gender relations on three levels: 1) The cultural overlay – the overarching conceptions of male and female prevailing in society, 2) The institutional level – the separation of male and female in organizations according to their characteristics, tasks and

localities, 3) The individual level – the interaction between individuals and the formation of the individual's identities. And Hirdman uses the concept of gender contracts to refer to the interpersonal agreements between men and women that define the gender roles in the society. The interacting three levels can be related to the gendered relations in engineering education.

An engineering university can be regarded as an organization at the institutional level of the gender contracts. In the past two decades, Western researchers have identified the engineering institution as a place where the power and interest of men are expressed and consolidated (Hacker 1989, McIlwee and Robinson 1992, Tonso 1996, Berner and Mellstrom 1997, Salminen-Karlsson 1999). Since the gender contracts as a whole define technology as a male task and an engineering university as a male place, women who have entered this male place are considered as 'boundary breakers' (Salminen-Karlsson 1999).

Gender contracts system is an ongoing process of negotiation and transformation, therefore, Hirdman (1990) believes that there is room for redefinitions by certain social changes and there exists the power to change the system with human thoughts. According to her notion, changes in gender contracts can happen by breaking the rules of separation of the sexes – letting women enter men's area, or challenging the primacy of male norm. With more women entering men's world, and taking men's tasks, it will be easier to overstep the boundary and transform the male norm in society.

Initiatives that have been taken in some countries like the U.K., Sweden, the Netherlands, Canada, the U.S.A etc., have met the expectation of increasing the appeal of technical studies for girls, but these educational reforms have alone not been the key to a larger intake, retention and output of girls (Hermanussen & Booy 2002). Most of the initiatives succeeded in increasing the visibility of women in engineering education, but did not manage to change the masculine culture in engineering institutions. As Salminen-Karlsson (1999, 2002) concludes, the numerical composition of sexes does not decide the basic gender values of an occupation, because men and women have different amounts of power. To really make the engineering education female-friendly, a bigger social change is needed – all the elements like curriculum contents, teaching methods and the prevailing culture in the engineering should be changed.

Initial Work Findings

If the image of engineering profession do not match the gender role of female, and the traditional engineering education only meets the need of males and leads to women's underrepresentation as many feminists identified, do women have different experiences in an innovative learning environment? With this question in mind, I started some empirical work with the intention of having a general idea of the gendered relations in PBL in this engineering university. I observed some group work processes and examinations and interviewed some teachers and students of both genders afterwards in Electrical and Electronic Department (EE), one of the traditional engineering branches. I could not understand Danish language, but I did get some useful information through the observation of their tones and gestures, and their ways of talking and behaving. Afterwards, I asked them both questions on some explanation of their performance and their opinions on some gender issues.

It was not difficult to realize women's underrepresentation in this department – there are only a couple of female students in each year and two or three female teachers altogether. I was somewhat shocked at the beginning when I realized that it was quite difficult to bring about the topic of gender. For many people (as well as people outside of the engineering field), there have been sufficient policies on gender equality in Denmark, so there is no need to discuss about it anymore. To the question on reasons for the general invisibility of women in engineering education, all the male teaching staff and students attribute to women's unwillingness and lack of interest, which in turn, is considered as either a result of sexual 'nature' or the problem of society and schooling at primary levels. They do not think that there is any problem with the university itself, because the door of the university is open to everyone, it is just because women do not want to come in themselves.

Since most women have little interest in technology, those who have entered this area are kind of different in their gendered social role. In concert with what McIlwee and Robinson (1992) have found in their research, I found that all the female teaching staff and students I have talked with share similar paths to the engineering profession. They had deep interest in math and physics and strong desire to 'solve problems' in the pursuit of career, or were influenced by an engineering father, boyfriend, or close friends. But their good background in science study can not bring academic achievements to these female students as they have expected due to their lack of technical background from childhood, their traditional gender role and the situation of

being minority (especially in EE department). They are by and large weaker compared with their male counterparts in examinations; they will have less opportunities than male students if there is limited access to experiments in the lab; their voice might be difficult to be heard sometimes in the group work, etc.

These women know that they are different from the average women in Denmark since they are dealing with technology. They are living in a male-centered world, which means they have to get used to the mild profanity, semi-sexual humors, and symbolic violence metaphors in the learning environment. They have to change and adapt to the culture by becoming one of the boys in order to survive.

All the informants were interested in the questions on gendered way of learning, but they could not come to any firm answers. Male teachers and students do not think that there is the need to stress gender differences in the process of learning and teaching, since there are only 'students', in their eyes, not 'female or male students' in order to achieve 'real equality'. Women would not like to be 'treated' in a different way, since they do not want to survive as weaker side of the gender, but they prefer to learn in a more friendly environment.

Thus, the impression I have got from EE is: 1) the learning environment does not meet the need of women yet; 2) gender is not thought of as a problem in this engineering institution; 3) gendered way of learning has not been addressed.

Further Research

My initial work has come to a stage where I can not find significant differences for women's experiences in problem and group work-based learning context from those in traditional learning environment. In addition, there exists difficulty in further generalization due to the limited representation of female.

Then I started to switch my questions from asking why there are few women in EE department even in the innovative learning environment to why there are more women in some new engineering branches. There have been new engineering departments built up in Aalborg University in recent years such as Health Technology Department (HT), where there are one third female students but few female teachers, and Architecture Department (A&D), where there are half female students and one third female teachers. What are women's experiences in PBL environment with new teaching contents?

An educational ethnography will be made through the observation of school life and in-depth interviews, in hope to seek a clear picture of women as well as men engineering students' experiences in HT and A&D in this learning context. Because the educational ethnography is regarded as research on and in educational institutions based on participant observation and/or permanent recordings of everyday life in naturally occurring settings (Gordon et al 2001).

Observation will be one of the main sources of data collecting, because the essential core of ethnography is to seek to understand the meanings of people's actions and events. Some of these meanings are directly expressed in language; many are taken for granted and communicated only indirectly through action (Spradley 1980). Two project groups in each department will be chosen to follow up their life – lectures, classroom activities, teamwork, and life outside of university if possible. The aim is to see how both male and female students deal with their relationships with teachers, supervisors, and group members, and how they influence / are influenced in the learning process.

The interview will be another source for data, because it is a good way of accessing people's perceptions, meanings, definitions of situations and construction of reality, and it is also one of the most powerful ways we have of understanding others (Punch 1998). Moreover, it is a principle means by which feminists have sought to achieve involvement of their respondents in the construction of data about their lives (Punch 1998). Based on this, the ethnographic interview will be employed in this study, because it is different from the interview used for other means of investigations, as Spradley puts, 'it is a particular kind of speech...it is a series of friendly conversations into which the researcher slowly introduces new elements to assist informants to respond as informants' (Spradley 1979). Thus, all the informants for observation will be the main sources of interviewee for more knowledge and communication. Besides, informal conversations and talks with informants will happen flexibly in the process of and after observation.

The results of the analysis will be used as an input to teachers to evaluate and adjust pedagogy, content, and culture in engineering education, and to students to have more knowledge about their way of learning. This study will also contribute to the pilot seminars with gender perspective for teachers and career councilors in 2005 at Aalborg University in cooperation with Technical University of Denmark. A module

of teachers training courses as well as materials for study consulting activities with gender perspective are expected to come into effect after this project, which will hopefully help make a further step in the journey of achieving gender equity in science and technology.

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INFLUENCE OF GENDER ON SECONDARY SCHOOL STUDENTS' ATTITUDE TO VOCATIONAL EDUCATION

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ABSTRACT

In Nigeria, many programmes have been designed at both national and state levels to improve the status of women technologically. The programmes, however, are considered not to have fully achieved their stated objectives such as economic and social development, especially in the informal sector. One common reason given for the failure of the programmes is that they were not gender-specific. Consequently, the National Policy on Education has made vocational subjects such as Home Economics, Business Education, Introductory Technology and Agricultural Science compulsory to both sexes at Junior Secondary School level. This study examined the influence of gender on students' attitude towards vocational education. The study involved one hundred and fifty students randomly selected from five chosen secondary schools in Isoko North Local Government Area, Delta State, Nigeria. The data obtained through a structured questionnaire are analysed with percentages, mean and rank order. Findings indicate that both male and female students have positive attitude (mean, above 3.0) towards vocational education. Females were more interested in Home Economics while males were more interested in Introductory Technology. Both sexes were interested in Business Education and Agricultural Science. Personal desire was the major factor that contributed to both male and female students' attitude to vocational education. This was followed by teacher's competency in teaching and peer influence respectively. Based on the findings, it was recommended, among others, that secondary school students should be given orientation on vocational education.

INTRODUCTION AND THEORETICAL FRAMEWORK

In the non-formal education system, which was also known as apprenticeship training, vocational education referred to very narrow skill training, which was imparted by parents and master craftsmen who were experts of their own skills and vocations. But formal vocational education is applied science. Basic science is pure science while applied science is associated with technology, hence the interrelationship of the two phenomena (Danmole, 2000).

Hence the National Policy on Education, therefore, defines vocational education as that aspect of education which leads to the acquisition of practical and applied skills as well as basic scientific knowledge. The policy also states that the general aim of vocational education is to provide instruction and opportunity for acquisition of skills to men and women of all walks of life, which is suited not only to their abilities but also to the needs of industries, commerce and community at large. The aims and goals of vocational education, which are embedded in technical education, show that Nigeria realises the need for a well orchestrated and articulated scientific and technological education to enable her achieve meaningful development economically, socially and even politically. The policy also shows that the nation is in favour of gender parity in the study of vocational education. Consequently, vocational education is now taught at all levels of education to both sexes, through the 6-3-3-4

educational system since 1982. In fact, at Junior Secondary School level, vocational subjects such as Home Economics, Business Education, Introductory Technology and Agricultural Science have been made compulsory.

But before the introduction of vocational education in schools through the 6-3-3-4 education system, there was a proliferation of vocational education institutions in many parts of Nigeria. These institutions organised their training programmes in an uncoordinated manner. The institutions included vocational training centres which offered two to three years post-primary training; domestic science centres and so on. These programmes, however, were considered not to have fully achieved their objectives such as economic and social development. One of the reasons given for the failure of the programmes is that they were not gender-specific, especially in the informal sector.

But it is hoped that with full implementation of vocational technical education, Nigeria will have an army of intermediate and junior manpower such as technicians and technologists – the kind of manpower needed to create, maintain and sustain the economic and technological growth of any developing nation (Ozor, 1975 and Ukpore, 1996).

Research, however, shows that there is a general apathy amongst educational administrators, teachers and students towards vocational education (Ukpore, 1999). Consequently, the goals of vocational education cannot be achieved to a large extent. Morah (1995) observed that it is only a handful of secondary school students that can be said to have been able to acquire sufficient basic technical and vocational skills to enable them perform thoroughly in the job market.

One of the factors that may cause people to have apathy or negative attitude towards a particular subject is gender. Gender is a cultural construct that distinguishes the roles, behaviour, mental and emotional characteristics between females and males by society (Azikiwe, 1990). It has been observed that there is gender disparity in vocational education. This is attributed to social and cultural discrimination, sex stereotyping, forced early marriage and unconscious influence in the home from parental/family opinions (Lassa, 1996 and Bille, 2002). The opportunity for females to realise their potentials in the technological areas is, therefore, suppressed or stifled (Igbemi, 2001). In fact, girls and women may be discouraged from reading some scientific and vocational courses because they are regarded as female or male programmes. Home Economics, for instance, is offered mainly by females at senior secondary and tertiary levels because it is domestic in nature (Ukpore, 1999).

This paper, therefore, considered the influence of gender on students' attitude towards vocational education in Isoko North Local Government Area, Delta State, Nigeria. This study is significant because occupational choice of the people is reflected in a nation's manpower development. All categories of workers (male and female) are needed for effective development of a nation. If any meaningful result must be achieved in the area of sustainable development, gender disparity in vocational subjects must be discouraged; as women constitute a substantial part of the population of any nation on earth. For instance, women form over half of the population in Nigeria (FOS Records, 1993 Census). There is need, therefore, to document strategies to assist parents, governments and educators on how to work towards eradication of gender discrimination and achieve the laudable goals of vocational education, especially in the 21st century in Nigeria.

Purpose and Research Questions

The purposes of this study were to examine the relative influence of gender on secondary school students' attitude to vocational education and to suggest strategies for overcoming gender disparity in vocational education.

The research questions for this study included:

1. What is the attitude profile of secondary school students towards vocational education?
2. Does gender have any influence on students' choice of vocational subjects?
3. What factors contribute to male and female students' attitude towards vocational education?

Theoretical Framework

The dominant attitude change theory used for this study is functional theory of Katz (1954) titled 'Motivation Construct'. This theory is chosen because if students are properly motivated at an early stage, they could develop positive attitude towards vocational education. Farris (2002) explained Katz (1954) theory as follows: Katz believes that motivation has an adjustive function and that people adjust attitudes to minimise harm and maximise happiness. This ego-defensive function of motivation helps to protect the individual's self-respect. It also serves as a value-expression function because one struggles with being true to one's beliefs. Katz gave three advantages of the motivational construct theory as follows:

1. It looks at personality, not merely exposure to media.
2. It does not oversimplify to say that attitudes are caused by one thing.
3. It recognises motivation for behaviours.

In support of this Katz's theory, Oppenheim (1978:106) emphasised that 'attitudes are reinforced by beliefs (the cognitive component) and often attract strong feelings (the emotional component) that will lead to a particular form of behaviour (the act tendency component).' This indicates that if gender disparity for vocational education courses is eradicated a male student offering Home Economics or a female student offering Industrial Technology will not be considered a deviant and his or her ego will not be affected. Thus the functions of Katz's motivation construct theory have been considered in writing the questionnaire used for this study. "As individual's attitudes are present but dormant most of the time, they become expressed in speech or other behaviours only when the object of the attitude is perceived" (Oppenheim, 1978:106).

METHODOLOGY

Population/Sample of the Study

The target population for this descriptive survey consisted of all secondary school students in Isoko North Local Government Area, Delta State, Nigeria. From this population, a sample of 150 senior secondary school one (SSS I) students was drawn from five selected public schools (3 mixed schools, 1 girls' school, and 1 boys' school). Thirty students were randomly selected from each of the secondary schools chosen. The sample was made up of 75 females and 75 males. The parental occupations of the sample were civil service (50%), medical profession (30%), farming (30%), law (27%) and trading (13%).

Instrumentation

The main instrument used for this study was a structured questionnaire. The questionnaire had three sections (A to C) and consisted of seventeen questions. Section A solicited for background information of the respondents. Sections B and C were made up of statements related to research questions 1 to 3. The items in section B were placed on a Likert scale of five – Strongly Agreed (SA - 5), Agreed (A - 4), Undecided (UD - 3), Disagreed (D - 2) and Strongly Disagreed (SD - 1) – while section C items were on rank order.

Data Collection/Analysis

A research assistant visited the five secondary schools chosen and distributed the questionnaires to the students and collected them back after completion.

The data obtained from the questionnaire were analysed with percentages, mean and rank order. A mean score of 3.0 was considered positive.

RESULTS

Research Question 1: What is the attitude profile of secondary school students towards vocational education?

Table 1

Attitude Profile of Secondary School Students towards Vocational Education

ITEMS	POSITIVE STATEMENTS	SA	A	UD	D	SD	\bar{x}
7.	I feel happy during the period for vocational subject	66	64	8	9	3	4.2*
9.	Vocational subjects are fascinating	93	23	2	21	11	4.1*
12.	Vocational subjects give me a feeling of productivity	99	28	3	13	7	4.3*
13.	I simply love vocational subjects	65	73	5	4	3	4.3*
	NEGATIVE STATEMENTS						
8.	It frightens me to do any vocational subjects	1	3	5	105	36	1.9
10.	My heart beats fast when I am asked to take part in vocational subjects	2	4	6	115	23	2.0
11.	I get lost, in a jungle, of technical terms during lessons in vocational subjects	1	2	1	114	32	1.8
14	I do not like vocational subjects	10	1	-	26	113	1.5

* Above acceptable mean

Presented in table 1 is the profile of students' attitude towards vocational education. The mean responses for both positive and negative statements indicate that the students have positive attitude towards vocational education. All the responses for positive statements were greater than acceptable mean of 3.0 while that for the negative responses were less than the acceptable mean.

Research Question 2: Does gender have any influence on students' choice of vocational subjects?

Table 2

Rank Order showing Influence of Gender on Students' Choice of Vocational Subjects

		Male	Female

Item	Vocational Subjects	N: 75 Frequency	Rank Order	N: 75 Frequency	Rank Order
16	Home Economics	2	4 th	30	1 st
	Agricultural Science	20	3 rd	13	3 rd
	Introductory Technology	32	1 st	7	4 th
	Business Studies	21	2 nd	25	2 nd

Table 2 shows rank order of influence of gender on students' choice of vocational subjects. Females were found to be more interested in Home Economics and males were more interested in Introductory Technology. Both males and females were interested in Business Studies and Agricultural Science. This finding indicates that gender has influence in students' choice of vocational education subjects.

Research Question 3: What factors contribute to male and female students' attitude towards vocational education?

Table 3: Factors Which Contribute to Male and Female Students' Attitude Towards Vocational Education

Item	Statements	Male		Female	
		N: 75 Frequency	Rank Order	N: 75 Frequency	Rank Order
17(i)	I feel I should do vocational subjects.	51	1 st	50	1 st
(ii)	I am offering vocational subjects because the teachers teach very well.	19	2 nd	6	2 nd
(iii)	I am doing vocational subjects because my friends are doing them.	3	3 rd	4	3 rd
(iv)	I am doing vocational subjects because the society believes that vocational subjects are good.	0	5 th	3	4 th
(v)	My parents want me to do vocational subjects.	2	4 th	2	5 th

The rank order presented in table 3 shows the factors which contribute to male and female students' attitude towards vocational subjects. Findings indicate that the major factor which influenced most male (51) and female (50) students' attitude to

vocational education was personal interest. The least factor for the males was society (0) while that of females was parents (2).

DISCUSSION OF RESULTS

This study has shown that students have positive attitude towards vocational subjects because of its creative nature. Findings indicate that the students love vocational subjects and so it gives them a feeling of productivity. In fact, they feel happy during the period for vocational subjects and they see the subjects as fascinating. These findings are in contrast with Morah (1995) observation that students have apathy for vocational subjects as earlier on mentioned.

The study also shows that gender influences students' attitude towards vocational education. Females showed more interest in Home Economics and males more interest in Introductory Technology. Both sexes were interested in Business Studies and Agricultural Science. Males were more interested in Introductory Technology because it is considered difficult and meant for males. This finding is in consonance with Lassa (1996) observation that there is gender disparity in vocational education.

Findings also indicate that personal desire was the major factor that contributed to both male and female students' attitudes to vocational education. This was followed by teacher's competency in teaching and peer influence respectively. This finding agrees with Igbemi's (2001) view that many factors contributed to students' attitude towards vocational education.

Conclusion/Recommendations

This study has shown that, generally, male and female students have interest in vocational subjects, but gender influences their choice of vocational subjects. The major factor to the gender disparity is personal interest. It could be concluded, therefore, that the National Policy on Education (1981) has influenced the secondary school students in Isoko North Local Government Area to have a positive attitude towards vocational subjects, but the issue of gender disparity in choice of vocational subjects needs to be addressed. Since parents and the society in particular no longer have much influence on students' choice of vocational subjects, students should be properly motivated, based on the theory of Katz (1954), to develop more positive attitude towards vocational education. The self-ego of male and female students will

be maintained even if they have to do a course that is labelled 'female' or 'male' subject; as they will not feel they are being deviant.

Based on the findings of this study, the following recommendations are made:

1. Secondary school students should be given orientation on vocational subjects so that they develop more positive attitude towards vocational subjects.
2. The teaching of vocational subjects should be made compulsory at both junior and senior secondary school levels.
3. Since it is universally agreed that gender discrimination starts at an early age, parents should encourage their children to read vocational subjects according to their abilities.
4. Government should provide all secondary schools with facilities and funds for effective teaching and learning of vocational subjects, as practicals in vocational programmes involve a lot of materials and funds.

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DIFFERENTIAL EXPOSURE TO FOOD AND NUTRITION IN THE LOWER SECONDARY AND ITS IMPACT ON THE NUTRITIONAL KNOWLEDGE AND HABITS OF YOUNG MALE ADOLESCENTS

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Introduction

Nutrition education of adolescents is an area of great concern in Mauritius with the rising incidence of diet-related diseases such as diabetes, high blood pressure and coronary heart disease (Ministry of Health, 2000). Moreover, adolescence has been recognised as a critical development stage during which beliefs, values, attitudes and habits are both demonstrated and reinforced (Seymour *et al*, 1997).

The school has been cited as being the prime medium for nutrition education of young consumers from both gender groups (Brown *et al*, 2000). For the school curriculum to be an effective vehicle of nutrition education, the focus should not only be on increasing students' knowledge, but also on developing practical skills which assist informed food choices in later years (Burke, 2002). These skills are regarded as life skills (Stitt, 1998). In Mauritius, a gender-biased school curriculum may be depriving our male adolescents from fully developing their skills to make informed food choices.

In the lower secondary curriculum, Science, a core subject, provides the opportunity for all boys and girls to study basic nutrition. However, the Science curriculum provides very little opportunities for students to engage in food-based practical activities. The subject which caters the most to developing food-based skills is Home Economics, an optional subject. Unfortunately, very few (eight) schools presently offer the subject to boys (PSSA, 2003). When the subject was introduced in 1977, it was only offered to girls since educationalists perceived food preparation and household duties as the girls ("wives-to-be") responsibilities. Despite changes in the Mauritian structure and way of life, this perception still largely remains.

It thus seems that the exclusion of Home Economics from the school curriculum on the grounds of sex is most unfair. As pointed out by Rutland (2002), all students should have access to all courses including the ones traditionally the preserve of boys or girls. Moreover, one of the objectives of the 1999-2006 national Gender Action Plan is to review the school curriculum to remove all forms of gender stereotyping

(Gender bureau, 1999).

In Mauritius, there has been no study until now to ascertain whether boys who are not taught Home Economics are at a disadvantage in terms of dietary knowledge, skills and practices. This study is the first of its kind to determine whether Mauritian male adolescents who are not being taught Home Economics have poorer nutritional knowledge, skills and dietary practices than their peers doing Home Economics.

Methodology

The study sample was comprised of teachers and students from twelve secondary schools representing all the four educational zones in Mauritius and equally distributed in rural and urban areas.

Student Sample

A list of schools offering Home economics to boys in lower secondary was set up before selecting the study participants. Since only co-educational schools were found to offer Home Economics to boys, study participants for the comparison group had to be chosen from co-educational schools not offering Home Economics at all, but otherwise with a similar profile. The final sample consisted of 315 form IV boys and girls from six co-educational schools offering Home Economics (n = 158) and another six co-educational schools not offering Home Economics (n = 157). Twenty five percent of the form IV population (boys and girls) was randomly selected from each school. The entire sample included 113 males (36%) and 202 females (64%). The mean age of the group was 14.9 years (range 13-18).

Teacher Sample

One Science teacher working in lower secondary forms was randomly selected from each school. In addition, one Home Economics teacher was also selected at random from each of the six schools offering Home Economics.

Questionnaire Survey

Two questionnaires were designed: one for teachers and another for students. The teacher questionnaire was pre-tested among a group of Home Economics and Science teachers. Student questionnaire was also pre-tested among a group of Form IV boys and girls attending a co-educational school offering Home Economics, and another group from a co-educational school not offering Home Economics. A few questions were re-worded for simplicity and to remove any ambiguity.

The same items were used to assess the nutritional knowledge of students and teachers. The knowledge questions were based on the lower secondary food and nutrition content in Science and Home Economics, and covered the following areas:

- sources of nutrients of concern to adolescents' health;
- association between diet and health;
- application of the concept of balanced meals.

A five-point likert-type scale was used for those responses to the items on eating habits, students' attitudes towards healthy eating and the teaching of food and nutrition topics. The student questionnaire, in addition, included items on nutrition-related skills such as food preparation and ability to give dietary advice. The teacher questionnaire also gathered information about teaching strategies and potential barriers to effective teaching of food and nutrition topics.

During the first school term, self-administered questionnaires were distributed to the study participants. They were given 30-45 minutes in class to complete the questionnaires, which were then collected for data compilation. Each questionnaire included a cover letter briefly explaining the purpose of the survey and assuring complete confidentiality of participants' responses.

Data Analysis

Responses for open-ended questions were grouped under common themes and then coded. All data were analysed using SPSS version 9.0 (SPSS Inc., Chicago, Ill) statistical software. A score for nutritional knowledge was computed for each participant (maximum score of 10). Comparisons were made between boys taught Home Economics and those not taught Home Economics in the lower secondary. Nutritional knowledge, attitudes and food-related skills of boys taught Home Economics were also compared to girls doing Home Economics.

Results and Discussion

Nutritional knowledge

Adolescents in the study were found to have a rather poor nutritional knowledge. The fact that more than 70% of the adolescents across the different groups failed to identify a balanced meal, a key concept in nutrition, is of considerable concern. Boys doing Home Economics (mean score = 3.9) did not score significantly higher than those not taught Home Economics (mean score = 4.3). Similarly, no significant

difference was found between girls (mean score = 3.89) and boys doing Home Economics. It would thus seem that extra exposure to food and nutrition concepts did not contribute to better nutritional knowledge. The overall poor knowledge on basic nutrition noted among the group can be partly accounted by the use of passive learning methods that rely on teacher explanations and textbooks. Moreover, analysis of teachers' questionnaire also showed that only 50% of teachers were using active learning methods such as practical work and cooperative learning, and the most popular teaching resource was books. Banet and Nunez (1997) found that active learning of nutrition concepts takes place through the use of active learning methods as opposed to passive methods. Another recent study also revealed that learning should be related to real life scenarios and the use of constructs, which are personally meaningful to young adolescents (Lakin, 2002). Other factors reported by teachers that may explain the poor performance are:

- poor academic and motivation level of students;
- students' greater interest in practical than theory classes; and
- lack of hands-on activities in the Science textbook.

Attitudes

Students' attitudes towards healthy eating and food and nutrition at school were assessed using ratings of items as shown table 1. Data in table 1 indicates that the majority of boys and girls feel the need to eat healthily, enjoyed food and nutrition topics taught in lower secondary and would like to learn more about food and nutrition from their teachers. It is worth noting that more boys not taught Home Economics as compared to boys taught Home Economics expressed the need for additional exposure to Home Economics. Moreover, a higher percentage of girls as opposed to boys expressed the need, possibly because they are more health conscious.

Table 1. Students' attitudes towards healthy eating and food and nutrition at school

Statement	Boys not taught Home Economics (%)	Boys taught Home Economics (%)	Girls taught Home Economics (%)
I am too young to worry about what I eat and drink.	21.6	28.5	12.0
If I want to stay in good shape, I should not regularly eat fast foods and junk foods.	63.3	58.0	78.0
I enjoyed food and nutrition topics taught at school	72.9	70.0	86

I would like to learn more about food and nutrition from teachers at school.	81.7	68.8	84.3
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Food-related skills

The food-related skills were assessed by determining the percentage of students who:

- help their parents in food preparation;
- regularly prepare food at home;
- give dietary advice to their family members and friends.

Table 2. Food related skills of students

Skills	Boys not taught Home Economics (%)	Boys taught Home Economics (%)	Girls taught Home Economics (%)
1. Help parents to prepare food	51.7	79.2	81.6
2. Regularly prepare food at home	26.7	49.1	43.7
3. Offer dietary advice to friends and family members	50.0	43.4	65.0

As compared to boys not taught Home Economic, a significantly higher percentage of boys taught Home Economics help their parents to prepare food at home ($p<0.01$) and regularly prepare food at home on their own ($p<0.05$). These results may be explained by the fact that boys taught Home Economics are provided with more opportunities to develop their food preparation skills. The mastery of food preparation skills should make the boys more responsible in their food choices (Stitt, 1998), whereas those with poor food preparation skills could become easy preys of manufacturers of fast foods and ready meals. In a study by Burke (2002), boys from co-educational schools in UK acknowledged the importance of adequate “hands-on” experience of food skills to assist them in making right food choices. Boys and girls taught Home economics did not differ significantly in their food preparation skills. This indicates that exposure to food preparation classes in Home Economics may help to overcome the common belief that females primarily hold the responsibility of food preparation.

Boys from both groups reported giving advice on healthy eating to their friends and parents. A significantly higher percentage of girls taught Home Economics gave dietary advice ($p<0.05$), possibly because they are more health conscious.

Eating habits

Eating habits were assessed from the reported consumption frequency of five healthy foods and seven unhealthy foods.

Table 3. Percentage of boys consuming healthy and unhealthy foods at least 4 times per week

	FOOD ITEMS	Boys not taught Home Economics (%)	Boys taught Home Economics (%)
HEALTHY FOODS	Plain or flavoured milk	49.2	57.7
	Fruit juice	78.0	67.3
	Fruits (fresh and dried)	71.6	67.3
	Vegetables (raw and cooked)	72.4	69.4
	Pulses	52.5	49.0
UNHEALTHY FOODS	Soft fizzy drinks	30.0	28.8
	Burger, sausages	41.6	34.6
	Potato crisps	28.3	34.6
	Fried savoury cakes	26.7	23.1
	Sweets, biscuits, cakes, pastries	45.0	28.0
	Fried rice/noodles not prepared at home	10.3	13.4
	Dolpuri/Roti not prepared at home	18.4	32.7

Consumption frequency of fruits, vegetables, pulses, soft fizzy drinks savoury fried cakes and fried rice/noodles not prepared at home were almost similar between the two groups (Table 3). The Home Economics boys had a higher consumption of milk, potato crisps and “dolpuri/roti” not prepared at home, and ate the following foods less frequently –fruit juice, burgers and sausages, sweets, cakes, biscuits and pastries. The lower fruit juice consumption among the Home Economics boys could be due to greater consumption of water – 21.6% of boys taught Home Economics reported buying bottled water from school as opposed to 5.0% among boys not taught Home Economics ($p<0.05$). Better food preparation skills among boys taught Home Economics may have positively influenced the consumption of milk and processed foods such as burgers and sausages. A significantly higher percentage of boys taught Home Economics reported preparing milk drinks regularly at home (35.8% vs. 8.3%, $p<0.05$).

Conclusions and Recommendations

It is evident from this study that a gender-biased curriculum at lower secondary level is depriving young male students from fully developing skills to make informed food choices. Poor food choices may predispose those youngsters to the already rampant non-communicable diseases such as diabetes, coronary heart disease and high blood pressure. Food related skills have been found to exert a stronger influence on the eating patterns of the youngsters than level of nutrition knowledge. Earlier studies by Seaman and Young (1996), Brown *et al* (2000) and Pirouznia (2001) have shown that nutritional knowledge is not a significant factor that influences eating behaviours of adolescents. Food-related skills such as meal planning, shopping, and meal preparation have been reported to be important determinant of the eating habits of young consumers (Brown *et al*, 2000; Burke, 2002).

Study findings thus support the need to include Home Economics as a core subject for all students (boys and girls) in the lower secondary curriculum. Home economics would help to reinforce the basic nutrition concepts already included in Science, and supplement the concepts with food-based practical activities. Moreover, the current Home Economics and Science curriculum should be reviewed to promote active teaching and learning methods. Although results of this study can best be generalised to boys attending co-educational schools, they still provide a sound basis to policy-makers and educationalists to promote a gender inclusive school curriculum in line with the 1999-2006 National Gender Action Plan.

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