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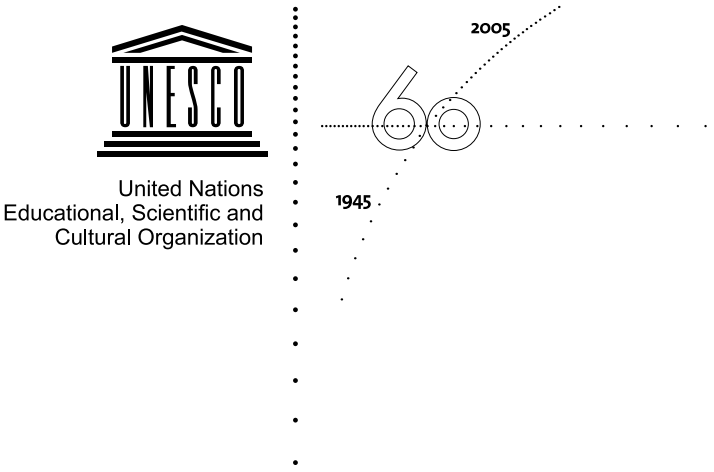
Girls and Science

A training module on motivating girls to embark on science and technology careers



Girls and Science

A training module on motivating girls to embark on science and technology careers

Edited by **Andrew Clegg**

Section for Science and Technology Education
Division of Secondary, Technical and Vocational Education

UNESCO 2006

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CONTENTS

FOREWORD

With women accounting for more than 50% of the world population, achieving gender parity is an issue of global concern. It has now been demonstrated conclusively that social as well as economic development of a country is closely linked to the educational level of its female population. The African continent is also on the world agenda, beset as it is by a number of problems – natural as well as economic and socio-political – that prevent the development of its full potential.

UNESCO has thus been actively undertaking actions to address both issues in all its fields of competence. In 1996 already, UNESCO designated women and Africa among the priorities of its Medium Term Plan 1996-2001 and in this context, launched a six-year Special Project on Scientific, Technical and Vocational Education of Girls in Africa in order to encourage girls to education and allow them to acquire the means to achieve self dependence.

The work accomplished in the course of this project allowed for a better understanding of the complexity of the problems which were not merely related to lack of educational infrastructures or resources, but more importantly, had deep roots in historical, socio-cultural, economic and other factors.

It thus became clear that to achieve gender parity in science and technology education (STE), it was important not only to motivate the girls themselves but also to address the surrounding socio-cultural and economic factors as well. And to the extent that in a rapidly globalising world it is the economic factor which is of overriding importance, it is essential to demonstrate the practical utility of STE if girls are to be encouraged to opt for science studies.

UNESCO's current Medium Term Strategy (2002-2007) emphasizes that progress towards gender equality and the empowerment of women should be demonstrated by eliminating gender disparity in primary and secondary education. And as in most developing countries, especially in Africa, women are under-represented in science and technology, a Science Career Guidance and Counselling Training Module was developed by UNESCO's Section for Science and Technology Education in collaboration with UNESCO/Windhoek targeting policy makers, teacher trainers, education and career advisors, teachers and inspectors.

The overall aim of this module is to help reduce gender disparities in the field of science and technology in Africa as well as to provide women with the possibility of embarking upon science careers in the quest of self-dependence and poverty reduction. Specific objectives include:

1. Promoting a positive image of women in scientific and technological careers;
2. Sensitizing parents, teachers, educators, school administrative staff, curriculum developers and trainers to counter gender stereotypes with regard to science careers;
3. Improving access of girls to scientific and technological education by providing clear ideas of career opportunities;
4. Providing teachers with the necessary career guidance tools to meet the needs of female learners seeking careers in science and technology.

The counselling and guidance materials cover science education, depicting the overall picture of women in science including beliefs, attitudes, cultural and societal pressures, together with examples of famous female scientists. They also provide the necessary career guidance tools as well as ways to reduce the under-representation and under-achievement of girls in science and technology subjects and to motivate girls towards science and technology education and related careers.

The Section for Science and Technology Education would like to express its particular appreciation of the enormous work done by the author, Mr Andrew Clegg, who worked untiringly to produce this Manual. Thanks are also due to UNESCO/Windhoek, without whose help and cooperation, it would have been difficult to accomplish this task.

Section of Science and Technology Education
Division of Secondary, Technical and Vocational Education

INTRODUCTION

The purpose of this module

Throughout the continent, more boys than girls tend to opt for scientific and technological subjects in schools and their performance in these subjects tends to be better than girls. When they leave school, more boys than girls tend to pursue careers in the science and technology sectors. This is a worldwide phenomenon, common to a great variety of different educational systems and hence is a much researched phenomenon and there is evidence that where research recommendations are reflected in practice, the disparities can be reduced.

The under-representation and under-achievement of girls in science and technology subjects can be seen as a serious inefficiency in educational systems in countries whose development depends crucially on the generation of human technological capacity. This is the case in most African countries. If only more girls could be persuaded to take up science and technology subjects in schools, and could be persuaded to do better in them, the countries, so the argument goes, would have the benefit of an increased technological output with few extra inputs.

There are also strong educational and social arguments why this issue should be addressed. Any properly rounded education should include science and technology and all students, both male and female, should have equal access to the subjects, have equal opportunities to perform well, and should be equally excited by the learning opportunities they are given. These arguments are cogently expressed in the various documents related to the Millennium Development Goals and the Unicef promoted Girls Education Initiative.

This module dissects this complex issue and addresses its many facets. It looks at the pressures placed on young female learners to conform to the traditional norms of society concerning the roles of women. It looks at how school issues might affect, both overtly and subliminally, subject choice and subject performance. It looks at the changes necessary for pre-service programmes to alert new teachers to the issues. And it also looks at how careers advice programmes might be better organised both to recognise and confront the problem of the under-representation of women in science-related careers.

How to use this module

The issue of the under-representation and underperformance of girls in science subjects is a very complex one and addressing it involves coordinated action by a number of different groups of people ranging from educational administrators to teachers to teacher educators. The module has been written in such a way as to address all these groups. The table below shows the purpose of each of its six units, the issues that each addresses and the target group or groups of each unit.

Unit	Purpose	Issues addressed
1 Introductory unit; setting the scene	To provide an introductory framework for the whole manual	• The overall picture of women in science • Beliefs and attitudes about girls and women in science • Cultural and societal pressures that impact on girls opting for the sciences • Why it is important that girls should study sciences • Advocating for more girls to study sciences
2 Training and supporting teachers	To provide an introductory framework for teachers, teacher support staff and school administrators	• How great the problem is in the country • Gender bias in teaching and teacher support and training institutions • How science and mathematics can be made more attractive to girls • Dealing with lack of confidence • The structure of girls' career education
3 Career guidance	To provide guidance teachers with an understanding of the issues and with mechanisms for addressing them	• How well are career guidance structures in schools addressing the issues • How well are the support systems for career guidance in schools addressing the issues • The characteristics of a good career service • Some mechanisms for attracting more girls into careers in the science and technology sectors
4 Career guidance activities	To provide guidance on how to develop and manage specific career guidance activities in a manner directed towards supporting girls opting for careers in the science and technology sectors	• How the needs of female learners seeking careers in science and technology can be met through activities such as: – career fairs – job shadowing – career talks – enterprise education – workplace and science centre visits – career publicity materials
5 Science and mathematics teaching	To provide guidance for science and mathematics teachers on mechanisms for making their subjects more accessible and attractive to girls	• Distinguishing between gender and sex • Gender bias in teaching styles and in curriculum, learning and assessment materials • Making science and mathematics teaching and the learning environment more attractive to girls • How science teachers can advise on careers
6 Science and mathematics teacher education programmes	To provide guidance for initial teacher trainers on how to integrate the issues into the construction and implementation of their programmes	• Analysing existing programmes for gender issues • Exemplary gender related exercises for trainee teachers • Training the science teachers to be career advisers • Developing courses and course descriptions

Target groups
All players
• Science teachers • Career teachers • School administrative staff • Teacher educators • Teacher support staff such as advisory teachers and inspectors • Curriculum developers and trainers
• Career teachers • Educational administrators and advisory staff responsible for supporting career education • Career teacher educators
• Career teachers • Educational administrators and advisory staff responsible for supporting career education • School administrative staff • Career teacher educators
• Science and mathematics teachers • Science and mathematics teacher educators • Science and mathematics teacher support staff
• Science and mathematics teacher educators

Each unit is divided into topics. Although the topics are presented in a logical sequence, by and large they can stand alone. The trainer using this module should build a programme that matches the particular needs of the trainees. Such a programme can include a mix of whole or part units according the trainees' previous understanding of the issues.
For example, a course for experienced science teachers may include most of Unit 1, the topics of unit 2 relevant to the classroom and the whole of unit 5.

The resource CD

There is a resource CD that accompanies this module. The CD contains a variety of materials that are useful for both trainers and trainees. Examples of the kinds of materials on the CD are:

- electronic versions of handouts for use in all topic activities
- useful background documents, in particular those produced by the UN agencies that are relevant to the issue of women in science and the education of girls
- relevant research reports
- examples of relevant policy and curriculum documents
- useful weblinks
- relevant instruments and evaluation tools.

The CD is formatted as a series of webpages and materials can be accessed by opening the homepage (index.html) in a browser and following links.

The CD constitutes a very useful resource for anyone studying the issue of gender and science in schools in Africa but it only contains materials published before the end of 2005.

Unit One
SETTING THE SCENE

Rationale

This unit of the module aims to provide an introductory framework for the career guidance manual as a whole, by introducing the reader to general background information on the status of women and girls in *science*.* [1]

The information presented in this unit will form the basis of the general advocacy work throughout this manual. The manual has been designed based on the principle that the fundamental barriers for women in science have common social and cultural roots. These sets of ideas influence all people, men and women, whether they are teachers, students, parents, educational administrators, or journalists. As the cultural and social stereotyping of women manifests in different ways for different groups of people, however, later units in this module will address concerns that are more specific to particular groups. For example, teachers have to find different ways to address these problems than journalists. However, they can all use general tools and this unit attempts to provide a generic basis for advocacy and guidance work in this area.

Through this unit, trainers and participants will be provided with clear, simple information about the status of women in all levels of science globally, with a specific focus on Africa. The section will also provide background information on the policy issues affecting women in science, the academic debates about women in science, as well as historical facts about women in science. The unit is also intended to provide a rationale for the importance of encouraging women and girls into science, and equip the trainer with both information and tools for advocacy work around women in science.

Target groups

All involved in science and mathematics education and careers education.

Learning outcomes

By the end of this unit participants should:

- be able to articulate clearly their own views about women in science and understand the social and historical influences that formed these views
- understand the main social causes of the low participation of women in science
- understand something of the nature of science and the practise of science as influenced by social and cultural norms
- be equipped with a range of useful information for career guidance, including both intellectual tools and practical steps for encouraging girls and young women into science
- have some basic knowledge of the history of the participation of women in science

[1] Throughout this module, words that are asterisked are defined at the end of each unit.

Contents

Items to bring to the workshop

Those involved with policy formulation and implementation should bring policy documents and related plans related to the education of girls.

Topic 1 THE SITUATION FOR GIRLS AND WOMEN IN SCIENCE

The Overall Picture

Women are under-represented in most areas of science, in most parts of the developing and developed world. Women are not well represented in science, engineering, and technology as students, teachers, professors, researchers or workers. Even in cases where overall numbers of women enrolments in science subjects equal or exceed those of men, more subtle inequalities are evident.

In an increasingly technologically and scientifically advanced world, education is the key to scientific progress and education is crucial to involvement in scientific pursuit. Gaining access to scientific careers, whether they are in research, practical technology or industry requires certain levels of education. Young people cannot study at further or higher education level in science, engineering or technology without the requisite school-level preparation. For example, it is not possible to study for a science degree at university-level without a background in school mathematics. In this regard, *sex-disaggregated** educational data is crucial in painting the picture of the status of women in science.

International statistics are difficult to provide as the collection of data varies from country to country. Sex-disaggregated data is not always available, although progress is being made in this regard as a result of international movements for gender equity in education.

Some key points to note are:

- At school level in many parts of Africa, there are still distinct enrolment inequalities between boys and girls. Of the significant numbers of out-of-school children in sub-Saharan Africa, the greater number are girls, particularly at secondary school level[2].
- A significant number of countries reflecting gender imbalances in primary enrolment are in Africa. At secondary level of 83 developing countries with data, less

[2] UNESCO, 2005, Education for All: The Quality Imperative. Global Monitoring Report. UNESCO: Paris.

than one fifth have achieved gender parity at secondary level, and only four countries at tertiary level. 64% of the world's illiterate people are women [2].

- In 1995 in Zambia 16% of physics and chemistry students were female; Kenya and Uganda show similar trends, with girls opting for biology; and in Ghana in 1992 girls made up on 23% of science enrolments at senior secondary school [3].
- Figures on performance of girls in maths and science in Africa are hard to find and vary considerably. What is clear however, is fewer girls take mathematics and science subjects as they progress in the education system. There is evidence from a number of countries that boys perform better than girls in these subjects [4]. Some studies do indicate that in subjects like physics, traditionally considered to be a male domain, girls do not perform as well as boys. There are also international studies indicating that girls do not believe they are as good as boys in subjects like maths and physics even where this is objectively not the case.
- At higher education level, most African universities have lower enrolments of women across all fields of study, but particularly in science (e.g. at the University of Botswana women made up an average of 28% of science students in 1999 [5]).
- There are fewer female teachers of maths and science. Women teachers tend to be concentrated in other fields of study [4].
- Women in science are paid less than men and tend to be in more junior positions. Most women in science are in academic and research institutions, where the pay is lower than in industry.
- Fewer girls choose to study in the science fields even in countries such as the UK, where there have been programmes to encourage girls to go into the sciences for many years. Although women in the UK dominate at undergraduate level in the health sciences and biological sciences, they are still in low numbers in computer science, mathematics, physical science, and lowest of all in engineering. These are all disciplines perceived to be "male subjects".

The situation in South Africa

South Africa is unusual in an African context in that at secondary school level there are more or less equal numbers of girls and boys in school and women dominate in higher education in terms of overall numbers. In 2002 women students made up over half of higher education enrolments (54%). There has been significant growth in numbers of women accessing higher education since the early 1990s.

In 2002 there were slightly more female students (51.1%) than males in the public schooling system. However, in the national school-leaving examinations (Senior Certificate) in 2002, boys performed better in both maths and physical science. In 2002 in the vocational fields of study (FET Colleges) women appeared in greater numbers in all areas of study except for engineering, where there were very few women.

A national SA survey of learner intentions for higher education study published in 2002 indicated that only 18% of females surveyed wanted to study in broad science and technology field (this excludes the health sciences).

Disparity in terms of race and class is an important issue in South Africa however, and higher education figures in particular mask the fact that white women have historically had greater access to education in science than have black women. If statistics are disaggregated by race, then black women are particularly in the minority in science.

Women are in the minority at postgraduate level, as well as in the sciences. Women in the sciences are mostly concentrated in the health and biological sciences. Few women study in the mathematical, physical and engineering sciences. Women are also in minority

[3] UNESCO, 1999, Women, Science and Technology, Towards a new Development?, World Conference on Science, Budapest, Hungary, UNESCO: Paris.
[4] Science, mathematics and ICT in secondary education in sub-Saharan Africa, a draft report to the World Bank (2004), Centre for International Cooperation, Vrije Uiversiteit, Amsterdam.
[5] World Conference on Science, UNESCO 1999 (http://www.unesco.org/science/wcs/index.htm)

as instruction staff in these fields. For example in 2001 only 9% of instruction staff and 14% of research staff in engineering were women. Women produce fewer publications than men (in 2000 only 23% of peer-reviewed journal articles were produced by women) and more men are rated scientists.

The South African policy framework includes a focus on the need for improving gender equity in education and employment. The National Human Resource Development Strategy, the National Research and Development Strategy as well as the National Plan for Higher Education give attention to both the need for increasing national capacity in science and technology, and to the need for greater equity in these fields. In addition there are a number of governmental and non-governmental programmes addressing these issues.

Some examples are below:

The National Research Foundation has a preferential funding programme for women in research, the Department of Education has a scholarship programme for undergraduate women students in science, engineering and technology, the Department of Science and Technology has a Reference Group on Women in Science and Technology which has initiated national awards for top women scientists as well as research into the situation of women in science, the Department of Education has a national strategy for improving maths and science education in 102 public schools (recently expanded to include a further 400 schools). In addition there are projects that contribute to the development of women in science such as SA-WISE (the Association of South African Women in Science and Engineering) and HERS-SA, which supports the development of women in management and leadership in academic institutions.

The following activity asks members of the group to reflect on aspects of their own experiences of gender issues in science and mathematics teaching and learning.

Activity 1.1 School Experiences of Science and Maths

1 Break the group up into smaller groups of about 4 or 5 people. Appoint an analyst/listener for each group, who will report back on the overall discussion.

2 Ask each participant to reflect on their own schooling experiences using the following questions: (each person should have about two minutes to discuss their experience with the group)

Did you have male or female maths and science teachers?

What subjects did you perform well in?

What subjects were you confident about?

What were your perceptions of maths and science?

What subjects were you encouraged or discouraged to do?

Who were the major influences in these decisions and why?

How has this influenced your career choices?

3 Bring the groups back and ask the analyst/listener to report back with a synthesis of the discussion.

4 Discuss in the group the gender dimensions of the schooling experiences of the group and identify any common trends. A summary of the major discussions of this exercise should be kept for later reference. This exercise is intended as a starting point for both introducing issues of gender in science education, as well as the process of reflection for workshop participants.

5 Feed into the final discussion the major issues outlined above. Give out, or display, the bullet point list of key points (shown above and also on the resource CD). How many of these points were raised by the participants?

The Policy Environment

The topic of improving women's access to, and participation in, science has been a focus of several international conferences and is addressed in a number of international agreements affecting education and gender issues. Issues affecting women in education in general have been on the international agenda since the first UN women's conference in 1975. At the same time there has been an increasing public interest in the field of science: in making science accessible to non-scientists and in making science work for human development. A focus on bringing values into science and the importance of science promoting peace and human rights has also resulted from the international attention to the need for equity in science.

Below is a list of some key international milestones [6] influencing gender equity in education:

- World Conference on Education for All (Jomtien 1990) prioritized the need for improving access to education for girls
- Fourth UN World Conference on Women (Beijing 1995) reaffirmed the need to improve women's access to science and technology education, which had been discussed at the 3rd conference in Nairobi in 1985
- The Eight Millennium Development Goals adopted in 2000 by the international community include the third goal whose target is to "eliminate gender disparity in primary and secondary education, preferably by 2005, and to all levels of education no later than 2015."

These conferences and agreements have raised the profile of gender disparities in education and in science and technology, and in some countries have forced these issues on to the national policy agenda.

Projects in Africa such as, the Female Education in Maths and Science in Africa project (FEMSA) which was created in 1995 as part of the work of the Forum for African Women Educationalists [7] (FAWE), directed towards increasing participation and performance of girls in maths and science in Africa. This project has gathered important data on women and girls in science in African countries, and addresses such issues as improving school curricula, training teachers, and reworking textbooks, to better reflect the belief that girls can also enter scientific careers.

A number of national projects exist to encourage girls into science careers (e.g. science clinics or camps, where girls are given special maths and science coaching and encouragement) and associations of women scientists and engineers have been set up in several countries. There is also a Third World Organisation of Women in Science and a Women in Science Network in Africa (WISTAN). International bodies such as UNESCO, Unicef. the Commonwealth and others have projects addressing gender equity in education broadly often with a specific emphasis on science and technology. All of these organizations pay attention to the need to increase the numbers of women in science and technology education.

Under the auspices of UNESCO, a World Conference on Women, Science and Technology was held in Ouagadougou, Burkino Fasso in 1999. The box below summarises some of its resolutions. The full declaration [8] is on the resource CD.

The Ouagadougou Declaration:

This extract from the Declaration of Ouagadougou, from the African Forum on Women, Science and Technology, held in Burkina Faso in 1999, noted that the situation for women on the continent was characterized by:

[6] Websites relating to these milestone conferences are included in the list at the end of this unit and details are on the resource CD.
[7] See http://www.fawe.org
[8] Available at http://www.unesco.org/science/wcs/meetings/afr_ouagadougou_99_declaration_e.htm

- "low school attendance among girls, with barely one girl of school age in four receiving a primary education;
- high illiteracy among women, especially in rural areas where six to nine women out of ten can neither read nor write;
- a low level of scientific and technical culture in the population overall, and among women in particular;
- an insufficient representation of women in scientific professions, and especially in decision-making;
- the almost total lack of any real policy on science and technology"

This is an example of the kinds of concerns that have been raised on the continent in recent years. The Ouagadougou Declaration urged the governments of member states to "pursue and intensify their efforts in order:

- to eradicate certain sociocultural factors that force girls and women into imposed, fixed roles;
- to promote informal education suited to the interests and aspirations of women and underlining the advantages that scientific and technological knowledge would procure for their future;
- to make use of the scientific and technological potential of African women; the knowledge, know-how, life skills, handed down over the generations in numerous fields (pediatrics, pharmacology, culinary practises);
- to renovate the scientific and technical teaching programmes and materials in order to make them more attractive to girls;
- to create technical training programmes for girls and women that integrate the advances made in science and technology;
- to adapt training of trainers policies as regards gender, i.e. social equality between the sexes;
- to promote women to decision-making positions in the field of science and technology;
- to create a new regional, national and international partnership aimed at promoting African girls and women in the realm of science and technology."

The next activity is for those involved in policy formulation and delivery. Participants will be asked to look at some of the key international declarations related to the education of women and girls, particularly in the areas of science and technology. They should then make some assessment of how far the country has come towards these goals and the extent to which the existing policies and practises are helping in the process and what is required to make them more effective.

Activity 1.2 The local policy environment

1 Hand out, or display, summaries of key internationally agreed goals relating to the education of women and girls (many of those mentioned above are on the resource CD). Have available for consultation, copies of key documents.

2 Divide into smaller groups and ask each group to look at the outcomes of one of the key conferences related to the education and development of women (Jomtien, Beijing, EFA goals, Millennium Development Goals, Ouagadougou Declaration etc) and assess the extent to which these objectives are reflected in (a) the national policy documents and (b) national practise. Maintain a general focus during the discussions on girls in science and technology.

3 Ask the groups to report their findings in a plenary session. During the session, ask the participants to try to identify areas of significant national weakness and to suggest (and prioritise) some implementable activities that will contribute significantly in meeting the internationally agreed targets.

The History of Women in Science:

Women have been participating in scientific activity for centuries. So why is it that they continue to be involved in such low numbers?

The history and philosophy of women in science has grown into a field of study in itself, although it focuses primarily on the history of women in science in the developing world. A concern for making the role of women in science more visible grew out of the women's movement and the concern in general about women's role in society. Much of this writing focuses on telling the biographical stories of exceptional women scientists, who made it in the 'male' world of science. Some authors have tried to emphasise the ordinary roles of women in science, who have mostly worked in lower level scientific and technological jobs, or in many cases in the informal economy.

It is interesting is that despite many formal barriers and discrimination for women having been removed in the developed world, women are still significantly under-represented in most scientific fields, particularly at decision-making levels

Some writers have suggested that we should broaden the understanding of what is science, to include for example, areas in which women have made significant contributions, such as the domestic sciences. Here Londa Schiebinger[9] reflects on the writing of Christine de Pizan in 1405:

> 'It was Isis who discovered the art of constructing gardens and of planting. Ceres taught humankind how to grind grain and make bread. Arachne invented the art of dyeing wool, and of making tapestries, flax and linen. Here Christine made a point that we have only recently begun to appreciate. In order to evaluate women's contributions to science, our definitions of science may need to be broadened. By ascribing equal significance to arts now commonly devalued as women's arts, Christine could claim that achievements of women were both ancient and significant.

This has also been spoken about in relation to women's traditional roles in the health sciences, e.g. the science of midwifery. This theme is also increasingly spoken about in discussions of women's contributions to other areas of science, such as food production, rural development, livestock management, water resources management and provision, and natural resources management. In an African context, these are often areas where women (and rural women in particular) are engaged in daily scientific activity.

Did you know?

- In late 1700s an encyclopaedia was published focusing on the history of women's achievements in natural science and medicine.
- The first conference on women in science was held in 1894 in Paris
- Craniologists in the nineteenth century tried to prove that the female brain was too small for scientific reasoning.
- Women were admitted to some universities in only the 1870s in England and only the 1900s in Germany
- Despite the fact that very few women gained access to these institutions until the 20th century at all there were some exceptions e.g. Laura Bassi (1711-1778) who had a chair in physics at the University of Bologna.
- Pythagoras' wife ran his academy after his death
- The Royal Society of London, and the Academie des Sciences in Paris, both founded in the 1660s, only admitted their first women members in 1945 and 1979 respectively.

(all from Schiebinger)

[9] Schiebinger, Londa, 1987, "The History and Philosophy of Women in Science. A Review Essay" in Harding, Sandra and Jean F O'Barr (eds), Sex and Scientific Inquiry, University of Chicago Press: Chicago.

Topic 4 in this unit addresses the stories of particular women scientists in more detail, bringing some visibility to high profile women in science, who despite having contributed to scientific discovery and development, remain relatively unknown.

The next activity addresses the state of the participants' knowledge about women in science.

Activity 1.3 Famous Scientists

1 In the full workshop group, ask participants to call out the names of famous scientists that they know. Draw up this list while the names are being called out.

   List all the famous scientists and inventors that the group has heard of.

   How many of these are women?

   If none of them are women, ask the participants specifically if they know of any famous women scientists? How many women are then mentioned?

2 Discuss these lists with the group. It is likely that very few women will be mentioned, as even women scientists who have made substantial contributions to scientific knowledge are relatively unknown. Discuss with the group why this is the case. Examples of famous women scientists can be found in section four of this unit.

3 Another question to consider: how many of the famous scientists mentioned are African?

4 Ask a second question: what is science? Is domestic science a science? Are the kinds of domestic jobs that women have traditionally carried out science? Ask the group to discuss this. After some initial discussion, show the quotation from Schiebinger above (on the resource CD) Try to get the group to explore both the issues of what counts as science, as well as the reasons why women scientists have not been visible. Summarise the conclusions of the group on a flip chart.

Topic 2 BELIEFS AND ATTITUDES ABOUT WOMEN AND GIRLS IN SCIENCE: THE IMPACT OF SOCIETY AND CULTURE

Introduction

Social and cultural beliefs about the role of women in society and the working world have had a powerful influence on determining the social and economic roles played by women in all societies, as well as determining the opportunities that women have access to. It is possible to argue that the principal reasons for the low numbers of women and girls in science are the social attitudes about the role of women in society, which still strongly define certain careers as male or female, and particularly define traditionally-male careers as not appropriate for women. The section introduces and explains commonly-held social and cultural attitudes that effect women and girls in science; facilitates participants' understanding of their own views of women and science as well as their understanding of resistance and barriers to girls and women's advancement in science. By making their own attitudes and those of broader society more explicit, it is hoped that participants will be able to challenge these beliefs and explore alternative views.

Women in Society

'A woman's place is in the home'

How many times have we seen this statement? Probably too many for those of you reading this manual. However, even those who claim that women should be equal to men in terms of access to education, public life and employment, may still hold the view that women are naturally born to play the primary caring role in families because of their biological responsibility for child-bearing. There are many who still believe also, that even if a woman can be a scientist or an accountant that having children will inevitably interrupt her career and this means she cannot possibly commit in the same way as a man could. These views assume that women should continue to spend more time than men on family responsibilities.

There is a particular discomfort in many parts of Africa with the idea that women's and men's traditional roles in society should change. This is often connected to a perception that gender equality is a Western import and a symbol of Western colonialism and oppression. This is a sensitive issue given the indignity, humiliation and severe oppression suffered by African societies during times of Western political and economic domination. However, it is important to recognise that culture(s) in all societies change and develop, and that globalization (in particular the relative ease of international travel and communication networks, trade networks and international political activity) has facilitated the development of cultural influence across the world, and is not necessarily just a one-way flow of information from the developed to the under-developed world.

Even if one believes that the influence of the developed world in political and economic terms on Africa continues to be a negative one, it is important not to assume that all social influence has been negative. Women in both the under-developed and developed world have embraced the benefits of feminist struggle. It is also important not to label feminist struggles for gender equity as purely a Western phenomenon, as it ignores the fact that *feminism** has developed in its own ways in different parts of the world, and it implies that African women cannot think for themselves.

Despite world progress in working towards equity for women and men in all spheres of human life, women are still under-represented in many areas of public life and the working world. Public policy and legislation in the majority of countries in the world now reflect the developments of the past 50 years of feminism in making reference to the need for women to participate equally in politics and decision-making, education, employment and other areas of public life. Governments are signed up to numerous international treaties and commitments have been made to improving the status of women in the majority of countries. However, despite these changes, the beliefs about the roles of men and women are still very strong, and women continue to play dominant roles as home makers, mothers and carers, and in professions considered to be the domain of women, such as teaching and nursing.

One of the biggest debates relating to women and science is the "nature/nurture" debate, one side of which (nature) explains gender roles as being determined by one's biological sex (see unit 5 for some workshop exercises on the difference between sex and gender). This biological determinism has been used for centuries to argue that women are intellectually inferior to men. Hippocrates and Aristotle, around 2400 years ago, argued than women were weaker than men. Science has been used to portray women as intellectually inferior to men and this has influenced modern day thinking on women's position in science. Scientists were preoccupied with studying biological differences between men and women to show that men were intellectually and physically superior to women, in the same way that nineteenth century European scientists were obsessed with brain measurement to claim the intellectual superiority of white people of European origin over other groups of people. Social Darwinists claimed that women were at a less developed stage of human evolution than men. The "nurture" debates developed in the 20th century to explain that gender roles are not biologically determined and that people are socialized into particular roles at a young age according to the social values and beliefs of the time. Most of these theories claiming women's inferiority have been revised, and strong challenges to these positions have come with the growth of feminist movements worldwide. Debates about biological sex differences are now used to focus on what the debates tell us about scientific discourse in society.

Although today one will find very few politicians and public figures claiming that biological difference between men and women makes men and women unequal because of the large body of international agreements working towards gender equity, many men and women still hold to these beliefs. This is why inequities continue. Some more recent debates in evolutionary biology suggest that it is women who have chosen these roles, and that the biologically determined roles are what women want. Some more recent literature on this topic does suggest that perhaps more attention should be given to the possibility that the choices women make better explain the paucity of women in science than the "so-called" barriers that exist to prevent women from going into science.

The next activity examines these issues. The activity uses the two quotations in the box below which should be displayed or handed out. They are available on the resource CD.

Quotation 1

"Let us not make schools into grim panoptic ons, where big sister is watching all that girls and boys do, judging them by the criteria of feminist political correctness. No oppression will result from letting boys be boys and girls be girls. Indeed, there is far worse injustice lying ahead if they are not allowed to be as nature guides them."

(James Tooley, Miseducation of Women, 2002, p213). James Tooley is referring in part to the policing of the curriculum in schools to ensure that all gender bias is removed and about the considerable attention given to encouraging girls to enter careers in science and technology He is writing in particular about the situation in the UK.

Quotation 2

"We would argue… that their (girls) under-representation in SET in HE should be viewed within this context of well-qualified young women as active mistresses of their occupational identity."

(Siann and Callaghan, 2001, "Choices and Barriers: factors influencing women's choice of higher education in science, engineering and technology", p93) Siann and Callaghan argue that instead of focusing on the barriers for women in science and technology it may be more useful to look at the choices that women make, and the fact that, for example, women may be choosing not to go into science and technology for other reasons, such as better pay in other fields.

The activity is designed to allow participants to bring out and discuss their own views on the biology vs culture, nature vs nurture, debate.

The next activity provides an opportunity for participants to discuss the nature/nurture debate. The facilitator, or someone with expertise in gender issues, could comment on the views that emerge using ideas such as those in the preceding paragraphs.

Activity 2.1 The biology/culture, nature/nature debate

1 Briefly provide a background to the topic using the arguments outlined above.
2 Display or hand out the two statements shown in the box (on the resource CD)
3 Break into groups with 3 or 4 members. Ask them to discuss both statements and explore their own views on these matters. They should consider the following:
   - What assumptions lie behind these two statements?
   - What aspects of the statements do you agree or disagree with?
   - Do you think the statements are relevant to the context that you know?
4 Ask the groups to report in a plenary session. Make notes of the points raised for future reference. Reflect on whether groups agree or disagree. Is there a dominant point of view? It is important for participants to recognise their own points of view if they are to be involved in advocacy work. It is also important that they understand the different arguments being made in this area. An expert view may be useful at this stage.

Some argue that religion has also contributed to strengthening views of the naturally-ordained place of women in society:

> 'Whether or not you believe in the existence of God, the supreme being portrayed in different ways in different religions, the divine delineation of male and female functions permeates social organization throughout the world and more importantly presents women as inferior to men, physically and mentally. The biblical account of creation depicts Adam created in the perfect image of God, while Eve, the woman extracted from his rib cage, is like a cutting from the perfect stem. It should be noted that Eve was extracted from Adam's chest and not from his brain an act that might have given women a chance to claim intellectual equality with men.'
>
> (Lydia Makhubu [10] 1999, UNESCO, World Conference on science, Ouagadougou)

Although this quotation is located in a Christian paradigm, the general point being made is that religious views, as components of social views (and often dominating social views about women's roles) can have a strong influence on women's access to education. This influence is not confined to Christianity, and depends on the particular religious beliefs in a particular society.

Modern science and the rise of capitalism have also influenced views about gender roles. Through the development of modern science and capitalism, intellectual skills (thought to be a male domain) have become more heavily valued over emotional skills (thought to be a female domain). Intellectual skills are to be practised in the 'public' domain of politics, economics and formal employment, while emotional skills are for the 'private' or family domain. In simplifying these arguments we must not ignore of course, that there are many ways in which people have tried to transcend these 'binary opposites'. (An example would be to look at modern business management theory which, in focusing on leadership skills, addresses ways of valuing what are seen as 'feminine' leadership qualities (compassion, listening skills etc) in leadership practise which has previously only valued 'masculine' leadership qualities (authority, hierarchy, aggression etc).

However, these opposites offer some explanation of our understanding of inequity between men and women. Schiebinger refers to a number of these 'binary opposites':

reason	feeling
culture	nature
science	belief
public	private
rational	irrational
masculinity	femininity

These ideas are debated in the next activities. Activity 2.2 considers a range of 'binary opposites' and 2.3 looks in greater depth at the masculine-feminine one.

[10] Professor of Chemistry, Vice Chancellor and one-time Dean of the Faculty of Science, University of Swaziland

Activity 2.2 'Binary opposites

1 Introduce the concept of 'opposites' in how we view society using the information above and in particular the idea that masculine and feminine characteristics could be perceived as opposites.

2 Write Schiebinger's list of opposites on a flip chart or white board. Discuss these opposites in the plenary group. Do participants see these as opposites? Cross out or bracket those that participants do not see as opposites. Ask them if they can think of others that can be added on. Write up any others that they suggest.

What do they think are the implications for their own views of gender equity?

The next activity requires the following two quotations to be displayed or handed out (they are on the resource CD):

> 'In order to get to the top, many of the pioneer women scientists had to overcome numerous hurdles, ranging from outright rejection in scientific institutions to open discrimination in appointments. The male scientific communities could not accept them as equal partners and colleagues who could contribute to the advancement of science as well as men. They were seen as potential liabilities who could withdraw anytime from teaching, research and other scientific activities in order to get married and have children. For many women a scientific career has meant a choice between marriage, motherhood and science. Should women have to face this choice? Can women be wives, mothers and scientists at the same time?'
>
> (Lydia Makhubu, World Conference on Science, UNESCO, 1999)
>
> 'One needs to look at the time it takes to complete degrees and courses in engineering; it's often very long. Women tend to get married at the age of 24 or less, after that they have to then deal with all the issues relating to being a wife – babies, housework, shopping and so on.'
>
> (anonymous posting on an African women in science email list, 2005).

Activity 2.3 The masculine-feminine 'binary opposite'

1 Display the two statements above

2 Break up the workshop into smaller groups. Ask them to examine the two statements and discuss. This exercise is about examining one's own view of family roles and our own ideas about the roles of women and men. Is it possible, as Lydia Makhubu asks, for women to be wives, mothers and scientists at the same time? It is important not to pre-judge the discussion so that people feel free to express their own views. Is it clear whether the second quotation is from a man or a woman? (it was in fact signed as 'man').

3 Bring the group back to report on their discussions, and try to summarise the views of the group. Are there gender differences, age differences perhaps? The point of the exercise is to allow the discussion to come out, not necessarily to come to an agreement about what is possible and what is not.

Girls' access to education

> 'Education is the great engine of personal development. It is through education that the daughter of a peasant can become a doctor, that the son of a miner can become the head of the mine and the child of a farm worker can become the President of a great nation.' (Nelson Mandela)
>
> 'The most urgent priority is to ensure access to and improve the quality of education for girls and women, and to remove every obstacle that hampers their active participation. All gender stereotypes in education should be eliminated.'
> (World Declaration on Education for All: EFA Goal 5: Gender)

As a result of the broader social issues discussed above, girls have not been viewed as having the same aptitude as boys in science, and it has not always been seen to be necessary to educate girls in science. Girls have not been encouraged to enter scientific careers and parents have chosen to send boys to school instead of girls. Girls often bear the burden of domestic chores and early marriage; pregnancy often interrupts the schooling of girls; sexist stereotypes in curricula and the views of teachers encourage girls and boys into particular careers; and a lack of role models of women in science helps to maintain the *status quo*. This can be seen from the data presented in Topic 1. One can also see that women are under-represented in higher education and particularly in scientific fields. A 'glass-ceiling' in *academia** has been spoken of, the point which very few women pass to enter the levels of professorship and decision-making.

However, from the quotations above one can see that education is important for accessing scientific careers. Education is also a powerful way of influencing social views and reinforcing or challenging strongly-held beliefs through curricula and teaching methods. If teachers do not expect girls to do well in science they do not encourage them. It has been shown that teachers' views influence the ways in which they teach boys and girls and that this can influence the self-esteem and performance of girls and boys in particular subjects. (these issues are addressed further in Unit 5)

Poverty also affects access to education and in a world where the cost of education is increasing, families often have to decide who to educate to what level because of scarce resources. In impoverished communities people are often resentful where special programmes are implemented to target girls only. This is because access to science careers and higher education may be a general problem. So ideas about the place of women in society are compounded by general problems of access to education and may explain why people do not always support the idea of improving education specifically for girls.

There are a considerable number of issues relating to girls access to and success in education in general that must be mentioned here. These issues impact on the quality of girls' educational experiences in general and are often related to poverty. It is not possible to discuss these factors in detail, but they can have a severe impact on girls' and women's access to education at all levels. It is important to note that although these issues do not only affect women and girls, they sometimes have differential effects on them. The resources section at the end of the unit offers suggestions of places where further information can be found, as well as some helpful resources. Resources are also available on the accompanying CD.

School safety issues include the difficulties that girls often face in the school environment of sexual harassment and violence. This is known to be a problem in many countries, as girls often face sexual advances from both male teachers and fellow students. School safety also includes the vulnerability of girls travelling to and from school in communities where they may be at risk or where they have to travel long distances.

Sanitation in schools is a major issue for girls, particularly in poverty-stricken areas where schools do not have adequate shelter, let alone proper sanitation. It has been documented in many countries that large numbers of girls are regularly absent from school during menstruation because they do not have access to adequate sanitary equipment or facilities.

HIV and AIDS is having a devastating effect on schooling for girls and boys in poverty-stricken environments. This is a complex issue that affects girls in many different ways, either because they themselves are infected with the virus, or from the loss of family members and

parents in particular, and the responsibilities that girls may have to take in their family environment, caring for siblings or for ill relatives.

> 'Orphans and Vulnerable Children have become a major policy focus in Africa, in part due to the devastating effects of the HIV epidemic. Teachers' roles are changing as they have increasing numbers of children infected by and affected by HIV. Schools have had to take on major social welfare responsibilities in the lives of children. School feeding programmes are one example of this. Also at issue is the fact that children at risk are not always able to access education, and increasing numbers of children are out of school. According to UNICEF/UNAIDS/USAID the figures for 0-17 years old in Sub-Saharan Africa in 2003 show that
>
> - 12.3% of all children (43 million) are either single or double parent orphans
> - 28% of all orphans (12 million) are orphans due to AIDS
> - 2% of all children are double orphans (7.7 million)
> - 59% of double orphans are orphans due to AIDS (4.5 million).
>
> (from World Bank OVC toolkit [11] – see resource CD).

Vulnerable children also include those affected by war through being orphaned, fighting as child soldiers, or being injured and traumatised by war. Large numbers of children are also refugees and displaced, and in urban areas street children are a major group.

It is impossible to face the problems of low numbers of women in science and technology without recognising the social problems that impact on women and girls accessing quality education in the first place. The areas mentioned above involve complex policy and humanitarian responses so it is not possible to do justice to the huge scope of the issues in this Unit.

The next activity is aimed at bringing out some of the social and poverty issues that may affect girls and women's participation in science and technology, and girls education in general. It is important that participants are able to link access to science and technology to access issues in general in education, and, in particular, to identify the ways in which some issues of poverty may affect boys and girls differently. The activity uses the quotation shown in the box from the UNICEF evaluation report of the African Girl's Education Initiative in 2004 [12]. The quotation is reproduced on the resource CD and the whole report is also on the CD.

Quotation form the UNICEF evaluation report of the African Girl's Education Initiative in 2004

Across countries, there was wide agreement of governments and development partners about the main factors constraining girls' participation in schooling.

The main supply-side constraints include:

(a) lack of a school within reasonable distance and
(b) lack of appropriate sanitary facilities in the school for girls, particularly at the point of puberty.

Main demand-side constraints include:

(a) family values and beliefs that do not value education for girls (e.g. parents' concern about girls being in the same classroom and having contact with boys);
(b) economic constraints on the family, often centring on the need for girls' labour in the home; particularly to carry water and collect firewood;
(c) the view of some parents that educating a girl is counterproductive to arranging a good marriage for her; and
(d) parents' concern (often well-founded) for the girls' welfare when they have to travel long distances to the closest school.

[11] See http://info.worldbank.org/etools/docs/library/108875/toolkit/index.htm
[12] *Changing Lives of Girls: Evaluation of the African Girls' Education Initiative*, UNICEF, New York, 2004

Activity 2.4 Constraints to girls' access to education

1 Show the group the list of constraints to girls' education in the box above.
2 Divide the participants into four groups. Ask them to discuss each issue in relation to their own experience and area of work. How does these particular issues affect their work? What do they know about the scale of the problems in their own country or region? What are the ways in which the particular issues are manifested in their work? How do the issues affect girls and boys differently, if this is the case? What are some of the strategies being used by their government and organisation to deal with these issues?
3 Each group should report back after a twenty-minute discussion. During the plenary ensure that the major issues mentioned above in this section are raised.

How society views women scientists

As a short starter exercise, ask participants to do activity 2.6. It requires the biographical note about the Russian mathematician Sofia Kovalevskaya shown in the box below. This should be displayed or handed out. The note is included on the resource CD.

Activity 2.5 Life cycles of women scientists

1 Place the biographical note of Sofia Kovalevskaya up on an overhead or board for all to read.
2 Break the participants up into smaller groups. Ask them to discuss the following:
   - What has changed in the period since 1850?
   - What are the similarities and differences between this story and the current situation for women in your own country?
   - What about this story resonates for the participants, if anything? Issues to be explored can be parental influence, marriage and relationships, having children, class issues.
3 Ask the groups to report back and record the points made for future reference.

Biographical note – Sofia Kovalevskaya

Sofia Kovalevskaya was born in 1850 in Moscow, Russia. She was the child of educated Russian nobility. She was attracted to mathematics at a young age and she was taught mathematics by a family tutor. When she started to neglect her other studies because of her interest in mathematics, her father stopped her mathematics lessons. However, she carried on with her interest at night. It took several years, but eventually her father allowed her to continue with private mathematics lessons. She was forced to marry so that she could go abroad to enter higher education but it was a marriage of convenience.

Sofia's father would not allow her to leave home to study at university, and women in Russia were not allowed to live away from their families without permission from their husband or father. Her husband was a young paleontologist Vladimir Kovalevskaya. She went to study in Heidelberg, Germany and studied maths and natural science, although she was not allowed to graduate as a woman. She managed to persuade the university to allow her to attend lectures unofficially. There she was noticed by her professors for her incredible mathematic ability and received private tuition. In 1874 she received her doctorate from Gottingen University but could not obtain an academic position, and taught arithmetic to school girls.

In 1878 Sofia had a daughter. Her marriage was a difficult one and apparently there were great misunderstandings and quarrels between Sofia and her husband. Her husband committed suicide in 1883, after they had been separated for two years. She threw herself into her work, and obtained a position in 1884 in Stockholm, Sweden. She was almost immediately appointed to a five year extraordinary professorship and in June 1889 became the first woman since Laura Bassi (1711 to 1778) and Maria Gaetana Agnesi (1718 to 1799) to hold a chair at a European university. She became a much awarded brilliant mathematician. She died at the age of 41 in 1891 of influenza complicated by pneumonia.

(from the History of Mathematicians website at the University of St. Andrew, Scotland, http://www-history.mcs.st-andrews.ac.uk/history/)

The list below gives a variety of contemporary views of women as scientists. They represent a variety of different views of women as scientists. There may be many more that workshop participants can think of. Activity 2.7 explores this further.

- My image of scientists is that of men in white coats who sit in laboratories examining test tubes of chemicals and looking under microscopes. It is difficult to picture a woman in this role. Is this the reality of the work that scientists do?
- Women in men's professions are often viewed as aggressive. Do you agree? Why is this?
- "Would you trust a woman to fly your plane?" Ali G. Ali G is a British television comedian. This statement, although meant as a joke and said in a meeting with an Professor of Gender studies was taken very seriously by her. Perhaps because it is a view that is often expressed seriously. Ask yourself the question!
- "In my view there will always be certain types of work in the Engineering field which women are by nature not capable of handling, given their physical weakness. Women are by nature not strong and building roads for example requires both strength and endurance. Look at what happens when a long road has to be built – men stay in steel huts for weeks on end: women can't stand the roughness of such jobs." (From a recent email sent to a women in science email discussion) What does this statement say about the barriers for women in engineering? What does it say about the nature of engineering itself? Is it a correct representation of what engineers do?
- "Engineering still carries the image of being hands-on, with grubby machinery and technical based – and I think that does put quite a few people off." (22 year old female design engineering student in Britain – from a Paul Hill article in the Times Higher Education Supplement)
- "As decidedly as that 2+2=4, what a monstrosity is a woman who is a professor of mathematics, and how unnecessary, injurious and out of place she is" (The Swedish writer, August Strindberg (1849-1912) speaking of Sofia Kovalevskia, (1850 to 1891) Russian mathematician.)
- Women have been scientists for generations. It is just that they are not well known. Like Rosalind Franklin who worked with Watson and Crick, their work is often not recognised.

Activity 2.6 Views about women in science

1 Provide the participants with a copy of the views above (they are on the resource CD).
2 Ask the participants to read the statements and discuss them in small groups. They should examine the statements in terms of what they know about science and also their own views.
3 Share the group conclusions in a plenary session.
4 As an additional, final, exercise, show the participants the two statements in the box below following and ask them for an explanation. These puzzles can take a significant time to work out, and the participants may need to be prompted to work them out. However the impact of working them out is powerful and time should be allowed for discussion in this section. Once the answers have been revealed to the group, the facilitator should allow for discussion and reflection on the results.

Explain

1 Michael was walking down the street one day when he met an old friend who he had studied engineering with. They had not seen each other for 20 years. This friend was with a child. They greeted each other warmly. Michael said, "goodness, your son looks just like his mother". How does he know this?

2 It was a dark and stormy night. A man was driving his son home. The car skidded and hit a tree killing the man instantly and seriously injuring his son. The son was rushed to hospital and was wheeled into the operating theatre where the surgeon exclaimed "I cant operate. That's my son. What happened?" Explain

The nature of science

This is an area of some complexity and the subject of different kinds of research. When talking about the nature of science in relation to gender and women, we refer to the ways in which science and scientific theories have represented women, as well as the effect that science has had specifically on women. When talking about the nature of science it is important to recognize immediately that scientists throughout history have claimed the rationality and superiority of scientific theories, but that it is now commonly accepted that science is influenced by values and the cultural environment in which scientists operate. Through writers like Evelyn Fox Keller and Sandra Harding, writing about women and the philosophy and nature of science has become a field of study in itself.

The way in which values influence science can also be seen with issues of science decision-making: who decides which are the important scientific issues? What funding is provided for scientific research? The research priorities of pharmaceutical companies, for example, have often been debated. Pharmaceutical companies argue that they put extensive funds into pharmaceutical research so they have to be sure they will get a return on the kinds of drugs that they produce. Malaria is one of the biggest killer diseases on the African continent, and yet very small sums of money are put into research into malaria drugs. This is because it is not perceived to be a profitable area to research. Yet millions of people die from malaria. Some people would argue that malaria is not a target area for research because Africa is not an economically important market for the big pharmaceutical companies.

Other areas in which the influence of culture on science have been the European preoccupation with the science of "race" in the nineteenth century and the use of science in warfare and the manufacture of weaponry (e.g. developing nuclear technology for use in warfare rather than in medicine).

Bleier has highlighted the issues of power as they relate to the practise of science.

> 'While… [a scientific] discourse appears to be the uncovering of truth, it [in fact] rests upon and conceals the struggle between those who have the power to discourse and those who do not. Both by their practises of exclusion and their definitions of what is, what is to be discussed, what is false or true, discourses produce rather than reveal truth.' (p30 Schiebinger, quoting Bleier.)

The best way to illustrate this is to work with practical examples. The following are some areas in which have been discussed by those interested in gender and the nature of science:

- Biological theories have been used to support beliefs that women are intellectually inferior to men and not capable of certain tasks
- Researchers have looked at ways in which the development of technology has affected women differently from men. For example, in formal employment, women have frequently been involved in repetitive, monotonous tasks, in lower paid positions.
- What science have women been involved in? Primarily the biological and health sciences, mostly at the lower research levels and in technological work that is not necessarily recognized as science, but which has traditionally been feminised. This refers to certain aspects of agricultural work, for example, the textile industry or food technology.

The quotation below also argues that the scientific process is fundamentally culture-laden.

'Facts, Evidence and Hypotheses

In our everyday world, we are surrounded by facts: singular facts (this ruby is red); general facts (all rubies are red); simple facts (the stove is hot); and complex facts (the hot stove burned my hand). Description of these facts is limited by the capacities of our sense organs and nervous systems as well as the contours of the language we use to express our perceptions. There is always much more going on around us than enters our awareness, not only because some of it occurs outside our sensory range or behind our backs, but also because in giving coherence to our experience we necessarily select certain facts and ignore others. The choice of facts to be explained by scientific means is a function of the reality constructed by this process of selection. What counts as fact – as reality – will thus vary according to culture, institutional perspective, and so on, making this process of selection one point of vulnerability to external influences.

Even the facts that enter our awareness are susceptible to a variety of descriptions. Accounts may be more or less concrete ("a rough-textured, grey, heavy cube" vs. "a building stone"); more or less value-laden ("she picked up the wallet" vs. "she stole the wallet"); and focused on different aspects ("grey" vs "hard" vs "cubical") A good portion of the history of epistemology and philosophy of science consists in the search for some privileged level of description. We are persuaded that such a search is futile. But the possibility for multiple descriptions of a single reality means that, despite the ideals of scientific description, any given presentation of data may use terms that reflect social and cultural biases when other less value-laden or differently valued terms might do as well. This is another point of vulnerability to external factors.'

(from 'Body, Bias, and Behaviour: A comparative analysis of reasoning in two areas of biological science', Helen Longino and Ruth Doell, p167.

The next activity tries to simplify these rather complex issues. Although complex, these issues are important in the classroom. In Unit 5, strong evidence is presented that the portrayal of science as value-free based on the objective collection of evidence is a significant contributory factor in deterring girls from the subject. There is evidence that a recognition that science is not value-free and that teaching science as a human activity that has a cultural context makes it much more welcoming to girls.

Activity 2.7 The nature of science.

1 Display the following two statements or give out copies

Science is neutral, objective and rational. It is based on the dispassionate collection of objective evidence around which theories are constructed. Such theories must be accepted until disproved by new evidence.

Science is a human activity is therefore influenced by our cultural norms and values. Scientists cannot be completely objective.

2 Break the group up into two camps. This should be done randomly. The one group should take on the first statement and the other group the second statement. Each group should prepare a presentation based on their particular statement (regardless of their own particular stance on the issue). You should ask the question, "in the area of science that you know well, think of an example that will allow you explore this question." A principal debater should then be appointed to read out the group presentation, and a debate should be conducted amongst the group, with the facilitator acting as chair/mediator.

3 As a group, discuss the debate. At this point bring in references to the feminist debate on the nature of science and also mention some possible consequences for the curriculum and teaching.

Topic 3 WHY CHANGE THE SITUATION OF WOMEN IN SCIENCE AND TECHNOLOGY?

Introduction

The aim of this section is to provide some intellectual tools for advocating for the development of women and girls in science and technology. It explains the arguments that are used to support the need to get more women and girls interested in scientific careers. Understanding these arguments is a useful tool for engaging in advocacy work around this issue. The discourses around the need for improving women's access to and involvement in science have been divided into three major focus areas below, in order to facilitate discussion and understanding.

Focus 1 – Human Rights, Equality and Social Justice;

Focus 2 – Human Resource Development;

Focus 3 – Development and Economics.

Focus 1 – Human Rights, Equality and Social Justice

> *"Science belongs to everyone. It is everyone's business."*
> Federico Mayor, UNESCO, World Conference on Science 1999.

The growth of feminism, emphasizing the rights of women to have equal access to resources and education, as well as the belief that women are equally capable as men of doing all kinds of work has influenced this focus area. Human rights discourses have provided added impetus for these arguments. Although national and international policy documents give clear attention to the need for improving women's involvement in science and technology, arguments about social

justice are not given as the primary reasons for changing the *status quo*. However, human rights and gender equity movements have certainly influenced the development of science policy.

In many cases equity and human rights arguments may not be convincing enough, as many people continue to believe that women should pay more attention to their traditional roles in society. Achieving full equity of women and men in all areas of human activity implies the need for changing and adapting women's roles in society and many are uncomfortable with this. For example, can women be scientists and mothers at the same time, and if they can, does this not imply that men's roles within the family should also shift to taking more responsibility for parenting and domestic work? These are difficult issues to debate. It is easier to advocate for greater equity between men and women by focusing on women's role in society than on women's rights and this explains why the arguments below are used more often.

Social justice standpoints also focus on the need for science to ensure that women as a group benefit from scientific and technological research and development. Although social justice advocates aspire to equality between men and women, they recognise that this is far from being achieved, and that women are affected differently by science. An example of technology that impacts on women and men in Africa differently is water technology. Rural women's responsibilities in the home and in food production means that women often have primary responsibility for accessing water, so scientific research that is focused on improving access to water and the safety of water and sanitation technology, has a greater effect on the time that women spend getting water. Contraceptive technology is also an area that impacts specifically on women's ability to negotiate sexual relationships and have control over family planning decisions. Sanitation in schools affects girls differently from boys, because girls need access to sanitation facilities when they menstruate. Research in Uganda has shown that girls often miss school when they are menstruating because of poor sanitation facilities. There are numerous other examples.

The next activity brings these ideas into the world of the participants. You will need some cards, about a third A4 size and Prestik or a pinboard and pins.

Activity 3.1 Understanding the social justice focus on women and science

1 Give each participant a sheet of card (they can have more than one if you wish)

2 Ask each participant to come up with a scientific or technological issue that impacts differently on men and women, particularly ones that relate to their own experience. Put each of these issues on a piece of card which is then placed on a display board. As they are placed on the board ask participants to sort them by placing their ideas next to a similar one that is already there. (It may be useful to start this process with one or two examples such as the ones mentioned above)

3 Finalise the sorting the cards into categories of similar issues with group input. This makes the discussions broader as there may be debates on where to locate particular issues.

4 Discuss each category of issues and its relationship to social justice. This is important for helping people understand what is meant by the social justice/equity/human rights discourses in relation to women and science.

Focus 2 – Human Resource Development:

> 'The full social and economic advancement of our countries depends crucially on human development as a first priority;
>
> There is no sustainable human development without the joint participation of women and men in all creative activities, including Science and Technology (S&T);
>
> Notwithstanding the lack of comprehensive and reliable statistical data, we testify to the enormous difficulties still encountered by women in accessing the domains of S&T;
>
> On the other hand we testify that women play crucial roles in the preservation of norms, values and practises that richly endow the diverse societies of the world and are fundamental to human existence;
>
> Since S&T have become major influences in our times, it is urgent that women come to the forefront to participate in shaping the agenda for the future direction of the scientific enterprise;
>
> The creation of TWOWS was inspired by the conviction that women have a unique and valuable perspective to bear upon the application of S&T to development…
>
> Third World Organisation for Women in Science (TWOWS) Second General Assembly and International Conference: Women, Science and Technology for Sustainable Human Development (1999)

The human resource development standpoint focuses on the need to enrich the pool of scientists in the world. This is particularly important given the constant need for new scientific insights and the need to increase and improve the use of our human resources in order to build on scientific research. These viewpoints focus on how human resources are wasted if we do not use the skills of 50% of the world's population, who have been historically largely excluded from scientific activity.

Human resources have become an area of focus because of the idea that increasing high level skills leads to greater economic and social development. Development theory has increasingly emphasized the need for developing countries to build on high level skills in order to become economically competitive in the world. South Africa's national education policies are very clearly located in this discourse, not only because past racial and gender inequalities have meant that a significant proportion of the population have been unable to gain access to highly skilled training and employment (social justice standpoint), but also because the country's development depends on higher numbers of skilled people to sustain developmental needs and to help to eradicate social injustices and poverty, (and some would argue in order to become more competitive in the world economy). In making these arguments we are overlapping very closely with the third area of discourse relating to women in science, discussed below.

African countries have the lowest numbers of scientists in the world, but the greatest levels of poverty and therefore arguably the greatest need for scientific and technological development and for scientists, technicians, engineers etc. African countries therefore, cannot afford to exclude women from these areas of activity where women make up more than 50% of the African population. The world of employment has also changed, and it is now impossible to participate fully in the world economy for example, without having access to information and communication technologies.

Some arguments also focus on the fact that women may have particular ways of doing science and particular skills to bring to scientific work which men have not brought. Some may say these relate to women's specific experience in areas such as agriculture, health care, and the environment, but there is also some research to show that women may in fact "do" science differently and can bring new skills to scientific research and work. This is not discussed specifically here, but some resources in section 4 May offer further information about this interesting area.

Activity 3.2 Human resources in science and technology

1 Ask each participant to think about a science/technology-related organisation or company with which they are familiar (it may the science department of a school, college or university, or a science council, or company that they know). Ask the participants to focus on the human resources of this particular organisations. What categories of workers are there in this organisation? What is the dominant gender of each category of worker employed by the organisation? Their findings should be written on a piece of card.

2 Ask a few participants to report back on their organisation. What trends can be shown? Where are women and men primarily located? What are the differences between the different categories and levels of work and the work that women largely do and the work that is mainly conducted by men? Are there similarities and/or between the different kinds of organisations? The facilitator can feed into the discussion some of the points made in the preceding paragraphs.

3 The cards should be grouped together for later reference or for the workshop report. This exercise should illuminate gender bias in the hierarchy of organisations as well as the types of activities that men and women are involved in.

Focus 3 – Development and Economics

"Educate a woman and you educate a nation".

You will have heard this statement [13] as many times as "a woman's place is in the home" and many of you may have used this argument before in advocating greater equity for women in education.

What does this actually mean? Much of development theory advocates gender equity as necessary because of women's role in society. Research has shown for example how increasing literacy of women in poor societies lowers birth rates (as women are able to take greater control over family planning) and improves child nutrition, (as women have a greater awareness of health care and how to take care of their children).

In this way, science and technology can improve the quality of people's lives as more women have access to advances in food technology, and in medical science. Women are seen to be more important in this area because they still have primary responsibility for domestic activities and family care. As African countries are amongst the least developed in terms of scientific and technological capability while developed countries dominate in the production of scientific knowledge and innovation these issues have become increasingly important for development discourse in Africa.

It can also be argued that women in Africa have least access to the developmental benefits of science and technology because of poverty, food insecurity, and lack of access to quality health care. As women are educated to be domesticated, they bear the brunt of these disasters. If science is thought of in development terms, in can therefore be seen as crucial to improving lives and in particular the lives of women. Over 30 of 47 of world's poorest countries are in Africa and as poverty affects access to education and social services, poverty affects women most

> 'In a world increasingly shaped by science and technology, scientific and technological literacy is a universal requirement… it is vital to improve scientific and technological literacy among women and girls, whose unique educational function

[13] Attributed to Dr Kwegyir Aggrey (1875-1927) of Achimoto School, Ghana. It seems that what he actually said was "The surest way to keep a people down is to educate the men and neglect the women. If you educate a man you simply educate an individual, but if you educate a woman you educate a family," which in this context, is perhaps even more appropriate.

within the family makes them such a major determinant of the attitude of present and future generations.'

Federico Mayor (UNESCO Director-General), 1999.

The problem with the above standpoints is that alone, they are not transformatory, and accept the social role of women as one which should remain static. The statements would not be true, for example. if the roles of women and men in society began to change.

In the next activity this issue is debated through the study of two quotations shown in the boxes below. These are also included on the resource CD.

From the Ouagadougou Declaration

"Given that such a situation constitutes:

- an injustice toward women, thus depriving them of the intellectual and practical means indispensable to improving their living conditions in economic and political contexts that are becoming increasingly difficult (structural dysfunction linked to the many-faceted crisis affecting Africa, to which must be added the various conflicts that continue to plague the continent);
- a considerable waste of human resources, given the essential role African women play in society; child rearing, family responsibility (nutrition, care, hygiene), management of natural resources (water, energy sources), agricultural production, fishing, crafts, small trade and odd jobs in the informal sector;…"

From Federico Mayor (1999), the Director General of UNESCO

"On a worldwide 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 a word, 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."

Activity 3.2 Women in science and development

1 Display or hand out the two quotations from the box above. Also mention, in the introduction, the Aggrey quotation from the beginning of this section.

2 In a plenary discussion ask questions like:
   - Which arguments are made in both these quotations?
   - Which ones are privileged by these statements? Which arguments do the participants think are the most important?
   - Which arguments work most strongly in advocating women's fuller participation in science and technology?
   - Which additional points could be included but are not? (here, I refer to the equality arguments which are included to a certain extent, but only in the sense that women are excluded from assisting in "building the world". The point is not really made that women have a right to be accessing the same opportunities as men. It is important to get to the point where people are aware that in general, the economic and developmental benefits of involving women in science and technology are the arguments that are used most strongly and that it is still easier to convince people of the importance of this area without actually engaging in the arguments of human rights and equality.)
   - Can the participants think of other reasons for improving women's access to science that are not covered by the above sections?

   Appoint a rapporteur to list the main conclusions from each question. An alternative way of approaching this is to divide the participants into five groups and ask each group to consider one bullet point and report back.

Topic 4 ADVOCACY STRATEGIES

Advocacy tools

This unit has provided a background to the issues facing women in science, as well as an overview of some of the major debates regarding women in science. At this stage participants will have had an opportunity to examine their own beliefs about women in science and what has informed these views. This section aims to provide workshop participants with some useful information to assist in advocacy work and in particular the use of role modelling of women scientists.

As historian of science Naomi Oreskes has said, "The question is not why there haven't been more women in science; the question is rather why we have not heard more about them." (quoted on 'Women in Science', San Diego Supercomputer Centre) The lack of visibility of women in science will have become clear during the workshop process, as exercises will reveal that people know about very few women scientists and also they may know very few women science teachers or women who are science professors. Part of acknowledging women's role in science work is to make women in science more visible, and focusing on role models is an important way of doing this. Often the reason why girls do not consider scientific careers is because they do not know anyone who is an engineer or a technician or a mathematician. If girls grow up thinking that women can only be nurses and teachers then it is they are unlikely to consider other alternatives.

It is also useful to focus on recognizing scientific work that has been done by women, e.g. nursing, which has been a female-dominated field. Positive images of women in science help to challenge stereotypes and attitudes towards women. The fact is that many women have done scientific work, and more and more women do scientific work, but the stigma still exists and the numbers are still far lower than those of men. Statistics have also shown that Africa is the region of the world where the least number of women are involved in science. According to *Future Scientists,* (UNESCO, 1998), 1990 figures show the numbers of women in science and technology in tertiary education at less than 15% whereas in Latin America, Western Europe, Asia/Pacific and Eastern Europe, while still below 50% the figures vary between 28 and 40%.

There are a number of tools and methodologies that can be used in advocacy work in this area including the use and promotion of sex-disaggregated data. Having access to as much disaggregated data as possible provides the necessary information for advocacy work in gender. In all kinds of institutions, including schools, government departments, universities, colleges etc, the more data is available, the easier it is to confront and address issues of gender inequity.

There are many resources and tools available for gender analysis in education. A significant number of these are listed in the publication 'Gender and Education: A Selection of Practical Tools' available on the website of the United Nations Girls Education Initiative (www.ungei.org) and the version dated July 2005 is included on the resource CD

Advocacy resources – Gender lens

A gender lens is a way of looking at an issue or topic so that the gender aspects of it are illuminated. It involves asking questions in a particular way so that both the concerns of men and women are taken into account, particularly where these concerns may differ.

> 'Think of a gender lens as putting on spectacles. Out of one lens of the spectacles, you see the participation, needs and realities of women. Out of the other lens, you see the participation, needs and realities of men. Your sight or vision is the combination of what each eye sees' [15].

[14] 'Women in Science', San Diego Supercomputer Centre, (1997), www.sdsc.edu/ScienceWomen/

A gender lens can be many things. A form of gender lens that is gaining popularity is a tool that governments and NGOs can use in their regular operations (e.g. A gender lens for training programmes would be used every time you develop training. A gender lens for planning could be used for developing each annual work plan. A gender lens for research and surveying can be routinely used in data collection.) The box shows a number of characteristics of a typical gender lens.

Some characteristics of a gender lens

An operational gender lens often has these characteristics:

- It is a list of questions, a checklist or list of criteria
- It is routinely used (see above examples)
- It is created in a participatory manner by those who will use it
- It is recorded in words or in pictures where literacy is low
- At least two copies are always kept in the same place in your organisation's files so people can find the gender lens to use it.
- The key people who do planning and program development are given copies of the gender lens and orientation in why and how to use it (e.g senior management staff and planners, pertinent stakeholders)
- A gender lens usually contains less than 10 points
- Each point focuses on the distinct realities of men and women
- Where appropriate, the distinct realities of girls and boys are included
- Many gender lenses include: planning, implementing, monitoring and evaluating. Other gender lenses focus strictly on one of these functions (e.g. a gender lens can be used for monitoring the gender sensitivity of communication tools like posters, brochures, street theatre etc. Another gender lens can be created to guide project evaluators, etc.

The box below shows and example of a Gender Lens for Education Projects. It is taken from the GENIA toolkit (Gender in Education in Asia Network) available on the UNESCO Bangkok website. It has also been included on the resource CD.

A gender lens for education projects

- Are men and women fully involved in the needs assessment and design, implementation, monitoring and evaluation?
- Will the needs assessment explore the distinct needs of women and men (boys and girls)?
- Are the risks, high-risk behaviours and vulnerabilities of men and women (boys and girls) in the target group being appropriately addressed?
- Does the project include women and men (girls and boys) who are disadvantaged?
- Does the project have sex-disaggregated baseline data, gender objectives, expected gender equality results and related indicators?
- If the project involves training:
- Will the 'life experience' of the female and male learners be valued in the training?
- Will the content and methods be appropriate for male and female learners?
- Will female and male learners be able to use the knowledge/skills gained in the local labour market, in their communities or in their homes?
- Will there be a gender balance of both trainers and learners?
- Will men and women be equal participants, decision-makers and beneficiaries?
- Does the monitoring checklist include clear gender mainstreaming requirements and sex-disaggregation of information?
- Does the project implementer have a gender-responsive organizational culture and a track record of empowering men and women (boys and girls)? If not, will the project implementation team be given gender training and be assisted to develop project-specific gender guidelines prior to the start of the project?

[15] from UNESCO Bangkok GENIA toolkit (www.unescobkk.org)

Activity 4.1 Developing a gender lens

1 Divide into small groups. They can be divided either randomly or according to their area of work; they could be a group of teachers, or policy-makers, for example.
2 Each group will be required to develop a gender lens for a project that they can choose. It may be something common to the group such as a curriculum design project, or it may be something that they choose to devise such as a policy-development process for a school. They will probably need an introduction to the concept of a gender lens which can be given using some of the examples shown (they are on the resource CD)
3 The groups must devise the gender lens and each group their ideas to the whole group after this process.
4 After each presentation, the plenary group should have an opportunity to discuss and ask questions, so that by the end of the session participants have a clear understanding of how to develop a gender lens.

Advocacy resource – Role modelling

We cannot over-emphasise the importance of recognising the work of women scientists and of providing positive role models for young women. This section aims to raise the visibility of women scientists, both historical figures and living scientists, so that women and girls can begin to see the extent of possibility for women in science. It is also useful to read about the life stories of women in science to see the social difficulties that many women scientists have had to confront, their difficulties in accessing scientific education and employment, how they managed their personal relationships, and how they have overcome some of these challenges.

It is important to note that there are very many scientists that can be mentioned in this section, and very few have been included here. For example, the Third World Organisation for Women in Science, has 930 members listed from African countries. The resources section suggests places where further information can be obtained.

Some contemporary African women scientists:

(information from various sources)

Professor Chinsamy-Turan is Professor of Zoology at the University of Cape Town, South Africa. She is a paleo-biologist, an expert in bone microstructure, studying dinosaur bones to help understand biodiversity. She is a mother of two. She was the first black woman to become a full Professor in the Science faculty of her university, and is still amongst a tiny number of women professors in science in South Africa. In 2004 she was awarded a National Research Foundation award for senior black scientists. She is also the 2005 winner of the South African Women of the Year Award (Shoprite/Checkers), as well as the winner in the Science and Technology category of the same award. She currently chairs SA-WISE, the Association of South African women in Science and Engineering.

Professor Wangari Maathai was the 2004 winner of the Nobel Peace Prize for her activist work in the environmental field. Born in 1940, she was the first woman in East and Central Africa to obtain a PhD. She became a Professor of Veterinary Anatomy at the University of Nairobi in 1976. Through her involvement in the women's movement in Kenya, she founded the Green Belt Movement, which has been responsible for the planting of over 20 million trees by women's organisations for environmental sustainability and improvement in quality of life. This movement is now active across the continent. Professor Maathai has received numerous awards as an environmental activist and a number of honorary doctoral degrees. She has also served as Kenya's assistant Minister for Environment, Natural Resources and Wildlife.

Professor Mamokgethi Setati is the first black South African woman to receive a PhD in mathematics education. Her research focuses on improving teaching and learning in mathematics in multilingual classrooms. She is the founder of the National Association for Mathematics Educators in South Africa. She is a mother. In 2004 she was awarded a research grant from the NRF for the best junior black researcher in SA. She was promoted to professor at Witwatersrand University in 2004

Professor Lydia Makhubu was the first woman in Swaziland to earn a PhD. She is the Vice-Chancellor of the University of Swaziland and a Professor of chemistry, as well as the President of the Third World Organisation for Women in Science. She has been on the Executive Board of UNESCO, the Dag Hammarskjold Foundation and the Board of Trustees of the International Foundation for Science. She also holds the UNESCO chair for Women in Science in Africa. Her research focused on medicinal plants of Swaziland, in particular a plant called Endod and its effects of Schistosomiasis, or Snail Fever, which is a fatal parasitic disease. Because of her work ways of controlling the disease have been implemented.

Professor Grace Alele-Williams is a Professor of mathematics education from Nigeria. She was the first Nigerian woman to be awarded a PhD (this was in 1963). She studied at Queen's College, Lagos, University of Ibadan, University of Vermont and University of Chicago. She was the first female Vice-Chancellor of a Nigerian university in 1985 when appointed the VC of the University of Benin. She has published widely on the subject of mathematics education, taught at a number of universities, in the United States and in Nigeria, and she is the Vice President of the Third World Organisation for Women in Science.

A woman scientist Unseen: Rosalind Franklin

"The most obvious example of patriarchy and social closure is that of Rosalind Franklin. Franklin played a key role along with James Watson, Francis Crick and Maurice Wilkins in the discovery of DNA, yet Crick and Watson became highly successful academics while Franklin remained in obscurity until her death from cancer at the age of 37. Anne Sayre, her biographer, shows how Watson and Crick effectively stole Franklin's results, failing to acknowledge her contribution and ensuring she did not receive recognition (Sayre, 1975)" (Bebbington, 2002).

Born in 1920 in London, Rosalind Franklin went to one of the only girl's schools in London that taught physics and chemistry and although she wanted to be a scientist her father thought she should be a social worker and didn't believe in higher education for women. She eventually persuaded him and went to Newnham College, Cambridge in 1938, graduating in 1941. After holding a graduate fellowship for a while she went to the British Coal Utilization Research Association, completing her doctorate in physical chemistry in 1945. She then worked for three years in Paris and learned X-ray diffraction techniques. In 1951 she returned to London to Kings College where she worked in John Randall's laboratory, and where she came across Maurice Wilkins, (who was to jointly win the Nobel Prize 1962 with Francis Crick and James Watson for the double helix model of DNA). The story of Rosalind Franklin's involvement in the discovery of DNA is told very differently by Watson in his book The Double Helix and Sayre's biography of her. The story seems to be that she came very close herself to solving the structure of DNA, but that she was beaten to publication by Watson and Crick, who acknowledged using aspects of her own research. None of this has ever been shown for certain, but it is clear that she was a brilliant scientist, and that she never received credit for her work. She died young of ovarian cancer, five years before Watson, Crick and Wilkins received the Nobel Prize. She may have received the Nobel Prize jointly with them had she lived. It is also not known how strong the link was between her cancer and her X-ray research, as the links between these two were not well established at the time. (from San Diego Supercomputer Centre site on women in science)

Focus on women who have won the Nobel prize for chemistry, physics and medicine/physiology

The Nobel prize for science has been in existence since 1901 and since that time, a total of 476 people have received the prize for either physics, chemistry or medicine/physiology. Of these people only 12 prizes have gone to women. Although you may know of very few people who have received nobel prizes for science they are an extremely high achievement in the science world, so it is notable that only 0.02% of nobel prizes for science

have gone to women. It is also notable that only two Physics prizes and three Chemistry prizes went to women. Seven women have won prizes in the Medicine/Physiology category.

The following are profiles of the eleven women who have won a Nobel Prize, (eleven because Marie Curie won a Nobel Prize on two occasions). The biographical detail is taken primarily from the Nobel Prize website.

Marie Curie: Nobel Prize for Physics (1903 – received jointly with Pierre Curie and Henri Becquerel) and Nobel Prize for Chemistry (1911).

Marie Curie is possibly the world's most famous woman scientist. She was born in Poland but went to Paris to study at the Sorbonne, where she met her husband Pierre, who was a physics professor. Following his death in 1906 she became Professor of General Physics and later Director of the Curie Laboratory in the Radium Institute of the University of Paris. She worked under difficult laboratory conditions, and had to teach a great deal. Henri Becquerel discovered radioactivity in 1896, and this inspired the Curies in their great research, which led to the discovery of Polonium and Radium. During the first World War Marie Curie devoted herself to using radium to alleviate suffering. She was recognised and admired during her lifetime, received numerous awards, and is still revered as one of the most important scientists ever to have lived. She did, however, have to struggle a great deal to obtain research funding and support, particularly after the death of her husband. She died of leukaemia in 1934 at the age of 67. Her life story is one of great courage and determination.

Irene Joliot-Curie: Nobel Prize for chemistry (1935 – received jointly with Frederic Joliot)

Irene Joliot-Curie was the daughter of Marie Curie, born in Paris in 1897 and was married to Frederick Joliot. She served as a nurse radiographer during the first world war, which interrupted her studies in science in Paris. She received a doctorate in Science in 1925, on the alpha rays of polonium. Their nobel prize was received for their synthesis of new radioactive elements. She was appointed a lecturer in 1932 in the Faculty of Science, in 1937 a Professor and later Director of the Radium Institute in 1946. She was a member of the Comite National de l'Union des Femmes Françaises and of the World Peace Council. She was appointed Undersecretary of State for scientific research in 1936 and was a member of several foreign academies and scientific societies, and had a number of honorary doctorates. She died in Paris in 1956. She was survived by a daughter and a son.

Gerty Cori: (Nobel Prize in Physiology or Medicine, 1947 – received jointly with Carl Cori and Bernardo Houssay)

Gerty Cori was born in Prague in 1896 and studied at the German University of Prague, receiving a doctorate in medicine in 1920. In 1922, She emigrated to America with her husband Carl. They had one son. She was made a Professor of Biochemistry in 1947 at St. Louis. The Coris collaborated in much of their research work and wrote many articles together. Their studies in biochemistry included work on the effects of insulin and epinephrine, work on carbohydrate metabolism, the pituitary gland and the enzymatic synthesis of glucose and starch. She received numerous honorary doctorates, awards and medals. She died in 1957.

Maria Goeppert-Mayer: (Nobel Prize for Physics, 1963 – received jointly with Eugene Wigner and J Hans D Jensen)

Maria Goeppert-Mayer was born in 1906 in Germany and on her father's side was the seventh straight generation of university professors. When she was four, the family moved to Gottingen where her father was a professor of Paediatrics and this is where she grew up. It was difficult for women to gain access to university as the only school at the time where women could write the "abitur" (the preparatory exam for university entrance) had closed down. However, she was taught by the teachers from the school and took the abitur in 1924. She initially studied mathematics but became interested in physics. Her academic career centred around Gottingen with a short spell at Cambridge. She passed her doctorate in theoretical physics in 1930 with three nobel prize winners on her doctoral committee. She spent time in the USA with her American husband (a Rockefeller fellow) between from 1930, but for many years was unable to find adequate scientific work, until in 1946 they went to Chicago and she became a professor in the Physics Department. She developed into a chemical physicist. She also wrote several papers with her husband, also a professor. The nobel prize was awarded for their discoveries concerning nuclear shell structure. She died in 1972.

Dorothy Crowfoot Hodgkin: (Nobel Prize for Chemistry, 1964)

Dorothy Hodgkin was born in Cairo in 1910 where her father worked. He later moved to the Sudan as Director of Education and Antiquities and on retirement worked in archaeology. Her mother was also an archaeologist and botanist. She spent her childhood predominantly in England with her sisters where she went to school. She and one other girl were allowed to join the boys doing chemistry at school, and she decided to study chemistry at university. She went to Oxford and Somerville College from 1928 to 1932, initially combining archaeology and chemistry, but eventually deciding to do research in x-ray crystallography. After Oxford she spent two years at Cambridge, returning to Oxford in 1934, where she remained for most of her working life. She became a university lecturer responsible for teaching chemistry for the women's colleges initially; then a university lecturer in 1946; reader in x-ray crystallography in 1956 and Wolfson Research Professor of the Royal Society in 1960. She studied penicillin and B12 using x-ray diffraction for which work she received great acclaim. Her nobel prize was awarded for her work on vitamin B12. She received a number of awards and was Fellow of the Royal Society from 1947, and a member of the Royal Netherlands Academy of Sciences from 1956, the American Academy of Arts and Sciences from 1958, and the USSR Academy of Sciences (1976). In 1969 she discovered the structure of the protein insulin. She married historian Thomas Hodgkin in 1937, a specialist on African studies and they had three children. They lived for some time in Ghana where her husband was Director of the Institute of African Studies. She died in 1994 after a stroke.

Rosalyn Yalow: (Nobel Prize in Physiology or Medicine, 1977 – received jointly with Roger Guillemin, and Andrew V Schally)

Rosalind Yalow was born in 1921 in New York City, where she has spent most of her life. Her parents came from European immigrant families and were not high school educated. She, however, received an education and went to college. She studied physics, although her parents wanted her to be a school teacher. She was encouraged by her professors to continue with physics at Hunter College in New York. She obtained a part-time position as a secretary for a leading biochemist at Columbia university, as a backdoor entry into postgraduate studies, but she had to agree to take stenography! She then took up a teaching assistantship at the University of Illinois, as the only woman in the College of Engineering amongst 400 staff members. She met her husband Aaron Yalow at graduate school. He was also studying physics. In 1945 she received her PhD in nuclear physics. After the war they returned to New York and both moved into medical physics. In 1950 she met Dr Solomon Berson who she worked with for 22 years, and who would have shared the nobel prize with her, had he lived. She and Aaron had two children. Rosalyn was famous for her work in endocrinology with insulin, using Radioimmunoassay (RIA), a technique that allows the study of small amounts of different substances in the blood by tagging them with radioactive tracers. She has received many honours for her work including over 50 honorary doctorates.

Barbara McClintock: (Nobel Prize in Physiology or Medicine, 1983)

Barbara McClintock was a great plant geneticist, born in Connecticut, USA in 1902. She went to school in New York, and received all her degrees from Cornell University. When she attended her first course in genetics in 1921 it was not yet an accepted discipline and there was some reluctance amongst biologists to accept genetic concepts. She was invited by Professor Hutchison, a professor in the Dept of Plant Breeding at Cornell, to attend the undergraduate genetics course there. She became fascinated by cytogenics, the study of chromosomes and their contents. She obtained her PhD in 1927, and remained at Cornell to study the chromosomes of maize. She became famous for her theory that genes are transposable on and between chromosomes through her studies of mutation in maize kernels. She never married. Most of her working life was spent at Cold Spring Harbor laboratory in New York. She continued her studies in this area for the remainder of her working life. She received many awards and honorary doctorates. She died in 1992.

Rita Levi-Montalcini: (Nobel Prize in Physiology or Medicine, 1986 – received jointly with Stanley Cohen)

Rita Levi-Montalcini was born in Turin, Italy with her twin sister Paola. Her parents were an engineer/mathematician and an artist. Although they had a rich childhood, their father believed that careers for women interfered with their roles as wives and mothers, and so they were not to enrol in university. However, Rita managed to persuade her father to allow her to study medicine. She graduated from medical school in 1936 summa cum laude and enrolled in the three-year specialist programme in neurology and psychiatry. However, in 1936 Mussolini issued the "Manifesto per la difesa della Razza" and subsequent laws barred non-Aryan Italians from academic and professional careers. Instead of emigrating to the USA, her family decided to stay and she built a small laboratory at home. During the war

she was forced to move around a great deal until working in Florence in 1944 as a medical doctor. After the war she resumed her academic positions at the university in Turin. In 1947 she was invited to St Louis, where she stayed until 1977, dividing her time between St Louis and Rome. She received the Nobel Prize jointly with Stanley Cohen for their discovery of Nerve Growth Factor (NGF) and Epidermal Growth Factor (EGF), which helped in the understanding of the mechanisms regulating cell and organ growth.

Gertrude B Elion: (Nobel Prize in Physiology or Medicine, 1988 – received jointly with Sir James W Black and George H Hitchings)

Gertrude Elion was born in New York City in 1918. She had a Lithuanian immigrant father and Russian mother. Her father was a dentist. She went to a good public school in the Bronx. Her grandfather died of cancer when she was 15 and this motivated her to study something that might lead to a cure for the disease. She entered Hunter College in 1933, and decided to major in chemistry. Because of the depression and discrimination against women in the sciences she was not able to go on to graduate school an so got an unpaid job as a laboratory assistant for a chemist. After saving her stipends she went to graduate school at New York University in 1939. She was the only woman in her graduate chemistry class. While studying she taught chemistry, physics and science at New York City schools. She obtained her M Sc in 1941. After a number of laboratory jobs she obtained a research assistant position with Or. George Hitchings and developed from an organic chemist into working in microbiology, biochemistry, pharmacology, immunology and eventually virology. After some years of doing a doctorate part-time, she made the decision to give up her doctorate and continue with her job. She later received a number of honorary doctorates! Her research focused on nucleic acid biosynthesis and the enzymes involved with it, and she concentrated on the purines. Eventually her work and that of her colleagues led to new drugs addressing real medical needs. She became head of department at the Wellcome Research laboratories in 1967, a position she held until 1983. She was associated with the National Cancer Institute from 1960, the American Cancer Society, the World Health Organisation and was a member of numerous academic societies. After her retirement from the Wellcome laboratory, she became a research Professor of Medicine and pharmacology at Duke University. Gertrude Elion invented the leukemia-fighting drug 6-mercaptopurine in 1954. Her research led to the development of Imuran, a drug that aids the body in accepting transplanted organs, and Zovirax, a drug used to fight herpes. Including 6-mercaptopurine, her name is associated with 45 patents. She never married.

Christiane Nusslein-Volhard: (Nobel Prize in Physiology or Medicine, 1995 – received jointly with Edward B Lewis and Eric F Wieschaus)

Christiane Nusslein-Volhard was born in 1942 in Germany. Her father was an architect and his father a professor of medicine. They lived in Frankfurt and she was encouraged in her academic pursuits by her parents. She knew very early on that she wanted to be a biologist as she was interested in animals and plants. When she finished high school she considered becoming a doctor, but after working in a hospital for a short while, decided against it. She started biology at Frankfurt university, but became drawn into physics and then moved into biochemistry at Tubingen University. She also became interested in microbiology and genetics. As a graduate student she worked in a chemistry laboratory on DNA sequencing techniques and developed a new method for large scale purification of very clean RNA polyamerase. She finished her thesis in 1973 as a molecular biologist. In 1975 she went to post-doctoral research in Basel working in genetics with Drosophila (flies). She won the nobel prize for her work in identifying genes that affect the development of the fruit fly. Their findings led to a better understanding of how a single fertilized egg develops into a complex multicellular organism. This has application in explaining congenital defects in humans. She is currently director of the Max-Planck Institute for Developmental Biology and has become involved in projects encouraging and supporting women in science.

Linda B Buck: (Nobel Prize in Physiology or Medicine, 2004 – received jointly with Richard Axel)

Linda Buck, the most recent winner of the Nobel Prize for Physiology or Medicine was born in 1947 in Seattle, USA. She studied at the Universities of Washington and Texas, going on to work at Columbia University and then Harvard. She has received numerous awards and honours. Her expertise and research interests are in the area of sensing of odors and pheromones. The work of Linda Buck and Richard Axel was the first to define in detail one of our sensory systems, by defining the genes and proteins that control olfactory response. She currently works at the Fred Hutchinson Cancer Research Centre.

The Nobel Prize and Sub-Saharan Africa

It is interesting to note that there have been five winners of the Nobel Prize in Science who are originally from Sub-Saharan Africa. They are all men and they have all been linked to universities either in the UK or the USA, where they have spent most of their careers. Aaron Klug for chemistry in 1992; Max Theiler for Physiology/Medicine in 1951; Alan Cormack for Physiology/Medicine in 1979 (co-inventor of the CAT scanner); Sydney Brenner for Physiology/Medicine in 2002 (all originally from South Africa).

Activity 4.1 Nobel prizes and role models

1 Hand copies of the brief biographies of women Nobel Prizewinners out to all participants and ask them to reflect on the numbers of women as well as the dates of their awards. Why do you think the majority of awards are concentrated in the latter half of twentieth century and early twenty-first? See if the group can come up with (at least) five reasons.

2 Ask the group to identify some of the differences between the stories of these Nobel Prize winners? What are the reasons for these differences? Discuss some of the trends that you notice about their lives? (e.g. the majority received the award jointly; some worked closely in their research with their husbands or partners). Write these observations up on the board or flip chart.

3 As an additional exercise, divide participants into small groups. Give out the list of African women scientists and comment briefly on it. Then ask each group to produce a list of 10 women scientist role models from their own country or local area. The method of dividing the groups will depend on where they come from. Give each group a piece of card, which should be put up afterwards. Each group should report back on their chosen role models, so that groups can share ideas. There should be some discussion on where information can be obtained on these individuals, so that the group can do their own research when they leave the workshop.

Reflecting on the workshop

The next activity is an opportunity to reflect on what has been discussed so far during the workshop.

Activity 4.2 Reflecting on the workshop

1 Divide the group into groups of 4 or 5 people. Display as many of the flip charts from the workshop around the room.

2 Ask the participants to discuss in their groups their views about women in science.
- Have their views changed or remained the same?
- What have they learnt?
- What further information do they require?

This should be recorded on a flip chart.

3 Ask the groups to reflect on the discussions and activities in topics 1-3. What tools do they have, from the discussions, that can be used in advocacy work? Each group should keep a record of their list of tools.

4 A third discussion for the group, which will lead them into the other modules is to ask them to discuss how biographical material can be used for advocacy and role-modelling work? The kinds of uses will depend on whether the group are teachers, curriculum developers, education managers etc.

Groups should record all their ideas, so they have a list of suggested activities at the end of the session. E.g. teachers may design a quiz based on the female winners of the Nobel Prizes in Science; education managers may discuss a series of key questions about the lives of female scientists – the influence of their fathers, teachers, husbands, or their exclusion from scientific communities. This, however, requires quite detailed biographical information which is not really available in this unit.

RESOURCES

Further information can be obtained from the following websites. Note that web pages and their URLs are constantly changing; these links were live at the end of 2005:

Organisations and projects: (relating broadly to women and girls in education)

Unicef girls education *www.unicef.org/girlseducation*

Jomtien conference site
http://www.unesco.org/education/efa/ed_for_all/background/world_conference_jomtien.shtml

Beijing Conference *http://www.un.org/womenwatch/daw/beijing/*

United Nations Girls Education Initiative *www.ungei.org*

Campaign for Female Education *www.camfed.org*

Beyond access project: *http://ioewebserver.ioe.ac.uk/ioe/cms/get.asp?cid=7746*
Has produced the Scorecard on Girl's Education in the Commonwealth

World bank site (OVC toolkit)
http://info.worldbank.org/etools/docs/library/108875/toolkit/index.htm

Girl's Education Movement (GEM): *www.gem.gov.za*

Global Monitoring Report: gender and education for all 2003-2004
http://portal.unesco.org/education/en/ev.php-URL_ID=23023&URL_DO=DO_TOPIC&URL_SECTION=201.html

Global Monitoring Report: gender and education for all 2005
http://portal.unesco.org/education/en/ev.php-URL_ID=35939&URL_DO=DO_TOPIC&URL_SECTION=201.html

Education For All site: *http://www.unesco.org/education/efa/index.shtml*

Quality Education for Social Transformation (QUEST). A project that focuses on both literacy issues and training teachers in issues of sexual maturation in Uganda, Kenya and Zimbabwe. Substantial research findings available online *www.questafrica.org*

Organisations and projects: (mainly specific to women in science)

TWOWS: Third World Organisation for Women in Science *www.twows.org*

FEMSA: Female Education in Mathematics and Science in Africa, a project of FAWE (Forum for African Women Educationalists) *www.fawe.org/femsa/*

SA-WISE: South African Women in Science and Engineering *www.sawise.org.za*

SARG: South African Reference Group on Women in Science *www.sarg.org.za*

SAASTA: South African Association for the Advancement of Science and Technology; promotes public understanding of science *www.saasta.org.za*

The Nobel Prize: the official site of the Nobel Prize *www.nobelprize.org*
This site provides detailed biographic information of all nobel prize winners, details about the history of the prizes as well as a number of scientific games, which have been developed to encourage interest in science amongst young people.

UNESCO: There are a number of sites within the UNESCO portal that are of use to those interested in women and science. e.g. UNESCO Bangkok, UNESCO project on Women in science in Africa, the Education for All Site. *www.unesco.org*

GENIA Toolkit: *http://www.unescobkk.org/index.php?id=322*

Women in Global Science and Technology *www.wigsat.org*

Gender Advisory Board – UN commission on Science and Technology for Development
http://gab.wigsat.org

Gender in Scientific, vocational and technological education. UNESCO project site:
http://portal.unesco.org/education/en/ev.php-URL_ID=7865&URL_DO=DO_TOPIC&URL_SECTION=201.html

World bank OVC toolkit:
http://info.worldbank.org/etools/docs/library/108875/toolkit/index.htm

Sites providing historical material and biographical detail on women scientists:

4000 years of women in science: biographies of women scientists.
From University of Alabama, USA *www.astr.ua.edu/4000WS/4000WS.html*

Some women's biography sites:
www.home.earthlink.net/~sharynh/WBSMT.htm
www.math.buffalo.edu/mad/PEEPS/madprofiles.html
www.cwp.library.ucla.edu/ an archive of women physicists of the 20th century.
www.sdsc.edu/ScienceWomen/ 'Women in Science', San Diego Supercomputer Centre, (1997)
www.fhwa.dot.gov/wit/page1.htm American women in transportation

Air, Space, Science, and Math: Women in Science and Technology. A history of women in science and technology, including scientists, mathematicians, pilots, astronauts, inventors, and more *http://womenshistory.about.com/od/airspacesciencemath/*

Links to bibliographies and academic material about women in science:

Gender, Science and Technology: an International Bibliography:
www.wigsat.org/bib.html
www.womenshistory.about.com/library/bio/blbio_list_science.htm

Smithsonian, women in science bibliography:
www.sil.si.edu/SILPublications/womenshistory-2000.htm

Association of American Colleges and Universities: women and scientific literacy resources:
www.aacu-edu.org/womenscilit/bibliographies.cfm

Gender and Science digital library:
www.gsdl.enc.org/

World Bank gender statistics site:
www.genderstats.worldbank.org/home.asp

EXPLANATION OF KEY TERMS

Advocacy:

Advocacy is the support of and promotion of a particular cause. Advocacy is used here to refer to the process of promoting the cause of encouraging more women to go into science, as well as lobbying for the barriers for women in science to be removed.

Gender:

Gender is a term used to describe the interpretation of and manifestation of sex roles and the differences between men and women that are culturally and socially determined. It is often contrasted with "sex" which refers to the biologically determined difference between men and women. Gender is a concept that encompasses both identity issues and social and cultural ideas about men and women.

Sex-disaggregated data:

Gender-disaggregated data or sex-disaggregated data (often used interchangeably) is information provided in a form that shows figures for men and women separately. In this way it is possible to identify gender or sex inequality wherever demographic data is provided and to identify

patterns of the different experiences of men and women. With a growing emphasis on building gender equity in all spheres of life, there have been increasing calls for the provision of sex-disaggregated data whenever possible. Having sex-disaggregated data is extremely important for understanding development priorities, research and policy-making processes.

Science:

Science is used here to incorporate the broad areas of the natural and hard sciences, engineering and technology. It does not refer to science as academia broadly, and therefore excludes the humanities, arts and social sciences. When referring to school level study, science includes both science and mathematics.

Gender analysis:

This is analysis that takes into account the social and cultural differences between men and women. It is a strategy of looking at something from a gender perspective by analyzing a policy, project, or even text and saying "what does this say about gender issues or relationships? And how might this affect men and women differently?" These are the kinds of questions involved in gender analysis. It also involves the collection of sex-disaggregated data.

Gender mainstreaming:

This concept refers to bringing gender viewpoints into mainstream of society. It is a strategy of including gender equity in policy making processes, considering the implications of a project or policy for men and women, as well as implementation and monitoring of policies and projects – the goal being the achievement of gender equality. It is not about adding a women's component to something, but rather about incorporating gender concerns into mainstream processes.

Feminism:

Feminism is a doctrine that advocates equality between men and women in all spheres of life. It is also a form of social movement. Early feminism is identified as starting in the early part of the twentieth century and was focused primarily on equality in politics and the law, particularly on the right of women to vote. The suffragette movement is an example of an early feminist movement. "Second wave" feminism is recognised as starting in the 1960s and has focused in more depth on social and economic inequalities between men and women. Much of the discussion around women's involvement in science is a result of second wave feminism. As with all social movements feminism is a developing doctrine, and feminists may hold different views in different social and political contexts, but the essence of feminism is a belief that men and women are and should be equal in all aspects of human life. Early feminism could be said to have started in the Western/developed world, but feminist movements exist in all parts of the world.

Academia:

Academia refers to the community and activities of the world of higher education and research.

Gender Equality:

Gender Equality refers to the idea that opportunities and life chances for women and men should be the same. Women and men should have equal access to opportunities and resources in all areas of human life. Gender equality is the state of being equal, while gender equity refers to the process of treating men and women equally.

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Unit Two

TRAINING & SUPPORTING TEACHERS

Rationale

This unit lays the foundation for more focused later units. It looks broadly at the issue of under-achievement of girls and encourages analyses of the local situation by developing, with participants, a toolkit that will enable them to do it. The unit also examines science curricula from the female viewpoint and asks how they might be made more attractive; this will then be examined in more detail in unit 5. Finally the unit looks broadly at how career education may be structured, or restructured so that it might better serve the interests of girls and this will lay the foundation for further work mainly in unit 3.

The detailed methodology and outcomes of this unit and will depend on the roles and responsibilities of the participants. The topics in this unit are suitable for a wide variety of educational personnel. They may be school staff such as principals, administrators, science or guidance teachers. They may be curriculum or materials developers, teacher educators or teacher support staff, inspectors or policy makers. While all topics are sufficiently general to be appropriate for all these groups, the detailed methodology and expected outcomes will differ and facilitators should adapt the materials appropriately to meet the needs of the participants.

Unit 1 is an pre-requisite for this unit; in particular, it will be assumed that the concept of a gender lens is largely understood.

Target groups

All involved in science and mathematics education and careers education.

Learning outcomes

By the end of this unit participants should

- be able to analyse enrolment and performance statistics at all levels within the system to pinpoint gender disparities;
- be able to analyse the performance of educational institutions and elements of the educational system for gender imbalances that might have a negative impact on the enrolment and performance of girls in science related subjects;
- be able to identify some of the main impediments in their own schools that inhibit access to, and performance in, science subjects by girls;
- be able to develop an instrument for evaluating the effectiveness of a career guidance service.

Contents

Items to bring to the workshop

Participants should be asked to bring the following information to the workshop. They may not be able to do so and therefore it is important that facilitators have back-up information and documents that may be used instead

- Statistics related to the enrolment and performance in science subjects in their institution(s) disaggregated by gender (see topic 1 for further details).
- Details or policy and administration issues in their institution that may affect uptake of, and performance in, science in their institutions (see topic 3 for further details).
- Details of the content, scope and needs of careers education offered in their institution(s).

Topic 1 HOW BIG IS THE PROBLEM?

In this topic participants will be asked to compare the enrolment and success of girls in schools and in science programmes. They should be encouraged to look at the performance of the country, regions within the country, and individual schools, and compare these with other countries. The workshop session could begin with a short presentation that 'sets the scene' based on the kind of information below.

Mention was made in the Unit 1 of the *Millennium Development Goals* (MDGs) set by the international community which are targets to be met by 2015. Two of these goals directly affect the education of girls; universal primary education and the promotion of gender equality [16]. In this module we are concerned mainly with the proportion of girls enrolled in secondary education and their performance and subject choice.

Table 2.1 shows the *gross enrolment ratios* (GER) [17] and the *gender parity indices* (GPI) [18] for the World's main regions in the 2002/3 school year. More recent figures may be found on the UNESCO Statistics website [19].

[16] For more information see the references list at the end of this unit and www.unmillenniumproject.org/reports/tf_education.htm
[17] The gross enrolment ratio is the number of children enrolled divided by the number of school age in the phase, expressed as a percentage. It can often be greater than 100% because many children that are enrolled are over the 'normal' school age for the phase.
[18] The gender parity index is the ratio of female to male students enrolled for a particular programme or phase. If all children are at school, it will be slightly more than 1 as slightly more girls are born than boys. The figure of 0.85 for Africa means that, taken over the whole continent, for every 100 boys there are at school, there are only 85 girls.
[19] www.uis.unesco.org

Table 2.1 Secondary enrolment by region and sex

	Secondary gross enrolment ratio			
Region	*All*	*Male*	*Female*	*GPI*
Africa	37	40	34	0.85
North America	84	84	85	1.01
South America	97	93	100	1.07
Asia	61	54	58	1.07
Europe	104	104	107	1.02
Oceania	111	111	111	1.00

Table 2.1 shows that the Africa region (which includes north Africa) has the lowest secondary enrolment of all regions and also (by a large margin) the lowest proportion of female students.

The UNESCO statistics show a very wide variation in these figures between countries in sub-Saharan Africa, from below 10% to above 90% GER. Also evident from the statistics is that no country has managed to achieve a GPI of 1.0 without first ensuring that it has achieved almost universal primary education. Universal primary education therefore seems to be a key prerequisite for improving entry of women into secondary science programmes and into scientific careers. Practical steps to achieve universal primary education is discussed at length in the MDG reports referred to above.

The main activity for this topic is to gather and analyse national, district and local (school) statistics to shed light on how great the barriers are that girls have to overcome in order to succeed in science subjects at school and enter scientific careers. Facilitators should try and collect useful statistics on secondary enrolment, enrolment in science subjects and mathematics and proportions passing leaving examinations in science and mathematics, all disaggregated by sex. Participants should also be asked to bring such information for their institution to the workshop.

A suggested list of *sex-disaggregated statistics* to be brought to the workshop could be the following, but this is not an exclusive list. They should be national statistics, district statistics (i.e. statistics referring to the administrative region that the workshop is serving) and individual school statistics.

- GER and/or numbers enrolled in each grade
- numbers, or proportion enrolled in science and mathematics subjects
- numbers or proportion passing exit exams in science[20].

This topic is intended to serve several useful purposes:

- to provide participants with an understanding of the scale of the problem
- to identify areas where information is lacking and to generate strategies to remedy this so that the uptake of science subjects by girls can be more carefully monitored in the future
- to identify the main obstacles in the system that result impede the progress of girls in science subjects and, if possible, prioritise them.

[20] Some countries no longer recognise pass/fail grade boundaries. In such cases, the grade boundary should be taken as that required for the student to progress to further education in science or mathematics, often around grade C or D.

Note that it is *not* the intention of this topic to propose solutions although participants may wish to discuss these; solutions will be developed in later topics and units. It is likely that this analysis will bring to light a number of disparities in the system. Typical statements that might emerge from the session are:

- the enrolment of girls in secondary education is lower than the enrolment of boys
- the enrolment of girls in science courses at secondary school is lower than boys
- girls do less well than boys in science programmes
- girls tend to opt for biological programmes and not the physical sciences
- girls do very much better in sciences in some schools than others
- etc.

Each of the statements that emerge from this workshop will require different strategies if they are to be addressed. The remaining topics in the workshop will look at possible causes of the disparities identified and develop strategies for addressing them at different levels in the system.

Activity 1.1 Identifying the major gender-related issues in educational statistics

Participants will work in groups. The facilitator should consider how best to divide the participants in order achieve the desired results. This will depend on the roles and responsibilities of the participants; in general groups should work on statistics that are of greatest interest to them and their institutions. So a group of teachers should consider mainly school statistics while a group of inspectors might more usefully examine area statistics, etc.

Available statistics should be collected in advance of the session and duplicated in sufficient quantities. It is also always useful to distribute statistics the day before the session to give participants time to digest them.

1 Divide into groups and distribute copies of available statistics if this has not already been done.
2 Ask the groups to analyse the statistics to find out what they show about the enrolment of girls and their success in science-related subjects, and identify the following:
   - areas where information is lacking
   - the main issues that should be examined if girls are to emerge from secondary school with good science qualifications in larger numbers.
3 Ask each group to list their findings and report back to a plenary
4 List the major issues emerging from the discussions. Prioritise the issues in order of significance or identify those which, in the view of the group, might be classified as key issues that should be addressed first.

Note that some participants may have little experience in analysing statistics and some groups may require some assistance. Demonstrate the process by helping them to draw one simple conclusion from them.

Topic 2 LOOKING AT YOUR INSTITUTION THROUGH A GENDER LENS

Participants may come from a number of different institutions. This topic encourages them to look at their institution through a 'gender lens'. Many participants may work in schools but some may be from teacher education institutions and others from educational administration offices and the gender lenses for each will be different, reflecting their different functions and ways of operating. The concept of a gender lens has been developed in topic 1.4. In this topic, participants are first asked to make their gender lens and then to examine their institution through it.

Refer the participants to Module 5 of this series in which trainees were encouraged to look, in particular, at schools and teaching through a gender lens. It was pointed out there that although schools may superficially appear to be gender neutral, a closer look often revealed hidden gender messages because schools tend to reflect the attitudes and behaviour patterns of the societies they serve. As Unit 1 has shown, these attitudes and behaviour patters are often far from being gender neutral; they often place a disproportionately high value on attitudes and behaviour that is considered masculine behaviour and promote gender roles that are often discriminatory towards women. Making and then using a gender lens instrument can help the workshop participants firstly to recognise those societal norms that may be reflected in the operations of the institution that are discriminatory and secondly to identify discriminatory practises within the institution.

A good gender lens should not be too complex but should encompass as many facets of the functioning of the institution as possible. The boxes in Unit 1 Topic 4 and on the Resource CD show examples developed at UNESCO workshops in Thailand and published on the UNESCO Bangkok website [21].

In the next activity participants will develop their own gender lenses that are designed specifically for the institutions in which they work. These instruments should address the functions of the institution but with a particular focus on those functions that are particularly relevant to the participation of girls in science based activities. Thus a question about whether school timetabling allows equal access to all subjects to boys and girls might be phrased in terms of equal access to all science and mathematics subjects.

Note; it is probably not a good idea at this stage to give out examples such as the ones mentioned above as this could influence their thinking unduly. These examples can be used by the facilitator to point out gaps

[21] UNESCO Bangkok GENIA toolkit, www.unescobkk.org

Activity 2.1 Developing a gender lens to analyse educational institutions

1 Remind the participants of the work done on gender lenses in Unit 1, Topic 4. Remind them of the purpose of such instruments and of their characteristics. Show some examples of gender lens instruments (but not at this stage, ones that have been developed for looking at institutions.)

2 Ask them to work in groups. The groups must be made up of people from similar institutions; a college, a school, a ministry regional office, etc. Ask each group to prepare a gender lens that could be used to analyse the functioning of their institution for gender equality. They should limit to lens to a small number, perhaps 10, of the most important issues and try and make the focus of the issue relate to girls and science.

3 In a plenary session, combine the points made by each group that is looking at similar institution to make one agreed instrument for each kind of institution.

Activity 2.2 Looking at an institution through a gender lens

The first step of this activity could be done by individuals as an evening exercise.

1 Ask participants to work individually (or in groups from the same institution) with the agreed gender lens and evaluate their own institution. Ask them to prioritise those elements of the activities of the organisation that raise the most serious gender problems and write the three (this number can be determined by the facilitator) most significant issues on cards

2 In a plenary session participants pin the cards on a board. They should pin their cards close to other cards noting a similar issue. The facilitator can help sort the cards into groups around similar issues as they are pinned up. The product will be a large number of issue statements grouped around common themes

3 Select the most important of the themes as determined by the number of cards devoted to it and debate it in plenary. Note down a solution, or a number of tentative solutions that might address the issue. Repeat this with all the issues, or with the more significant ones.

An alternative mechanism for this would be to divide the group into task groups, each of which would address one (or possibly more than one) of the issues and develop tentative solutions. This mechanism would be faster but would not have such a large number of people addressing each problem.

The products of these two activities are important workshop outputs and the facilitator should ensure that both the gender lenses and the issues and tentative mechanisms for addressing them are captured for later use. A number of the issues raised in this activity will be examined in greater depth in topics below.

Topic 3 HOW CAN SCIENCE BE MADE MORE ATTRACTIVE TO GIRLS?

> 'Increasing girls' educational attainment is essential to fulfilling education's potential for positive social transformation. Education is the key intervention for increasing inclusion of women in decision-making in public life, as well as empowering them within the home and the workplace. Given the barriers to girls' education, specific interventions are needed to make schools more accessible and secure for them.'
>
> (MDG Education task force report [22])

This quotation could be displayed and read. After getting some idea of the extent of girls' under-achievement in science, and looking at how sensitive to the issues are the institutions involved in all aspects of planning girls' education, the attention of the group should turn to school structures and procedures and focus on barriers that these might be (inadvertently) placing in the way of girls achievement in science. The group must also consider the messages that some of these structures might subliminally, or overtly, be passing on to girls – like offering a choice on the curriculum between, say, home economics and technology.

Increasing access to education for girls

Providing female teachers for girls may address some security concerns, as well as provide positive role models. International cross-sectional data suggest some positive correlation between gender parity in enrolment and the proportion of female teachers (Herz and others 1995). Qualified female teachers, however, are in short supply.

Schools need to be safe places for girls. Girls need to be protected against harassment from male peers and predation by male teachers. The problem is a serious one: in Cameroon 27 percent of girls surveyed reported having had sex with teachers. Changing this pattern of behaviour involves significant cultural changes.

Decreasing the distance to school raises girls' enrolment and attendance by assuaging their concerns about safety and reputation. Research in such diverse places as Ghana, India, Malaysia, Peru, and the Philippines indicates that distance matters for all children, especially for girls. Providing schools in local communities substantially increased enrolments in Egypt, Indonesia, and several African countries. The impact is particularly pronounced for girls. In Egypt, for example, following a campaign to construct rural primary schools, girls' enrolment grew by 23 percent, while enrolment of boys rose 18 percent.

Girls and their families may find little reason to attend school if they are taught that girls are of less value than boys or if they are tracked into fields of study or low-paid occupations considered traditional for women. Analyses of textbooks in Africa, Asia, and the Middle East consistently find stereotyped material, with women portrayed as subordinate and passive while men are shown as displaying intelligence, leadership, and dominance. Many developing countries also practise gender streaming in secondary school, directing girls away from math and science. Teaching practises – such as giving boys more opportunities than girls to ask and answer questions, use learning material, and lead groups – may further discourage girls. Several countries in Africa and Asia are beginning to use gender sensitivity training for teachers and administrators to encourage girls' participation.

[22] See reference list, MDG Education task force report - Towards Universal Primary Education; Investments, incentives and Institutions

> The opportunity costs for girls' education that arise from their heavy burden of household chores can be addressed in a variety of ways. Some measures reduce the need for girls' work by establishing day care centers and preschools for younger siblings or students' children or improving the supply of accessible water and fuel. Others – such as flexible school schedules – enable girls to pursue an education while assuming household responsibilities. Takehome food rations for the families of girls in school can offset the loss to the household of the girls' labor. Flexible schedules, double sessions, and evening school hours have been introduced in Bangladesh, China, India, Morocco, and Pakistan.
>
> No programs appear to be in place that encourage boys take on a larger share of the domestic load, although preliminary evidence suggest that at least in some situations, declines in boys' school attendance may be associated with significant increases in girls' attendance. If such an association does exist, it is likely to be because boys must perform some or all of the household labor previously performed by girls. In Latin America the fact that girls' enrolment often exceeds boys' enrolment may reflect the higher opportunity cost of boys' time (working in the fields or in the streets). This illustrates the need to shape specific interventions based on local conditions.
>
> From MDG Education task force report – Towards Universal Primary Education; Investments, incentives and Institutions, 2005, page 58.

The box lists a number issues that affect girls enrolment. It was written with primary enrolment in mind but all the points made apply equally – many even more so – to secondary education, particularly the need for a safe haven for girls if the girl has to board.

The list below illustrates other issues that impact on girls enrolment and performance in science; it is not an exhaustive list.

- Admissions policy. Are equal numbers of girls and boys admitted and if not, why not? Has a quota policy ever been considered? If admission are made strictly on merit, has a pre-admission programme for girls ever been considered to raise their primary leaving qualification?
- What is the gender balance between teachers, particularly science and mathematics teachers? If this is skewed is gender an issue that is taken into consideration in making appointments?
- Is science compulsory for all students? If not, what is the gender balance in science and mathematics classes? If there is an imbalance, what, if any, studies and procedures have been put in place to determine why there is a gender imbalance and what can be done about it? Should science be compulsory until grade 12 as it now is in almost all the countries where students perform well in science? Should science, particularly at junior secondary level, be taught in an integrated way or as two or three separate subjects?
- Timetabling. Are there any subject choices that presuppose splitting along gender lines (like biology or physical science, home economics or CDT, or even football or hockey)?
- How does male and female student achievement in the sciences compare? What are the possible reasons for any differences? (Note, Unit 5 will take a closer look at curricula, methodologies and materials to look for hidden gender messages but obvious ones can be addressed in this topic)
- How are subject choices made? Are students and parents informed of the impact of subject choices on career paths. Are parents involved in the process at all? Are choices free or based on previous achievement?

Activity 3.1 What are the main school-related impediments to girls' science achievement?

1 Start this session with a short plenary presentation of some of the issues mentioned above. The quotation in the box could be duplicated and given out and some of the points raised could be discussed. Allow discussion to clarify any issues raised.

2 Ask participants to analyse their own institution for reasons why girls tend to enrol in science programmes in smaller numbers than do boys, and also, analyse girls performance compared with that of boys. Participants should initially work individually and then share analyses and develop solutions to the main problems they identify. These solutions may be then classified as follows:

- beyond their competence to address, other than in the form of a recommendation
- soluble but in the longer term
- soluble though immediate remedial action

Note that some participants might be looking at the functioning of a school or training institutions whereas others, such as inspectors or administrators might be looking at a group of schools or even all the schools.

3 Ask all participants to write, on pieces of card of one colour, any issues relating to the way their institution, or the system in general, functions, that discourages girls to take up science subjects in fewer numbers that boys. On card of a *different* colour they should write down any issues that might cause girls to perform less well in science subjects than boys.

Participants should then pin up the cards on a pinboard. They should pin the card next to one describing a similar problem so that the cards are automatically grouped as they are pinned up. Only if there is no other with a similar issue should they start a new group. (This process also ensures that participants to read the contributions of others).

4 After all the cards are in place, briefly discuss the groupings in a plenary session. This may lead to some reclassification. It will also be evident that some groups are related to each other while others are very different in origin.

5 Divide participants into a number groups equal to the number of card groupings. Ask each participant group to address one card group problem and develop possible solutions. Classify the solutions according to the three types listed in 2 above. Their task will lead to an outline programme for action that they could then take away and try to implement. They may go further and agree on a timed intervention and to meet again at some point to share successes or failures. (Or they might arrange to share such information electronically)

Topic 4 DEALING WITH LACK OF CONFIDENCE

There is much evidence testifying to lack of self-confidence as a major influence on girls' education generally and on their science and mathematics education particularly. This seems to be a worldwide phenomenon but is particularly marked in Africa. The contributory factors to this are less easy to determine unambiguously but many have been raised in Unit 1 and more will be examined in detail in Unit 5 on teaching and learning in science and mathematics, and also in Unit 3 on career guidance.

More details on this issue can be found in a number of resources on the accompanying CD.

The purpose of this topic is to raise it as an important issue and this will be done by asking the participants, whether they are male or female, to think back to their own school days and the reasons why they did badly in any subject or lessons; almost certainly lack of confidence will emerge as a significant reason. The box below is a note from a female Namibian research student recalling some early experiences in mathematics and how one of the consequences of these was that lack of mathematical confidence instilled by insensitive teaching turned into a persistent phobia.

Experiences of a female Namibian completing a research degree in the USA

I am not yet qualified, I am slowly catching up with the gaps produced by the old order of the education systems.

Negative Experiences:

- From grade 8-10 (std 6-10) I had the same teacher who would teach Maths, but no questions asked! She made me to hate the class, pay no attention, learned nothing and avoided Math in my curriculum from Grade 11-12 (std 9-10) not to mention in my degree programs. As a result I felt stupid, anytime I page through a book or document I jumped sections that have numbers, tables, figures… etc and go to words. Since then, it became a phobia.
- During my Bachelors Degree, I wanted to major in Psychology. It was required that I pass Statistical Methods. I avoided majoring in Psychology just because of calculations.

Positive Experiences:

- In std 5-6, I had two different teachers, I liked Math, got answers before the they could even finish the illustrations. It amazes me when I think about it today.
- The second exposure to Educational Statistics was at Honors level in my postgraduate degree. Then I had no choice but to do it. I passed, but I will call it surface learning.
- In my Masters, it was required that I get introduced to both Quantitative and Qualitative Approaches. I did a qualitative study for my Masters Project.

In my Ph.D Program I am currently required to have competencies in research approaches educational statistics multivariate analysis, etc. I have no choice but to read books that will cover the basic mathematical skills that I lack and try to fill the gap as far as I can. In the mean time my Math Phobia is slowly fading!

Activity 4.1 What are the causes of lack of confidence at school?

1 Ask participants to close their eyes and think back to their own schooling days (the facilitator may wish to help create an atmosphere for reflection by playing some reflective music in the background; the workshop atmosphere is often important to assist thinking). Ask them to think about what subjects they disliked. What was it about the subject that they disliked most? What was the cause of this dislike? Was it something about the teacher personally? Was it the way it was taught? Was it the materials used? Did they just not understand it no matter what they did? Why did they not understand? Did they feel unhappy in the lessons? Why did they feel unhappy? Were they made to look foolish or to feel 'small' in the lessons. Did they get good marks or poor marks? Were there influences outside school that were important?

2 Ask for volunteers to share their experiences. It is likely that the lack of self-confidence in the subject will emerge. Read out the reflection in the box from a female Namibian reaching the end of her doctoral studies in the US.

3 Divide the participants into groups and ask them to discuss their experiences and to try and identify any contributory factors that generated any feelings of lack of confidence. They should also make suggestions on how these causal factors might be removed. Note that the participants may well be qualified in science or mathematics and therefore they may not share the Namibian experience of mathematics. The facilitator should, however, encourage discussion around this, particularly if similar experiences in mathematics or science emerge from female members of the group

4 In a final plenary list the issues raised together with pointers towards remedying their causes. This list should be used in later training sessions in Units 5 and 6

REFERENCES

Birdsall, N and Levine, R, (2005), *Towards universal primary education; investments, incentives and institutions,* UN Millennium Project, Task Force on Education and Gender Equality, Earthscan, London *www.unmillenniumproject.org/reports/tf_education.htm*

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UNESCO (2005), *Global Educational Digest 2005,* UNESCO Institute for Statistics, Montreal, 2005 *www.uis.unesco.org*

www.connexions-direct.com UK government-sponsored career guidance website.

EXPLANATION OF KEY TERMS

Millennium development goals (MDGs)

The MDGs are the world's targets for dramatically reducing extreme poverty in its many dimensions by 2015 – income poverty, hunger, disease, exclusion, lack of infrastructure and shelter – while promoting gender equality, education, health, and environmental sustainability. They were agreed at the UN Millennium summit in 2000 and consist of 18 targets addressing between them, 8 goals.

Gross enrolment ratio

The gross enrolment ratio is the number of children enrolled divided by the number of school age in the phase, expressed as a percentage. It can often be greater than 100% because many children that are enrolled are over the 'normal' school age for the phase.

Gender parity index

The gender parity index is the ratio of female to male students enrolled for a particular programme or phase. If all children are at school, it will be slightly more than 1 as slightly more girls are born than boys. The figure of 0.85 for Africa means that, taken over the whole continent, for every 100 boys there are at school, there are only 85 girls.

Sex-disaggregated statistics

Statistics in which the figures are given not just for all students, but also for boys and girls separately

Gender lens

A simple instrument for analysing something (such as an institution, teaching styles, learning materials, etc) for gender disparities or bias. It would typically consist of around 10 straightforward questions that should be quite easy to answer.

Unit Three
CAREER GUIDANCE

Rationale

The purpose of this unit is to provide guidance teachers with the basic knowledge and skills to provide a sound careers service with a particular emphasis on mechanisms through which girls in particular could be enticed into careers in the fields of science, mathematics and technology.

The unit will examine firstly the methodology of *career guidance* and how that may be improved, and will go on to consider why girls are not traditionally attracted into science careers and to consider ways that careers services, both nationally and in schools could address this issue.

Target groups

All who have responsibility for the careers education service, at the senior administrative level, at the professional organisational level and at the school level.

Learning outcomes

By the end of this module participants should

- be knowledgeable about what career services could, and should, look like; both at the administrative level, at the professional level and at the school level;
- have the knowledge and skills to conduct career guidance activities and to design career guidance tools;
- be able to motivate girls, through career guidance, to take a greater interest in, plan for, and enter careers in the area of science, mathematics and technology.

Contents

Items to bring to the workshop

A number of copies of a variety of career guidance manuals and additional career related materials such as guides and information manuals will be required. These should ideally come from more than one country. ICT materials on career guidance should be made available if there is access to computers. Some examples are provided on the accompanying CD.

Acknowledgements

All the cartoon strips used in this module are taken, with permission from the 2003 edition of 'What Color Is Your Parachute?' by Richard N. Bolles[23].

Topic 1 INTRODUCTION

The word "vocation' derived from the Latin for "voice". It is assumed that an individual is *called* to a certain vocational field or a particular career. It is presumed that, when "called", the individual will utilise all her prized skills and derive meaning and fulfilment form her career.

Start with a short activity for the whole group in the idea of a vocation, and who or what does the 'calling' is explored

Individuals are asked to think about their own careers and try and identify the main influences on them at the outset of their career. These influences could be listed and the list can be used in later sessions as a basis for considering what might be the most influential changes needed to persuade more girls to choose science-related careers.

Activity 1.1 Who or what 'calls' someone to a vocation

1 Show the comic strip above.

2 Ask the group to think individually about their own careers and try and identify who or what 'called' them into the profession they have chosen.

3 Ask the group to share their experiences. Through group discussion formulate ideas on who or what 'calls' a person to a certain vocational field or particular career? This will give some ideas on what might be the most important influences on individual career choice.

Consider whether these influences might deter girls from seeking careers in science. Consider, in outline, ways in which these influences might be exploited to persuade more girls to seek scientific careers

[23] For more details of this useful book see, Topic 4, the resource CD and the website: http://www.JobHuntersBible.com

Topic 2 EXPLORING CAREER GUIDANCE IN SCHOOLS

In this topic the participants are asked to reflect on how careers advice systems have changed since they were at school. A source of background music to induce reflection is desirable.

Activity 2.1 Career guidance when I was at school

1 Ask the participants to sit back breathe deeply, close their eyes and relax. Use appropriate background music. Through visualisation the participants go back the school that they attended. Guide them through slow questioning to visualise all the aspects of the career guidance that they received, including
   - in what grade(s) they received career guidance,
   - how many (if at all) periods were allocated to career guidance,
   - what was the teacher like; knowledgeable, sympathetic, helpful?
   - how the teacher conveyed the information,
   - the information that was available,
   - gender myths that were directly or indirectly conveyed, etc.

   Ask participants to conceptualise the personal consequences of their career exposure at school.
2 After the visualisation participants are invited to share their career guidance experiences.

In the second activity participants are asked to visualise and list the main characteristics of the career guidance that their institutions currently offer to the learners. They should then be asked, based on the thoughts and observations that have emerged in the previous two activities, to discuss the likely impact of the service currently offered. Then in activity 2.3 participants are asked to compare past and current practice.

Activity 2.2 Career guidance at my institution now

1 The participants visualise all the aspects regarding the career guidance that his/her institution offer to learners: including
   - in what grade(s) learners receive career guidance,
   - how many (if at all) periods are allocated to career guidance,
   - the teacher(s),
   - how the teacher convey the information,
   - the information available,
   - the facilities,
   - gender myths that are directly or indirectly conveyed, etc.
2 Ask for volunteer participants share their experiences how career guidance is handled at their institution.
3 Encourage participants to discuss the possible consequences of such career guidance for learners.

Activity 2.3 Developments between then and now

Ask participants to discuss whether any changes occurred between the time when they were at school and now, and what these changes entail and what their consequences might be. Ask them to reflect also on what aspects of the service have stayed the same with regard to career guidance, and why.

Topic 3 EXPLORING THE CAREER GUIDANCE SERVICE ADMINISTRATION AND SUPPORT

Under this topic participants will look at how career services are supported at the administrative level by the education authority. The box shows a list of questions that could form the basis of a questionnaire that each participant should complete about how the service in their institution is supported. This list is not exhaustive and facilitators should change it to suit their own conditions. A copy of the list, set out as a questionnaire is on the resource CD

Questionnaire questions

- How does the Ministry of Education facilitate career guidance?
- How do the regional offices of the Ministry of Education facilitate career guidance?
- How do other ministries facilitate career guidance?
- How do NGOs facilitate career guidance?
- How do business and industry facilitate career guidance?
- How do tertiary institutions facilitate career guidance?

The questionnaire raises broad issues and participants may need some more detailed guidance about matters that should be taken into consideration when completing the questionnaire. The following checklist may be useful. You or (and) the participants may wish to add to this list. Display the list on a flipchart.

Checklist of careers guidance issues to be considered

- Does a careers guidance policy exist?
- Is the policy fully implemented in the careers service?
- Does a career counselling service (as distinct from teaching about careers) exist in the school(s)?
- How effective is the careers guidance service?
- Who does it and how well is it delivered in schools?
- How effective is the training and in-service support of careers advice teachers?
- Do careers teachers have enough up-to-date information about careers? Where do they get it from? Does it get to all the schools and if it does, is it used and available.
- If information is available, is it couched in language that is at an appropriate level and is it free of gender bias?
- Are teaching and learning instruments available that encourage students to look closely at themselves, their abilities, their likes and dislikes, so that they can match these against career demands?
- Is there a careers room in the school where students can go and read information about careers?
- At what age does/should career guidance start?
- How is careers education timetabled and is the time allocated adequate? (Is there, for example, a dedicated careers teacher or is it a task shared by may who may otherwise have light timetables)

- Are the materials and methodology used in careers teaching gender neutral
- Does the teaching offered include activities/materials that might encourage more girls to enter scientific careers?
- Are there companies or higher education institutions that provide an exemplary careers service and materials that others could be encouraged to follow.
- Are there careers fairs or other examples of mechanisms that allow young people to find out about careers?
- Is the information provided by employers, companies and higher education institutions gender neutral (or does it usually show engineers as male, etc)?

Activity 3.1 Investigative questionnaire

1 Display (or give out) the issues list in the box above. Give out the questionnaire and give participants time to complete it individually.

2 Discuss the responses in a plenary session. Be prepared to make a summary list of problematic issues under each of the headings. This list can remain on display for the rest of the workshop as it will be useful in later sessions.

Topic 4 WHAT ARE THE CHARACTERISTICS OF A GOOD CAREERS SERVICE?

The next activity asks the participants to explore what an ideal careers service programme should consist of. The participants could be provided with materials to help them think more clearly about this; one might be the list of questions to ask about a good careers service for girls in Unit 2 Topic 5.

Activity 4.1 The Careers Fairy Godmother

1 Ask the participants to imagine what they would ask of the Careers Fairy Godmother if she would grant them whatever they ask.

2 Every participant should write down his/her wish list writing each wish on a separate card.

3 Participants should then pin their cards up on a pin-board. ask them to pin their card near another that is similar; this will ensure that they are categorised as they are put up on the board and also encourages participants to read the contributions of others.

4 Each participant is then asked to vote for
   - the 2 most important factors about career guidance at the administrative, and
   - the 2 most important factors about career guidance at the school-level.

5 Follow this with a discussion to draw up a final list of the most important elements of a careers service. Throughout the discussion, and during the drawing up of the final list, make sure that the participants have in their minds, the issue of career guidance that encourages girls to take up science -based careers.

A careers service monitoring instrument

As an optional activity, an objective monitoring instrument for evaluating the effectiveness of a careers service provided by a school (and indeed an education authority) may be developed based on the outcome of Activity 4.1. The next activity guides participants in the preparation of a draft instrument for doing this. This could later be refined as a set of standards for use by inspection services when they report on a school.

There are many different kinds of monitoring instruments and it would be useful to bring to the workshop any instruments already in use by the Ministry or the Inspectorate so that participants can consider whether they feel that they can design one for monitoring a careers service using the same or a similar format.

The evaluation instrument should address all the important aspects of the career guidance process. These may be classified under appropriate headings such as:

1 institutional matters
2 pedagogical matters, including the curriculum , the materials and the teaching methodologies
3 teacher qualifications and support
4 the use of ICT
5 gender issues.

The first point in this list, 'institutional matters', might include an evaluation instrument that asks questions such the following:

- is career guidance on the timetable and does it have adequate time
- is there a careers room, or a place in the library where careers information is available
- is there a good support service from the ministry responsible
- is there a systematic career guidance curriculum with good teacher and learner materials
- are extra curricular activities organised or available, such as careers fairs and works shadowing

The other headings in the first list can also be unpacked into sub-components that can each be independently assessed. Point 2 deals with aspects of teaching and learning. The third point looks at how well qualified the careers teachers are and what is the quality of the backup they get from their ministry and/or from industry. The fourth addresses the issue of ICT in careers advice which, in many countries is now well developed[24] (though not yet in Africa). The fifth point in the list asks them to develop a gender lens though which to view the service (see topic 3 above)

It is useful for any instrument to have an evaluation scale. It is sensible to make this as simple and as easy to use as possible. One possible scale that is often employed in such circumstances might be as shown in the table below. It is a 4-point scale and the difference in meaning of the grades is clear. The marks for each component can be aggregated to provide an overall assessment of the service that the school offers.

[24] An example is the UK government-sponsored site, www.connexions-direct.com which has much life-skills advice as well as a good careers advice service.

A generic evaluation scale for instrument to assess a component of a career service

Score	*Meaning*	*Explanation*
4	Very good	This grade is awarded when the school has made a considerable effort to go beyond what is normally required
3	Good	This is the grade awarded when all the expected components are present and working well
2	Satisfactory	This is the grade to award when this element of the service is present but does not function well
1	Inadequate but exists	This grade indicates that the component may be present but does not function properly
0	Does not exist	This grade is self-explanatory

In the next activity participants are asked to work in groups and construct a draft instrument for evaluating a career guidance programme. They may wish to use the suggestions above as a basis for this task or they may wish to work out their own classifications and grading system.

Activity 4.2 Developing an assessment instrument for a careers service

1 Participants may work in groups or individually if they wish. Show them the examples of the possible categories in the first list (above) and go though the sub-categories for point 1 in the list. Go through the meaning of the possible evaluation scale. (Copies of all these are on the resource CD). Stress that these categories have been shown only as an example to show how an instrument might be constructed; they need not use them in their instruments. The gender lens section (point 5), however, should be compulsory for all groups.

2 Ask groups to produce an evaluation instrument which they can display on a flip-cart or by other means. When most are complete, spend some time sharing ideas and encourage individuals to modify their own personal ones in the light of the discussion.

This collection of instruments should be a useful output of the workshop and participants should all get copies.

Career guidance in the school

Career guidance programmes in schools require resources for both teachers and learners. In the next activities, the participants are asked, firstly, what they think that good career teaching and learning materials should contain. Then they should be given an opportunity to evaluate and discuss one or more examples of career guidance guides. For this they should be provided with materials which could be local and/or from other countries. The Namibia Career Choice Manual is a good example and is provided on the resource CD.

Activity 4.3 What should go into a good Career Guidance Guide?

1 Working either in groups or in a plenary session, ask participants to brainstorm on what a good Career Guidance Guide should contain. In doing this they should have in mind the output of the previous activities in this topic and they should also remember that this workshop is directed towards improving career guidance in particular for girls.

For the next activity, the participants will need career guidance materials that allow them to relate their likes and dislikes, knowledge and skills to a possible career path. The Namibia Career Choice Manual on the resource CD allows participants to do this.

Activity 4.4 Experience a Career Guidance Guide

1 The participants are divided into pairs. Using the Namibian Career Choice Manual, or locally developed materials if similar materials are available, each participant work through the manual. In doing this the participants will determine whether they are actually in the 'correct' career.
2 Allow time for feedback and discussion.

In the next activity, the participants, working in small groups, compare different career guidance materials. Each group will need copies of the materials but not all groups need have copies of all the materials if there are not enough to go around. They should consider, as a group, what aspects of the materials they are going to compare. This list can vary from group to group but one aspect should be common to all groups; all should look at them from a gender perspective. A suggested reporting form for this activity is included on the resource CD. This form is used to report back 'best ideas' in each aspect of career guidance that the group has chosen. At the end of this activity, the group should have a list of what they consider to represent best practice in career guidance. This list should include a gender perspective.

Activity 4.5 Comparative analysis

1 Participants are divided into small groups. A number of Career Guidance Guides are made available, including some that are commercially available and some that are ICT tools if computers are available. The groups investigate the Guides and compare them. The following aspects could be explored:
   - which components are included in the Guides
   - format
   - questionnaires
   - graphics and pictures
   - applicability (to your country, which grades, etc.)
   - gender sensitivity
   - costs
   - shortcomings
2 The groups are then requested to give feedback and a checklist of best practice ideas can be developed on a flipchart.

A traditional Career Guidance Guide will include ways in which a learner can augment her personal knowledge. Competencies (aptitudes, skills), interests, personality (temperament, traits) and values are considered 'knowledge' which could help us to choose a career which will 'fit' us.

Skills and competencies may usefully be considered in three families: 'Data-skills', 'People-skills' and 'Things-skills'. Usually one of these skills will be fundamental to a career, whereas the other skills will be peripheral. The diagram (Figure 3.1), from "What color is your parachute?" (Bolles (2003); see references) is very useful to determine on what level you operate in these three skill areas, and can help you to identify your functional skills.

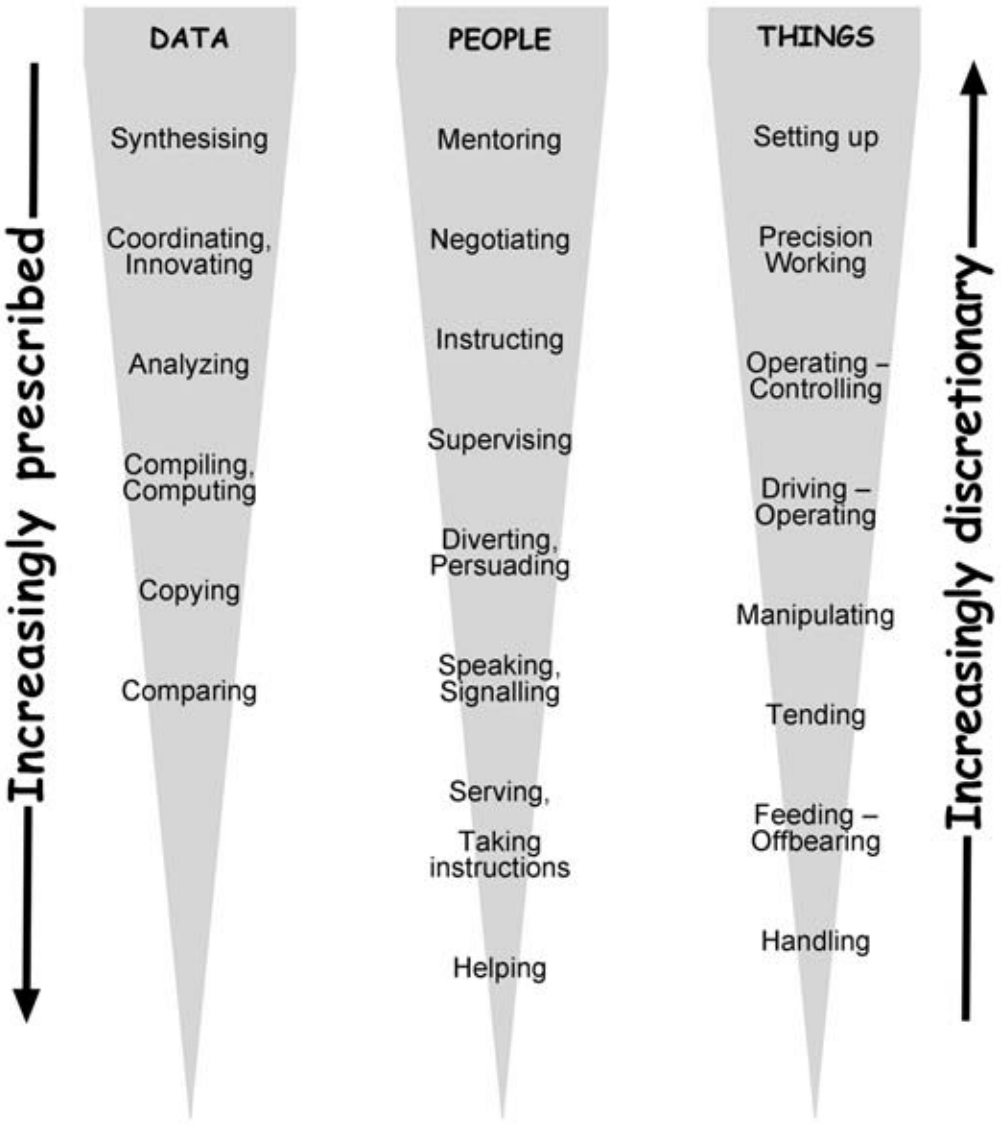

Figure 3.1 Skills related to data, people and things (from 'What Color is my Parachute'; Bolles (2003))

Personality traits should not be confused with skills. Personality traits determine the style with which you apply your skill. For example, a skill might be 'Mentoring people' whereas 'is sympathetic' describes the style with which you mentor.

The analysis by Bolles might be examined from a gender perspective, firstly to consider whether the distinction between the three groups of skills is an equally useful one for both boys and girls and secondly, if it is, to consider which skill groups girls might excel in compared with boys. Conventional gender wisdom might suggest, for example, that girls might be particularly good at 'people skills' but rather less so at 'thing skills'. But is this distinction an innate one or is it a consequence of the views of what are 'male' and 'female' skills that is generated by society?

Obviously, a learner should not only know herself; she should also know the world of work. Careers knowledge which should also be included in Career Guidance includes:

- subject combinations, fields
- specific careers
- bursaries, scholarships and loans
- training institutions

The next activity is in the form of a short presentation followed by a discussion and it offers an opportunity for input from the trainer to address any issues about the contents of career guidance materials that have not be raises so far. The trainer should use her own knowledge of trends in career education worldwide to develop such a presentation. The website URLs included in the references are a useful source of information.

A key element in this presentation should be a discussion around the self-knowledge issues raised above. Figure 1 is also available on the CD and this can be displayed or provided as a handout to stimulate discussion

Activity 4.6 Trends in career education

1 Make a short presentation to the whole group on trends in career teaching. Allow time for questions and discussion

Activity 4.7 Additional resources

1 Participants are divided into small groups. A number of additional resources – pamphlets, career books, posters, etc – are made available, including some commercially available and ITC tools. The groups should explore and critique the resources.
2 Ask the small groups to give feedback to the larger group, highlighting good ideas.

The next activity can only be undertaken if there workshop can use a room with a sufficient number of computers with a good internet access. Alternatively, a presentation can be carried out using a single computer with an internet connection and a data projector. The list of URLs of careers websites in the box below, also available on the resource CD (where the links are live), can be given to the participants

Useful web resources for career teachers

General Information:

http://www.ics.org.na
(Careers site in Namibia) (Click on "Careers in Namibia 2000/2001" icon)
Curriculum Vitae
Career Planning (aspects to consider)
Study skills
Preparing for a job interview
Admission requirements to institutions of higher learning
Career information
Tertiary education opportunities

To write your resumé:

http://www.garywill.com/worksearch/reswri.htm (also: cover letters; interviews)

http://www.google.com (Type: "how to write a resume". Try both with or without the inverted commas)

Jobsites:

http://www.ics.org.na
(Careers site in Namibia) (Click on "Careers in Namibia 2000/2001" icon)

http://www.rileyguide.com (Click on "A-Z" index" to explore further)

http://www.connexions-direct.com (UK government careers and lifeskills site)
(Use the link "jobs4u" to go to the careers data base.)

Hottest careers:

http://www.google.com (Type: top ten careers/jobs)

Self-knowledge:

http://www.missouri.edu/ (Use the search facility to find the "career interest game": The career interests game)(Click on different personality types and explore them further)

http://www.personalitytype.com/ (Click on "take our quiz" and explore further. It relates to personality types such as introvert, extrovert, sensor, intuitive, etc)

http://www.9types.com/ (This instrument explores nine different character types, using the RHETI Test) (Also use the link "introduction to the Enneagram" which gives information on how different character types operate)

http://www.keirsey.com/ (Keirsey Temperament Scale, like Myers-Briggs)(Although a full report has to be purchased, the abbreviated report of your temperament is very useful)

http://www.review.com/career/careerquizhome.cfm?menuID=0&careers=6 (Princeton Review Career Quiz: 24 part questionnaire)(A short questionnaire which gives a cryptic result of your interest and style. More complete questionnaires has to be paid for).

Activity 4.8 Demonstration: Free information on the internet

1 Use whatever services are available to show how the internet can be used as a source of careers advice and information. The list of URLs in the box can be used to plan this session; all should be tested before the session as some may have changed.

Career guidance support services

Depending on the audience (i.e. whether the workshop attended by administrative and support officials from the ministry or by school-based guidance teachers) one of the two following activities, 4.9 and 4.10, can be done. In the activity directed at the teachers, the policy, curriculum and support structures of the career guidance service are studied and analysed, particularly in the light of the promotion of opportunities in science for girls. Any shortcomings are identified and proposals for addressing them developed. For this activity, multiple copies of all policies,

syllabuses and any other relevant documents for a number of different countries will be required. Some of these are available on the resource CD.

Activity 4.9 Analysis of career programmes

(For school-based guidance teachers)

1 In a plenary session, share information is shared with the teachers regarding the in-country career programme(s). Introduce all the documentation

(*For example:* In Namibia Career guidance is carried in the subject Life Skills. One 45 minute period per 7 day cycle is allocated to Life Skills. One third of the time allocated to Life Skills-time is specifically apportioned to career guidance, There is syllabus and career guidance materials are available)

2 Participants break into groups and analyse the documents. The following aspects may be covered with a particular focus on the gender issue under consideration:
   - policy (time tabling, specific grades, syllabi, etc)
   - careers projections and feed-back to schools
   - structures
   - supportive activities (e.g. fairs)
   - facilitate collaboration with business and industry
   - advocacy
   - training (especially methodology)
   - gender matters generally

3 Groups present the major conclusion from their discussion.

Activity 4.10 Analysis of career programmes

(For administrative and support officials)

1 Working as a group brainstorm on how career guidance in schools should be supported

2 Working in groups carry out a comparative study of the policy documents, etc. related to career guidance in different countries. The following aspects may be compared:
   - structures
   - policy (time tabling, specific grades, syllabi, etc)
   - training (especially in the methodology of career guidance)
   - supportive material and instruments
   - supportive activities (e.g. fairs)
   - career projections and feed-back to schools
   - collaboration with business and industry
   - advocacy
   - gender advice

3 Feedback to the larger group and identify positive points from the study, particularly noting issues related to careers guidance for girls

4 Each participant should be encouraged to write a list of undertakings for improving his/her practice.

Topic 5 ATTRACTING GIRLS INTO CAREERS IN THE AREA OF SCIENCE, MATHEMATICS AND TECHNOLOGY

In this topic, participants will be given the opportunity to develop practical activities to entice girls into science, mathematics and technology. The first activity is an open brainstorm on classroom activities for career guidance lessons. The subsequent ones are some 'ready made' lesson ideas that may be tried out on the group.

Activity 5.1 Brainstorm ideas to attract girls into science-based careers

1 Participants brainstorm creative and practical ways in which the awareness of girls of science, mathematics and technology careers could be enhanced.
2 Some of the best ideas can then be demonstrated with the group.

Activity 5.2 Comics, pictures and statements

1 Give each group a set of copies of comic strips or pictures that have subliminal (or explicit) messages about job-related roles of women. The groups identify and discuss the subliminal 'message' of each picture. Some examples[25] of comic pictures are shown at the end of this topic and are also included on the resource CD.

Activity 5.3 Science, mathematics and technology vocations

1 Participants list all the science, mathematics and technology vocations that they know of. If they have a local career guide this list can be extended. Ask students to describe the kind of work they think is involved in the job.

[25] Reproduced, with permission, from the 2003 edition of 'What Color Is Your Parachute?' by Richard N. Bolles, where more such examples can be found.

Activity 5.4 Girl careers/Boy careers

1 Participants discuss what things they think girls cannot do, and what boys cannot do, and why.
2 Participants make a list of Girl-only and Boy-only careers (with a reason for each opinion).
3 The lists are then discussed by participants of the opposite sex.

Activity 5.5 Socialisation

1 In this activity we wish to sensitise girls and boys about the way in which children are socialised and the effect of socialisation. It is important that girls recognise how many women bow to the self-fulfilling prophecy; their attitudes, behaviour, likes and dislikes tend to conform to what society in general expects them to be. Speech bubbles can be used to convey the 'messages' visually.

   Participants investigate:
   - Career advertisements
   - Familial messages
   - Societal messages
   - Messages received at school

Activity 5.6 Interviews

1 Students are given the task of interviewing two women:
   - One woman who wanted to pursue a career in science, mathematics and technology and who *did*;
   - One woman who wanted to pursue a career in science, mathematics and technology and who *did not*.
2 Students give feed-back on the two interviews.

Activity 5.7 Handling parents

1 Volunteer participants role-play parents who are reluctant for their daughter to pursue a career in science, mathematics or technology.
2 Participants discuss how such a situation could be handled and an interview is role-played. The role-play is then discussed and perhaps repeated with revisions.

Activity 5.2 examples

Identifying the Gender mes

REFERENCES

Bolles, R.N. 2003. *What color is your parachute? A practical manual for Job-hunters and Career-changers*. Berkeley: Ten Speed Press.

Unit Four

CAREER GUIDANCE ACTIVITIES

Rationale

This unit aims to provide teachers with the basic knowledge and skills to carry out certain career guidance activities that can be utilised as vehicles to encourage girls to pursue careers in science and mathematics.

Career guidance does not amount to much unless learners are engaged in practical activities that expose them to world of work and equip them with skills that prepare them for work. Girls need to be exposed to a variety of careers and professionals in science so that they get to appreciate how unlimited the field is. Exposure could also help change mindsets that inhibit girls from widening their horizons.

Target groups

This unit is designed for teachers, advisory staff and administrative staff who organise career guidance activities in school, in the local community, in school clusters, regionally or nationally. It describes a number of possible activities and provides training in what they might achieve and how they should best be organised to achieve it.

Learning outcomes

By the end of this module participants should:

- be knowledgeable about a wide variety of career guidance activities
- be knowledgeable about what career guidance activities could and should look like
- have the knowledge and skills to develop, implement and facilitate career guidance activities
- be able to guide, and motivate girls to appreciate these activities and the benefits of the exposure that these activities provide

Contents

Items to bring to the workshop

Participants should be asked to bring the following information to the workshop.

- Curriculum details of any enterprise education programmes that are operational
- Examples of career information brochures, books and websites available in the country
- Similar materials from other countries (some are on the resource CD).

TOPIC 1 INTRODUCTION

The activities in this unit could be organised within a school, or by a group of schools in a cluster, or by the regional education office or nationally. The introductory activity asks the participants to think of the advantages and disadvantages of running activities at each of these levels and which activities are best organised at which level.

School based activities

Conducting activities in the schools has a number of advantages such as:

- They tend to run efficiently and effectively especially if resources are readily available within the location of the school.
- Student numbers are manageable.
- Resource persons have adequate time to dialogue with individual students or small groups of students.

Cluster based activities

Conducting activities as clusters has logistical implications such as:

- Transporting large numbers of students to a central venue and finances for transport and meals.
- Having to divide learners up into manageable groups so that resource persons can interact easily with them and answer their questions.

Cluster based activities are recommended:

- Where resources (human and financial) are inadequate.
- Cluster activities are a good way to make best use of external resource persons. Remember that these are people who leave their jobs to spend time with our students, so expecting the same resource persons to attend to individual schools can be unrealistic.

Regional and national activities

National activities, or activities in regional centres are recommended:

- When the activity is very large (such as a careers fair) and the logistics of holding it many times in clusters or schools are prohibitive
- When one of the objectives is to encourage children to come together regionally or nationally (such as regional or national science fairs – see unit 5)

Activity 1.1 Challenges of organising activities at different levels

1 Show the group the list of activities in the Table of Contents (this could be on a slide or a flip chart) Ask the group to discuss the challenges of school based and cluster based career guidance activities, looking at how each impacts students' learning.
2 Ask the group to discuss what might be the best level to organise each activity and why. Decisions could be put on a chart next to the activities. It does not matter if there is no agreement on some of the activities, the purpose of this session is to start the participants thinking rather than coming to any conclusion. Feed into the discussion, if necessary, the information summarised above.
3 It is common practise to have career guidance activities designed for both boys and girls. Ask the participants how they see girls benefiting more from those activities that are specifically designed for them?
4 Ask the groups if there are any other useful activities that they might add to the list, particularly those that may be useful in encouraging girls into science careers.

The workshop sessions below look at the activities in the Table of Contents. Further workshop sessions could be devised around additional activities suggested by the group

TOPIC 2 CAREER FAIRS

A career fair is an activity designed to enhance and support career guidance lessons by exposing learners to information and providing them with a forum to interact with people from a variety of careers and professions. In career guidance lessons, learners learn about careers, self exploration and self knowledge. They read career manuals, and get information from the guidance teacher. A career fair is an opportunity to meet with and hear the people who are actually involved in the careers. Resource persons could be professionals from organizations and institutions, private and public sector, and self employed people. Invited guests could be community leaders, education officials and parents.

Career fairs can be run locally, using local employers only, regionally or nationally. Remember to include also tertiary education institutions as they are often particularly good at providing career information related to the courses they offer.

In the next three activities the participants should be taken through the process of planning a career fair, drawing up a programme for it and thinking about how its effect can be evaluated. The fair can be a small local one or a large regional or national one, but for this exercise, if the participants have never been involved in this before, ask them to plan a local one.

(The following activities suggest small group work. If the overall number is quite small, say 15 or less, these activities could be completed faster using plenary sessions and still allow effective participation)

Activity 2.1 Planning a career fair

1 Briefly discuss with participants the nature and purpose of a career fair.
2 Divide participants into groups. Ask each group to develop an outline plan for a career fair. The plan should include
   - Roles of the team members i.e. guidance teacher and her team
   - Identifying and inviting resource persons
   - Venue
   - Funding and arrangements for meals for resource persons, guests from the community, and students
3 Share ideas in a plenary session. Make a list on a flip chart of all the points that have to be considered in planning a fair. Participants should have this list when they leave the workshop.

Activity 2.2 Planning the programme of the career fair

1 Remind the participants of the importance of a good clear plan so that activities are conducted in an organized manner. Remind them that a chaotic situation will embarrass them in front of their resource persons and guests and that this may jeopardise their future support of such activities. Resource persons often turn up in large numbers at fairs that are well organized.
2 Working in the same groups as Activity 1.1, draw a program of activities for the career fair day.
3 As with Activity 1.1, share ideas in a plenary session

Activity 2.3 Develop evaluation instruments for a career fair

1 In a plenary session identify the key groups of people whose opinion should be sought on the success of the fair. These may be:
   - learners
   - resource persons
   - invited community leaders and parents.
   - etc.
2 Divide into groups. Each group should then develop ways of evaluating the activity i.e. questionnaires and interviews, etc. Each group should address a different key group identified in step 1
3 Share ideas in a plenary session

TOPIC 3 WORKPLACE VISITS

Workplace visits have a profound impact because learners get real life exposure. They do not just meet the people who work in the place, but also get to see the setting and equipment at the place. Unlike at a career fair they even get to see workers in their work clothes etc. One another advantage of visits is that learners get to meet people in many different professions in the organization. For instance a visit to the mine gives learners an opportunity to meet different engineers e.g. mining, electronic, electrical, mechanical, metallurgists etc, all in one setting. This is good because it may not always be easy to get all these different engineers at a career fair.

Like all other career guidance activities, workplace activities require a lot of planning. One essential thing is to know your learners. During career guidance lessons the teacher should assist girls to know themselves regarding their interests, abilities, values, personality. They should also be realistic about their environment; family circumstances socioeconomic situation and job markets.

In the next activities participants will develop ideas about how maximise the usefulness of workplace visits. They should be encouraged to focus particularly on what can be done to alert girls to the possibilities of careers in science and engineering. These activities can be done in small groups or as a plenary if the numbers are not too large.

It is important that participants realise the value of visiting small organisations as well as large ones as the learners are more likely to find jobs with small enterprises than large companies.

Activity 3.1 Preparing for a workplace visit

1 Ask the group to identify a place to visit and find out more about it (from its website or by telephone).
2 One way of preparing learners for a workplace activity is to assist them with questions they would like to ask the various people they would meet there. Ask participants to prepare questions they would like to ask. Focus on questions that might be of interest to girls.
3 Discuss the questions in a plenary session

Activity 3.2 Drafting a letter of thanks

1 Organisations always like to know how useful the visit was so that they can improve the way they handle such visits. Draft an outline of a letter of thanks that is not too long but mentions the most useful aspects of it, particularly the sections that had the greatest impact on most girls
2 Discuss the drafts in a short plenary session

Activity 3. 3 Integrating the visit into career teaching

1 Ask the groups to develop a short teaching sequence that could be done with the class to prepare them for the visit and a similar sequence that addresses what they have gained from the visit. The sequences should consist of child-centred activities that get the learners to reflect on their perceptions and expectations before the visit and how their perceptions might have been changed by the visit. Include in the plans, some activity that allows the girls to reflect on how appropriate some of the work they have seen is for women.
2 Share ideas in a plenary session.

TOPIC 4 CAREER TALKS

Career talks are school-based activities. The school invites a professional to address learners about their own career or about careers in their institution. Unlike at a career fair, the speaker has more time with students, and shares with them a variety of issues regarding their profession. The presenter at a career talk does not share the forum with many presenters as is the case at a career fair.

In the next activities participants are asked to reflect on the reasons why they may wish to organise career talks and how they would integrate such talks into their career teaching.

Students feel empowered and enthusiastic if they are involved in the preparation stages of the process of planning a career talk. Find out what they would like the presenter to share with them. They can be involved in writing a letter to the chosen presenter, inviting him/her to address them. This should state the objectives of the activity and ask the presenter to bring any displays and props if there are any. The learners can be involved in the organisation of the event itself; making welcome remarks; introduction of guests; giving a vote of thanks etc.

After the lesson, someone should write a letter of thanks.

It would be particularly relevant if this event was created by and for the girls and the person invited was a women who could talk about making a success of a career in an area of science or technology that is traditionally 'male'.

Activity 4.1 Preparing for a career talk

1 Working in groups develop an outline lesson sequence for involving an external speaker in a careers talk. The outline should ensure that the event is planned and managed by the learners themselves.
2 If possible try and identify a female speaker who may be able to come and talk about her experiences of working a science or engineering field where the majority of workers are male.
3 Compare plans in a plenary session

TOPIC 5 ENTREPRENEURSHIP AND ENTERPRISE EDUCATION

The character of economic competitiveness has changed significantly in the global village. Work is no longer just confined to factory work, public service and a few big corporations. Individuals are now going into business as producers and providers of services and goods. Even the character of big companies is changing; investors now engage the services of experts to run businesses for them. These experts are expected to bring into the business expertise in the field of the service, and business skills. For instance a pharmacist may be engaged by a pharmaceutical company as CEO of their business, and she will also be expected to be a skilful entrepreneur. Sometimes, it is a team of experts that come together to start a business, e.g. a team of geologists can open a prospecting company. Again, it is essential that these geologists have entrepreneurial skills because without these skills, the business is unlikely to succeed.

Given all this, it is important to equip girls with basic enterprise education so that they get to appreciate how careers in science can lead to a business career. This helps them appreciate self-employment and how empowering it is. It also shows learners that self-employment is not an alternative to academic excellence and professional training. Self-employment becomes more meaningful when one is well-educated and has adequate skills. Enterprise Education is therefore a career guidance activity in this module that encourages girls to pursue careers in science, mathematics and technology fields, e.g. medical doctors, engineers, radiologists, etc, with a vision of going into private practises, consultancies and similar business ventures. Enterprise Education stimulates in girls creativity and innovation. It also increases a sense of self-reliance, self-confidence self-efficacy that lead to career satisfaction.

Figure 5.1 illustrates some of the key qualities required of a good entrepreneur. This list has been developed from enterprise education programmes in several countries and some useful links to such programmes are provided on the resource CD. Participants will be asked to consider this list of qualities, make changes that they see fit and then note particularly which are particularly important ones for girls if they are to develop the kind of independence of vision needed to embark on careers in science and technology. Participants will then be asked to think about developing lesson activities aimed at developing these qualities.

This topic is divided into two parts, A and B. If your country already has a select part A, if it has not, select part B

(Note that Module 9 of the Training Modules produced by UNESCO for the Guidance and Counselling and Youth Training Centre covers Enterprise Education. The main focus of Module 9 is the basic mechanics of starting and managing an enterprise. Module 9 may be used in conjunction with this topic which focuses on developing the kind of skills and personality required of a successful entrepreneur. In addition, the main focus here is on female entrepreneurs.)

Topic 5 Part A (WHERE A WELL-DEVELOPED ENTERPRISE EDUCATION PROGRAMME EXISTS)

In the next activity, participants are asked to consider the characteristics of a good entrepreneur (figure 5.1 is available on the resource CD together with some ideas for developing enterprise education) and add any others that may be part of their own programme. Then they will be asked consider which of these are most the most appropriate characteristics for enabling and empowering girls to take up careers in science and technology and to look at how these are translated into activities in their enterprise programmes. They will then be encouraged to think of ways of developing these activities further or giving them greater emphasis.

Activity 5.1 Ideas for developing entrepreneurial skills (1)

1 Show participants the list of key qualities in an enterprising learner (figure 4.1). Discuss the list comparing it with their own from their enterprise curriculum. Add to and/or subtract from the list as appropriate.

2 Select those elements from the list that are key characteristics that are likely to help empower young female students to opt for careers in science and technology

3 In groups (or in a plenary if the number is small) develop ways of enhancing those elements of the existing enterprise education programme in order help young female learners develop these characteristics

4 Share ideas in a plenary

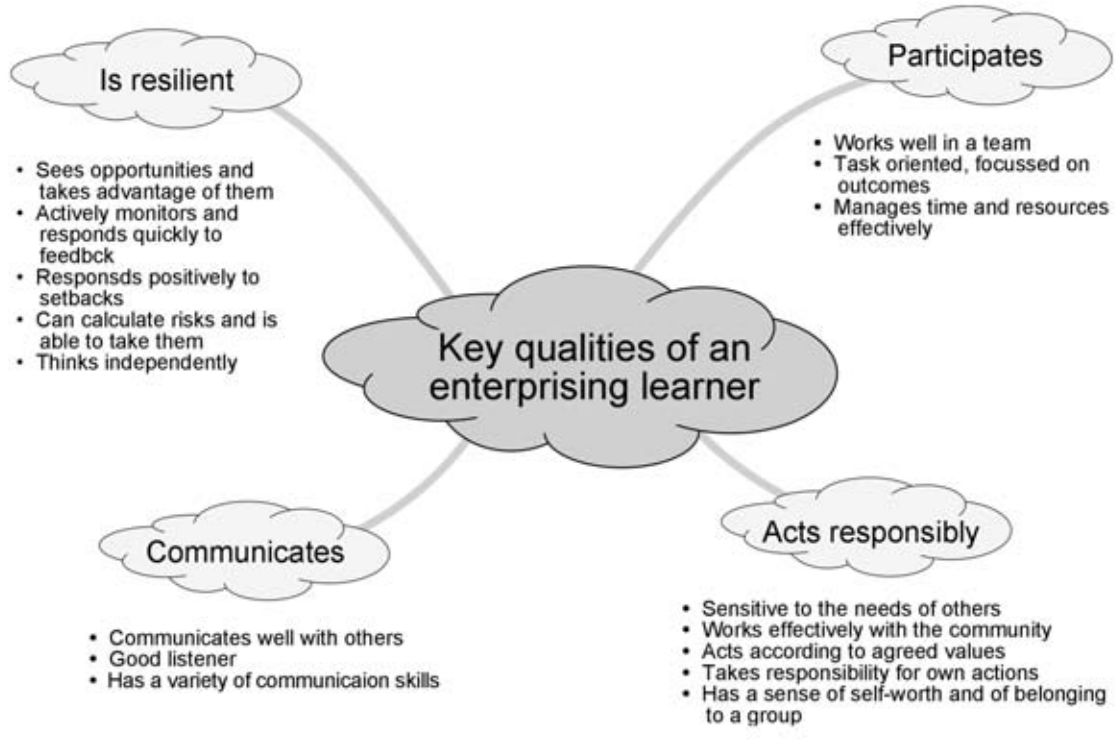

Figure 5.1 Key qualities of a good entrepreneur

Topic 5 Part B (WHERE THERE IS NO ENTERPRISE EDUCATION PROGRAMME)

In the next activities, participants will be encouraged to develop classroom activities related to the idea of entrepreneurship that are designed to empower girls to make independent decisions about their future careers. The first activity takes the teachers through an activity that they can do with their class on visualising their future. This can be a good starter activity for discussing enterprise and self-employment (but when the do it with learners they will start at point 3).

Integrating Enterprise Education into African curricula is a relatively new idea and is fraught with difficulties related to curricula, costs, teacher preparation, lack of access to good examples, depressed economic conditions prevalent in rural areas, etc. A Working Group for International Cooperation in Skills development exists under the auspices of the World Bank and its 2002 report concentrates on sub-Saharan Africa. A chapter of the report analyses Enterprise Education in Botswana, Ghana and Kenya[26]. The full report is included on the resource CD.

Activity 5.2 Visualising my future

1 Ask participants to close their eyes and relax. Play some relaxing music.

2 Ask them to think back to a recent day at work, a specific day which was rather a tiring one. Ask them to try and recall the details of it starting from the moment they got up. Take them through the day asking them what happened at each stage of the day, allowing pauses for them to reflect.

3 Now repeat the process asking the participants to visualise what they would consider their ideal day at work. Explain that the work need not be the job they are currently doing but should be their idea of an ideal job. Take them through the day as before.

4 Discuss the differences between the real day and the ideal day. Ask questions like:
- What were my most important feelings about the ideal day?
- What type of work did I choose for myself? Why?
- Did I work with people, ideas or things?
- Did I use my favourite interests/hobbies/skills?
- Did I work for someone else, or was I in charge of the business?
- Was I satisfied with the job I chose? Why or why not?
- What were the main differences between the real and the ideal day?

5 Discuss the likely outcomes of this exercise if they were to do it with students. The discussion will probably focus on a desire to possess some material goods such as clothes, a phone, a car etc. It may also focus on the idea of a day doing something that they like doing, using the skills that have started to develop. They may not want to be told all the time what to do.

6 Focus the discussion on any activities in anyone's dream that involve women doing things that are normally, in society done by men. List these.

7 Subsequent classroom activities can be built around this dream and how to develop the necessary skills and independence to realise it. Try and identify these skills and characteristics needed to realise the dream.

[26] Also available at www.norrag.org/pdf/Paper%207.pdf

Now ask participants to think about the characteristics of a good entrepreneur (figure 5.1) and about the kind of school activities that might develop these characteristics. These may include any activities that offer learners an opportunity to develop leadership and related skills that are characteristic of an enterprise programme but can be developed through other activities. Focus, in particular, on the female learner. Examples could be

- surveying the community to find out how they viewed the activities of the youth in the community and of the school in particular, with a view to developing a positive response to improve youth-community relations;
- undertaking community based activities;
- joining the community activities of NGOs and FBOs;
- assisting developing circles of support in the community for children orphaned by AIDS.
- establishing and running out-of-school activities such as HIV and AIDS clubs, etc.
- assisting younger students develop learning skills such as how to use the library, how to use a computer to access the internet, etc.

These are all ideas for developing authentic learning experiences for young people to make stronger connections between what they learn at school and the real world.

Activity 5.3 Ideas for developing entrepreneurial skills (2)

1 Show participants the list of key qualities in an enterprising learner (figure 5.1). Discuss the list comparing it with their own from their enterprise curriculum. Add to and/or subtract from the list as appropriate.
2 Select those elements from the list that are key characteristics that are likely to help empower young female students to opt for careers in science and technology
3 In groups (or in a plenary if the number is small) develop ways of helping young female learners develop these characteristics.
4 Share ideas in a plenary

The next activity asks participants to share ideas on how they might give their learners some experience of enterprise in real life by taking them to some small or medium sized businesses and allowing them to question people working there.

Activity 5.4 Finding out about small and medium enterprises

1 Ask the groups to consider the three categories of enterprise, small, medium and large scale. They should discuss the differences of these three, and come up with examples of business they know of that are in each category. The purpose of this exercise is to ensure that the participants (and later the learners) are clear about the distinction between these three categories
2 Ask the groups to develop lesson activities that identify science and technology related small or medium business ventures within reach of the school and arrange for interviews about the business e.g. how they started, resources needed (physical and financial), business competition, business plan and any other issue pertaining to business sustainability.
3 Share ideas in a plenary session.

TOPIC 6 JOB SHADOWING

What is job shadowing?

The job shadowing work experience is a temporary, unpaid exposure to the workplace in a career of student's interest. It is designed to increase career awareness, help model student behaviour through examples and reinforce in the student, the link between classroom learning and work requirements. Students are allowed to experience working life through spending a day or two actually performing real work with organizations. In this case, the idea behind the Job Shadowing is to create a safe learning environment that enables girls to develop interests in maths, science and technology related careers.

The success of the Job Shadowing Program is strongly dependent on the volume of economic activities in a particular locality. For instance, schools in the remotest areas would experience difficulties in identifying work places of the desired quality. In contrast, schools located in urban centres would have a wide array of business activities to choose from. In addition, transport to the work place, feeding and other finances are some of the problems encountered by students and schools participating in the Job Shadowing Program. Therefore, Job Shadowing for girls in mathematics, science and technology requires the organiser to carefully identify placement opportunities within the locality, neighbouring places as well as the wider region that the can be of interest to students and are within reach. Also, a careful environmental scanning may identify some useful school based enterprises that students can benefit from. Schools need to develop strategies that encourage parents and communities to appreciate the value of the programme and deal with the subsequent challenges.

However, the bottom line is that the experiences of Job Shadowing provide students with the opportunity to observe, practise, ask questions and acquire relevant information for future 'career decision making'.

Job Shadowing Programme

Organising successful Job Shadowing

The organisation of Job Shadowing placements has many challenges which can reverse the expected benefits. Firstly, there are teething problems regarding the financial contribution expected from parents to assist in transporting and feeding of children. Secondly, how to ensure the safety of children placed in an industrial environment. Thirdly, the challenge for schools in the rural areas is how to find a placement of the student's interest and ensuring the quality of such placement. Lastly, students who participate in Job shadowing for the first time lack some critical skills to benefit from the programme; such as listening, questioning, interpreting and just being themselves.

The lists below summarise some of the benefits of job shadowing and also the responsibilities of all parties if the experience is to be successful. These are elaborated in the job shadowing teacher guide included on the resource CD.

Materials needed for effective job shadowing

The following materials will be required. developing them can be a collaborative exercise between the teacher and the students before the activity takes place. Examples of these are shown in the teacher guide on the resource CD.

- Student personal profile
- Student evaluation form
- Student self assessment form
- Student question form
- Employer participation form
- Employer evaluation form
- Employer thank you letter
- Teacher evaluation form
- Parent consent form

The benefits of job shadowing

The following are some of the benefits from a successful job shadowing programme. To this list must be added that it can be used to allow girls to obtain experience of a technology related work environment.

- Experience and understand the realities of the work environment
- Exposure to employability and job skills
- Appreciate a wide range of occupational choices
- Understand the importance of good grades for good jobs
- Value of professional training and importance of ongoing learning
- Increase their employability and trainability
- Gain valuable insight on what it takes to be the person you are observing
- Acquire job seeking, retention skills and behaviours to help them make informed career choices.

Some student responsibilities in a job shadowing programme

The student must:

- Arrive at agreed time and place
- Prepare a resume
- Behave professionally at all times
- Be assertive – alert the employer about things you like and what you are not comfortable with.
- Ask questions for broader understanding
- Report back to the school or write a project
- Send a thank you letter to the employer
- If unable to attend contact your teacher immediately
- Collect assessment form from the employer.

Some teacher responsibilities in a job shadowing programme

The teacher should:

- Call employer to arrange placement
- If students are unable to attend contact the employer a week before the planned visit
- Maintain the relationship with employers
- Develop assessment guidelines for the classroom and work place
- Conduct pre-placement counselling for students
- Collect assessment forms from students.

Some responsibilities of the employers in a job shadowing programme

The employer should:

- Be prepared to accept a phone call from teachers and students
- Spend time with your student doing your normal work – Be yourself!
- Complete a short assessment form
- Answer student questions to the best of your ability
- Complete a short assessment form of the job shadowing experience
- Have a short end of visit meeting
- Provide student with 'hands on experience'
- Use different strategies to expose the students to your job: videos, brochures, excursions etc.
- Explain safety and emergency procedures.

Activity 6.1 Thinking about job-shadowing

1 Ask all participants to think of a day in their lives recently. It should be a day in which they can recall details of what they did. It need not be a day at work; it could be a day doing household jobs, looking after children, visiting, working in the community, on the farm, etc. They could be asked to close their eyes and perhaps some music could be played.
2 Ask them to write down in a list, the various skills that they used on that day, *and which someone shadowing them would have observed*. Remind them of the skill categories – dealing with data and information; dealing with things; and dealing with people.
3 In a plenary, make a list of all the skills that the group collectively used on their 'day'. Identify those skills that might be particularly useful in empowering girls to make independent decisions on their careers

In the next activity, the teachers will plan a job-shadowing exercise. The bullet points in the box above can be used for this. These are reproduced on the resource CD. Also on the resource CD is a teacher guide used in Botswana to plan and maximise the benefit from job shadowing.

Activity 6.2 Planning job-shadowing for girls in science and technology-related companies

1 Work in small groups. Plan an outline series of lessons in which job-shadowing is discussed with the students, the reason for, and advantages of job-shadowing are discussed, a plan is drawn up, companies identified, tasks are identified and allocated, etc. The importance of arranging job-shadowing for girls in positions where they can experience work in the field of science and technology should be part of this planning
2 Share ideas with other groups

TOPIC 7 DEVELOPING A PORTFOLIO

A portfolio is a package of a student's achievements that are relevant to their career. Its purpose is to document life or work experience and school achievements. It includes documents, photographs, records letters of commendations, school projects work samples etc. A portfolio includes not just achievements made at school, but also those made in areas of leisure and hobbies, home. Achievements made at home and through leisure activities can be a significant indication of our career potential. Portfolios are often associated with careers in the arts and technology. For instance, learners who would like to go for training in interior design, architecture, design and technology, and art are expected to present a portfolio of their work and talents to be considered for college/university admission. They are also expected to present it for job

interviews. A portfolio is not just important in opening doors for you. It also helps students appreciate their talents and potential, and how these can be translated into a career. A well-presented portfolio is inspirational and motivating and it helps students to really know themselves and set career goals.

The box below (also on the resource CD) shows what kind of material can go into a portfolio The list below is not conclusive and teachers should assist students to come up with more.

What can go into a portfolio

Awards and certificates

Curriculum Vitae

Psychometric tests such as Personality tests, aptitude tests (interest inventories and values surveys etc.

Records of school achievements

Letters of reference form former teachers, employers or organizations you have done community work with

Extracurricular activities

Job shadowing experience

Hobbies

Certificates of attendance and brochures of seminars you have attended

Membership of clubs

Books you have read

Examples of work done

The next activity considers how students might be trained to develop their portfolios. The process could start with how to write about the things that students like doing and do well. It should be in an easily readable attractive format, preferably with photographs. It could be done on a computer.

Another exercise could be to create a well illustrated document that summarises, at a glance, the kinds of things the student might see herself doing later in life. This offers an opportunity for the teacher to help the female students think about technology-related careers. It could contain pictures of women doing this kind of work.

These preliminary exercise can lead to the preparation of a career portfolio. This is a long term project that should include everything that tells the reader who the student is up to this point of her life. The design of the portfolio is very important, it must be neat, attractive and carefully organised. The material must be logically arranged. At the same time, it is important to be simple, and avoid clutter and unnecessary detail. It should be a personal document.

Activity 7.1 Building a portfolio

1 Work in small groups. Plan an outline series of lessons in which job-shadowing is discussed with the students, the reason for, and advantages of job-shadowing are discussed, a plan is drawn up, companies identified, tasks are identified and allocated, etc. The importance of arranging job-shadowing for girls in positions where they can experience work in the field of science and technology should be part of this planning

2 Share ideas with other groups.

TOPIC 8 POSTERS AND PAMPHLETS

Where to find up-to-date careers information is a problematic issue in many countries in Africa. In part this is due to a lack of resources on the part of governments to produce materials for schools and in part it is due to the fact that industry, which elsewhere would produce materials, has not had the incentive to do so in Africa where unemployment is high and there has not been a shortage of applicants for jobs. This situation is now changing, however, and many countries are experiencing high unemployment and also unfilled job vacancies because the skills required by employers are not produced by the education sectors.

This topic therefore looks at four aspects of this problem:

1 What pamphlets, posters and other information sources are available
2 What good pamphlets and posters and information sheets should look like
3 How can such materials be produced?
4 Do these materials actively encourage girls into science related careers

Participants should be reminded in their invitation that they should bring to the workshop examples of materials that are available. Some examples are available on the resource CD.

Some of the material may be online and computers with internet access would be useful to view it. It this is impossible, some pages may be downloaded beforehand. Examples may be the career and vacancy pages of local companies, the websites of Universities, or of the local chambers of commerce or chamber of mines.

The following activity addresses these issues in sequence.

Activity 8.1 Career guidance information sources

1 Allow access to all the materials that have been brought in. Some participants may wish to briefly show what they have found. Show some from the CD, either printed out or using a projector or computers.
2 List the sources of the materials that have been shown. How many of these are government funded sources. Are there differences between government-funded materials and others?
3 As a group, debate and list the most significant gaps in the career information collection.
4 Is there any gender bias in the information provided? Does it address both sexes equally? Does it make assumptions about what careers are 'female' and what are 'male'. How are these assumptions revealed?
5 Discuss the quality of the information provided. Does it satisfy the needs of the learners? Does it give a good, quick picture of what the job is like; does it provide career information; does it outline the qualifications needed; does it give any indication of salary and other benefits; is it up-to-date; is it readable and interesting etc? Identify any gaps and shortcomings in the information.
6 Can the group identify an example of posters or pamphlets that they regard as exemplary? This judgement should include whether the material is pro-active on gender issues, such as showing girls wearing hard-hats, doing scientific and engineering tasks, etc
7 Divide into discussion groups related to different career areas in science and technology. The group should decide on the areas but the following might be examples; medicine and allied health sciences; engineering (this could be split into smaller branches); extractive industries; agriculture and agrochemicals; etc. Ask each group to identify and list the following:

- existing sources of information
- information gaps
- possible mechanisms for filling the gaps.
- what information should be included in the posters or pamphlets (draft specifications)

The output of this session should be an action plan for approaching appropriate bodies to discuss what can be done to fill the gaps and how it might be funded. The participants themselves should be the people delegated to carry out the plan. A key element of the specifications is that the material should make a direct and specific appeal to girls.

8 Share ideas in a plenary and if possible, leave the session with a draft plan that can later be refined and taken to the various industries for discussion.

TOPIC 9 SCIENCE CENTRES

A few countries in Africa have science centres. South Africa[27] has very many and they are of a variety of different kinds. Science Centres are centres devoted to the popularisation of science. Some centres are off-shoots of other science activities such as National Science Laboratory Facilities of various kinds, or of science faculties in Universities. Other Centres are commercially run centres, often set in places like shopping malls, designed to provide an interesting and exciting science experience for all, and particularly children. Others have grown out of museums or theme parks. Some centres have travelling exhibitions aimed at rural schoolchildren.

For South African users of this manual, see topic 2 on workplace visits, contact your nearest science centre (see the SAASTEC website) and organise a visit. Ensure that the science centre organisers are aware that a primary purpose of the visit is to inspire girls to take up science subjects and careers.

The following activity presents some alternative ideas for countries without science centres. All countries have a number of science and research institutions. These probably include institutions such as the following:

- university science departments
- agricultural research institutes and veterinary laboratories
- marine research institutes
- national botanical centres (holding national seed collections etc)
- geological surveying laboratories
- NGO research institutions
- national parks research and management centres
- national museums
- private museums linked to a particular industry
- archaeological research centres
- meteorological monitoring and research centres
- centres for alternative technology research.
- water research and analysis centres

[27] See www.saastec.co.za for the activities of southern African Science Centres

A list of many of these may be held centrally by whichever ministry is designated to oversee science and technological development. Before the workshop try and obtain a list of as many of them as possible. The purpose of the next activity is to initiate a process of creating a network of science and research centres that also have a limited capability of the showing the future science workforce something of what life is like as a research of an analytical scientist.

Activity 9.1 Visits to research and analytical laboratories

1 Present to the group the list of science and research centres in the country that you have been able to identify. Discuss the list and the functions of each centre. Participants may be able to add other centres.

2 Develop a plan within the group for visiting as many of the centres as possible and discussing with the scientists there how they might mount activities that may be useful for students seeking a career in science. During these negotiations have in mind the usefulness of female role models; women who are working in the centre and who may be encouraged to play a part in any presentation to students. During the negotiations also, emphasis the desirability of involving student visitors in some 'hands-on' activities or even some long-term science programmes that might involve a school link.

3 Arrange a process for reporting and sharing progress in these investigations after the workshop.

For ideas on how to integrate research centre visits into the classroom activities see Activities 2.1 to 2.3 in this manual.

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Unit Five

TRAINING & SUPPORTING SCIENCE & MATHEMATICS TEACHERS

Rationale

This unit, and also unit six, is premised on a number of observations. Firstly research has shown that it is not likely that any individual in a learning situation will accept change unless they can 'see' the need for it. Though it is now common knowledge that gender imbalances in science, mathematic and technology areas exist, those affected are often found to be unaware or accepting of the situation and thus would not naturally feel the need to address them. Secondly, much of what goes on in education has been cited in the propagation of gender imbalances; that is, research shows that classroom behaviours, textbooks or other curriculum materials etc., reflect a balance against girls' participation in the areas science and technology. This makes the science and mathematics teacher a key to the process of promoting gender equity in the classroom, but only if they are sensitized to these issues. Thirdly, teachers are well placed to counsel and guide all learners into non traditional areas of learning and work since they spend the greater part of the day with them and command an appropriate degree of respect from learners. Lastly, teacher education has traditionally not dealt with issues of equity in any area and so by the time teachers reach the school, they have little idea about gender imbalance or strategies to redress them. Including gender issues in teacher education appear to be necessary to ensure holistic development of teachers to deal with this aspect of learner development.

Earlier units in this module consider that science and technology education is a gateway to national development and to poverty alleviation and that all sectors of society must be seen to participate optimally in it, including girls. Units 1 and 2 address gender issues at the larger society level but this unit targets serving teachers whose roles and work have direct influence on learners of school-going age and thus on the future of society. Traditionally, guiding these youngsters into career options is often left to chance and thus career choices of non-traditional areas occur infrequently. Who is to blame? This unit, and the next, argue that the whole system, both inside and outside the school has contributed to the current state of affairs. The unit subscribes to NSTA[28] idea that 'discussions about research-based issues related to the pedagogy of gender equity are (should be) an integral part of professional development and teacher education programs'. This unit will address gender issues in science and mathematics classes and in schools generally with a view to removing personal and cultural obstacles placed in the way of girls that inhibit them from choosing science subjects, from performing well in them and ultimately from choosing science related careers.

Target groups

This unit is designed for teachers, advisory staff and administrative staff who organise science, mathematics and technology teaching in schools, It is designed also for those responsible for training and supporting these teachers and for those responsible for the curriculum and its assessment.

[28] NSTA, National Science Teachers Association (US). See the NSTA position Statement on Gender Equity in Science Education on the accompanying CD.

Learning outcomes

By the end of this unit participants should:

- understand the concept of gender and distinguish between gender and sex
- be able to recognise and rectify elements of science teaching, learning and assessment that discriminate against girls
- be able to include in your teaching, activities that are particularly attractive to girls
- be able to identify and rectify elements of the larger school environment that discourage girls from choosing science subjects
- understand and develop your role in encouraging girls to consider science-based careers.

Contents

Items to bring to the workshop

Participants should be asked to bring the following resources to the workshop.

- Science curriculum documents
- Textbooks and other learning materials
- Instruments for evaluating textbooks
- Topic tests and examinations in mathematics and the sciences

Topic 1 UNDERSTANDING GENDER AND SEX

Introduction and overview of the unit

The issue of gender permeates contemporary educational discourse in ways paralleled only by a few other global issues such as HIV and AIDS. The main problem stems from observed imbalances in every walk of life along gender lines. At the school level, gender differences are manifested in participation, performance and achievement levels between boys and girls. In the workplace, gender differences are observed in the differential representation in science and technology related careers also along gender lines. These disparities appear to be related to gender roles defined by society.

As noted in Unit 1, society sanctions certain behaviour from one sex and frowns upon the same behaviour when it involves the opposite sex. Such gender role restrictions result in participatory exclusion of particular sections of society in some activities. For example, society frowns upon boys in the kitchen whiles it expects girls to function in that capacity. Boys are not expected to display emotional reactions while girls are actually expected to do so. Similarly boys are expected to be risk takers while girls are not. Anything hard, rough, courageous and difficult is reserved for boys while anything soft, emotional, nurturing and tender is considered to be the

girls' domain. This and many other factors aggravate differential participation and even achievement in areas of importance. Furthermore these socio-cultural beliefs and expectations of boys and girls are deeply trenched and thus command conformity.

Quite often gender differences and sex differences are confused thus the concept of gender equality and equity is often rejected by society. Teachers emanate from society and could be expected to hold the same contempt for the concept of gender equity unless they are trained to understand it. This unit argues that understanding the difference between gender and sex is central to dealing with misconceptions associated with them. Teachers need to be fully aware of these differences in order to distinguish, not only those due to the sex of the individual from those due to socialization (gender) but also those teacher behaviours and actions that may negatively influence gender differences from those that would enhance or maximize them. The unit also considers the urgency, possibility and desirability of eliminating, modifying or tolerating specific gender disparities as well as consider gender equalities and gender equity. This unit argues that gender differences arise from human behaviour and practices rather than from nature. In the classroom, differences may be aggravated by lack of teacher knowledge about their existence and manifestation and the unit will show how teacher behaviour has been found to perpetuate gender stereotypes and thus marginalise participation of a section of the classroom society in certain activities. Finally, the unit will elaborate strategies for redressing gender inequities and for encouraging girls into non-traditional areas of study.

One of the greatest problems about gender issues is that people confuse gender and sex and use the terms interchangeably. Make sure you understand the difference yourself (more information is available in the resource materials and in module five). The box shows how these differences were explained in Module 5 of the series of Guidance manuals produced by UNESCO for the Guidance, Counselling and Youth Development Centre for Africa.

Sex

Sex is a biological term referring to people, animals, etc., being either female or male depending on their sex organs or genes. Sex also refers to the differences between individuals that make them male or female. These differences are biologically determined. Sex is therefore biologically determined. According to module 5, Stoller says for example:

'...to determine sex one must assay the following physical conditions: chromosomes, external genitalia, internal genitalia, gonads, hormonal states and secondary sex characteristics....One's sex, then, is determined by an algebraic sum of all these qualities, and as is obvious, most people fall under one of two separate bell curves, the one of which is called 'male' and the other 'female'. (Cited in Oakley, 1985, p. 158).

Thus it is not possible to alter the sex or sex related behaviour of an individual. For example child bearing can only be done by a female, sperm production is characteristic of only males.

Gender

Meanwhile, 'gender' has social, cultural and psychological rather than biological connotations. It is defined in terms of femininity and masculinity. While the proper terms for describing sex, for example, are 'male and female' while the corresponding terms for gender are 'masculine and feminine.' Although the latter may be independent of biological sex, masculinity pertains to the attributes that describe males in the social and cultural context. Hence, the 'normal' male has a preponderance of masculinity, while the 'normal' female has a preponderance of femininity. Therefore, 'gender' is the amount of masculinity or femininity found in a person.

Gender also refers to 'subjective feelings of maleness or femaleness (i.e., femininity or masculinity), irrespective of one's sex'. This is known as gender identity. It is possible to be genetically of one sex with a gender identity of another sex, e.g., transsexuals identify themselves with the gender of the opposite sex. This implies that one's gender may not necessarily be synonymous with that of one's sex.

One's gender can be determined in many ways, e.g., behaviour. In most societies, for example, humility, submissiveness, etc., are considered feminine behaviour and women are expected to behave that way. Men, on the other hand, are expected to be dominant, aggressive, risk takers etc.

Other determinants of gender may include dress, gestures, occupation, social networks and the roles played by sexes in society.

This box and also the preceding discussion are reproduced on the resource CD and they can handed out be used in an introductory discussion about expectations from the Unit

Pre workshop assignment

Ask participants to list similarities and differences between male and female as a pre-workshop assignment. They should cover as many differences as possible. They should bring these to the workshop for use in small group discussions. If you do not set the assignment, draw up your own list on flip chart paper. Include physical sexual characteristics as well as social and societal differences.

Activity 1.1 Gender and sex

1 Divide the class into small (about three per group). Ask each group to discuss and reach a consensus about what gender and sex mean. This should be presented to the whole class and further discussion should help the class reach a consensus. If no consensus is reached, note the differences in opinion.

2 Divide the pre-workshop list of male and female differences among the group such that each group gets no less than five differences or similarities. All the characteristics should be covered by the group as a whole but many characteristics will be covered by more than one group. Each group should discuss its list of differences and similarities to discuss and classify them in a table such as table 5.1 below (a copy is on the resource CD).

3 Combine the lists for the whole class. Is there consensus on the classification?

4 Finally discuss the following questions about the characteristics raised:
- Which of these would apply to every society?
- Which of them vary depending on the society?
- Which could have an impact on learning?
- Which can be controlled or altered? How?

Help the group to see that sex differences between male and females are biologically determined and thus can neither be changed or modified and they apply to many living organisms. They are referred to as *male* or *female* characteristics.

Table 5.1 gender and sex features

	Gender features	*Sex features*
Similarities		
Differences		

Table 5.1, together with the text box on gender and sex and table 5.2 are available in the handouts file on the resource CD

Other differences are due to the roles attributed by society to male and female individuals. These similarities and differences differ depending on societies e.g., household responsibilities, emotional reactions, intellectual performance and they can be changed or modified by the same or a different society. They are often referred to as *masculine* or *feminine* characteristics. Ask the group to think of more examples that could be described as masculine or feminine characteristics.

The next activity concerns gender issues that have an effect on learning. Ensure that participants fully understand the differences between biological and social roles; often the social dimension of labour, for example, is treated as a natural or biological phenomenon and this leads to the wrong assumption that women are not capable of playing roles normally played by men and vice-versa.

The discussion should focus on how gender might affect learning, if and how this could be changed or if it should indeed be changed or just tolerated (ie, the advantages and disadvantages of changing). Ensure that the decisions are recorded; they will be needed later.

Sex and gender roles

A sex role is a function or role which a male or female assumes because of the basic physiological or anatomical differences between the sexes. It is a biologically determined role which can be performed by only one of the sexes, e.g., women give birth to children while men make women pregnant. These roles are not exchangeable because they are biologically determined. Meanwhile gender roles are defined as referring to society's evaluation of behaviour as masculine or feminine, e.g., cooking is feminine, while fishing is a masculine role in most societies.

Activity 1.2 Sex and Gender Roles

Working in the same groups as for the first activity ask participants to do the following

1 Look at their list from activity 1.1.
2 Note which similarities refer to sex or gender roles?
3 Discuss these roles adding more to the list.
4 Display (or hand out) and discuss table 5.2 below; it shows the differences between gender and sex roles (adapted from the classification by Susan Basow.)

Table 5.2 Differences Between Sex Roles and Gender Roles

Gender roles	*Sex roles*
May differ from society to society	Same in all societies: they are universal, e.g., it is only women who give birth to children all over the world
Can change with history	Never change with history
Can be performed by both sexes	Can be performed by only one the sexes
They are socially, culturally determined	They are biologically determined

Topic 2 ATTITUDES TO SCIENCE AND MATHEMATICS

A number of studies have been done on what students, particularly girls, like and dislike about their science lessons but few have been done in Africa and this could be a rich vein for potential researchers to mine. It can also be a useful way for teachers to find out about the gender differences in likes and dislikes about aspects of science lessons.

The box below summarises some work published by Joan Solomon, a leading researcher on this issue in the UK, in 1994[29].

Gender issues in mathematics and science

Solomon (1994) suggests that for too long the gender issue has been addressed based on inaccurate theories that suggest ineffective strategies. According to Solomon gender issues have been around too long and there has been too many studies that propose solution that have made little impact on the problem. She calls many of these theories 'reductionist' theories because they tend to place the girl child in the position of inability. For example, she describes the initial dominant theory that explains the observed phenomenon in terms of sex characteristics. That is, girls are said to be incapable of handling scientific and technological tasks due their genetic makeup which determines their nurturing roles. After all, the child bearing characteristic is seen to go hand in hand with nurturing characteristic.

Proponents of this theory would say do not attempt to solve the problem because it is natural. Gender disparities are considered to be fair and thus the status quo is maintained. However, this claim has not produced consistent evidence and therefore was rejected.

The second theory says that girls' lack of participation and performance in science and technology is due to stereotyping. According to this theory affirmative action should solve the problem. Again Solomon views this to concur with the reductionist theory in that softer options are offered to girls. The underlying assumption is that girls are unable to perform in the harder options. According to Solomon, this theory must be rejected as well on the similar grounds as the last.

The third approach is to look at the reason why boys and girls chose what they do and what affects their interest. She concluded that:

- Boys do not necessarily choose the hard sciences because they have an interest in it while girls who do tend to maintain interest.
- Girls tend go for socially constructed knowledge.
- Girls get more emotionally involved in discussions while boys stick to the clear cut mode.
- Girls tend to be interested in something that involves personal values and ethical issues while boys tend to 'want it straight from the scientist' and have no interest in discussion where no clear cut answers are available.
- Boys tend to choose hard science options because of prestige rather than liking it
- Boys are influence more by 'finding it easy' while girls tend to be influenced by enjoyment.

Based on these observations, Solomon suggests that rather considering hard/soft science, education should consider how the science, hard or soft, is presented. It is a question of appeal rather than ability. The way science had traditionally been presented it appeals only to boys and to girls.

This discussion makes reference to a supposed spectrum of sciences ranging from what might be considered 'hard' science to 'soft' science. This categorisation, which is often used (but perhaps not very helpfully) is a measure of the extent to which science is related to everyday human activities and environment. Thus, abstract pure mathematics or the mathematical aspects of cosmology will be at the 'hard' extreme of the spectrum, the biological sciences are generally seen as 'softer' and the human sciences such as psychology are at the 'soft' end of the spectrum. It should be noted that this should not be seen as a gradation of difficulty but of kind.

[29] Solomon J. and Aikenhead G. Ed. (1994). STS Education. International perspectives on reform. Teacher College Press. London.

Because most of this research on girls' likes and dislikes in relation to science and mathematics education comes from outside Africa, it will be more productive to investigate the actual likes and dislikes of the girls in the school to gain useful local knowledge and also to gain information on the extent to which the kind of results obtained by Solomon transcend cultures. The next activity focuses on the development of an instrument to gather such information.

The basis of the instrument is a five point scale where 1 = dislike very much and 5 = like very much. This is applied to any aspect of science teaching they wish to identify, such as group practical work, answering written questions, etc.

Activity 2.1 Girls' attitudes to science

1 Working in groups ask participants to develop a questionnaire that girls could complete that gives some information on their likes and dislikes in relation to school subjects.

2 Questions should move from the general to the particular starting with likes and dislikes about the school, likes and dislikes about subjects to what they specifically like and dislike about mathematics and science. These questions about mathematics and science should address very specific teaching strategies – such as individual practical work, group practical work, etc. They should also focus on different topics that have been studied recently. Do not worry if the questionnaire is quite long but ensure that questions do not overlap – avoid repetition.

3 Teachers might like to ask about spare-time activities to give an idea of their interests outside school which might be exploited in their science or mathematics lessons.

4 They might also consider developing a similar questionnaire for boys to give information on differences.

5 Once the questionnaire has been developed it should be refined within the groups if time allows and then time should be given to a plenary presentation of all the questionnaires. Give some thought to how this can be done that makes best use of time. One way would be to ask one group to make a presentation and then ask all the other groups only to add something that is different and has not been mentioned earlier.

6 All participants should have a copy of all questionnaires to take away.

7 Suggest to the participants that this is something that they may wish to collaborate on so that it could become a national research topic and ultimately be published.

Topic 3 GENDER SENSITIVE SCIENCE AND MATHEMATICS TEACHING

This topic addresses a number of issues related to science and mathematics teaching that have (or may have) a gender dimension that may have a deterrent influence on girls. The sub-topics that will be addressed are the following:

- Curricula
- Teaching and learning materials
- Teaching styles
- Contextualising science and mathematics topics
- Classroom activities
- The learning environment
- Assessment practices

These issues could be addressed in a series of sequential activities or in seven parallel activities (or in a combination of the two). If they are addressed in parallel a plenary reporting and discussion session will be needed to draw the ideas together at the end. The advantage of sequencing the activities is that all participants will have an opportunity of considering each issue in depth. Treating the issues in parallel groups will take less time but will not give an equal chance for all participants to debate each one.

Curricula

In the next activity participants will develop their own gender lenses that are designed to analyse science and mathematics curricula. The concept of a gender lens has been covered in Units 1 and 2. If the participants have never met the idea before some preliminary work from Unit 1 will be necessary.

For this exercise to be effective, participants should have copies of their science or mathematics curricula with them. Some examples of curricula are included on the resource CD

In drawing up the gender lens they should consider what are the known difficulties and deterrent influences that girls experience with the curricula and develop questions around these difficulties. Some difficulties are listed below and if these are not raised, give them as examples to the groups to consider or add them to the plenary discussion at the end of the activity. Alternatively the list could be fed into the initial discussion:

- Do the examples cited in the syllabuses have any gender bias?
- Are topics that girls are known to have difficulties with introduced at an appropriate time, or are they introduced too early?
- Do the syllabuses recognise and cater for known dislikes of girls?
- Are process skills specifically mentioned in the syllabuses and if so, is there any gender bias in the recommended way of teaching and assessing them?
- Are the sciences to be taught in an integrated manner or as separate sciences?
- If the sciences are separate are they compulsory or optional?
- Are there any gender issues related to the curriculum outlined in the introduction?
- To what extent does the curriculum touch on everyday life matters, particularly moral and ethical issues?

Activity 3.1 Developing a gender lens to analyse curricula

1 Remind participants of the purpose of gender lenses and of their characteristics. Show some examples of gender lens instruments (see resource CD, Unit 1, Topic 4). Discuss with the whole group the kind of things that they might look for in a curriculum that is as relevant and appealing to girls as it is to boys
2 Ask them to work in groups. They should limit the lens to a small number, perhaps 10, of the most important issues.
3 Participants should then use the lens to analyse their own curriculum documents.
4 Allow groups to share and discuss their ideas in a plenary session. A single exemplary gender lens instrument could be developed based on the contributions.

There are several issues that could fed into the final discussion on this topic

- It is known that girls do better in integrated science programmes than in the separate physical sciences
- Girls are attracted to cultural and value-laden aspects of science
- Science curricula, particularly physical science curricula are often constructed around, or illustrated by, interests that are traditionally male.
- The work of female scientists is seldom included in curricula
- Girls often dislike (and do badly in) the kind of practical work done in more traditional science classes, particularly physical science classes. In part this may be because the image of physical science practical work is closely related to traditional male activities such as technical workshop activities. Care is needed in devising activities to ensure that this is not the only image presented by practical work.
- Even if the curriculum documents themselves may be largely gender neutral, their interpretation can be very gender biased. This happens when the curriculum becomes contextualised (see below) in the learning materials and in the teaching. Curriculum documents often contain suggestions of such contextualisation and this element of them should be very carefully reviewed.

The two lists above are available on a file on the resource CD if the facilitators wishes to hand them out.

Learning materials

In this activity participants will develop their own gender lenses that are designed to analyse science and mathematics learning materials. Thy should have brought some textbooks with them to analyse but it would be sensible to have some on hand in case there are not enough to work on.

The learning materials should not only be looked at for bias in content, context and illustrations, but also for whether their general approach could be described as 'girl-friendly'. The organisation of the content and the activities embedded in it should be looked at; bearing in mind the known preferences of girls for more highly contextualised science particularly linked to moral or ethical issues. The contexts must be real to them. (see below)

Most ministries will have developed instruments for evaluating learning materials so that schools can be advised on their relevance and usefulness. Try and have copies[30] of one or more

[30] A copy of the instrument used in Namibia can be found on the accompanying CD.

of these available at the workshop so that the gender elements in it can be checked against the lens they have developed.

Activity 3.2 Developing a gender lens to analyse learning materials.

1 Remind the participants of the work done on gender lenses in Units 1 and 2. Remind them of the purpose of such instruments and of their characteristics. Show some examples of gender lens instruments.
2 Ask them to work in groups. They should limit to lens to a small number, perhaps 10, of the most important issues.
3 Ask them to analyse the science or mathematics learning materials they have brought using the gender lens that has been developed.
4 Allow groups to share and discuss their ideas in a plenary session. A single gender lens instrument could be developed based on the contributions.

Teaching styles

The next activity requires some knowledge of the process of peer coaching whereby two teachers help each other by observing each other in the classroom. Peer coaching is a powerful self-help tool for improving teaching quality. A key element in peer coaching is the agreement before observation sessions on exactly what aspect of teaching will be observed and commented upon. In this case, a list of possible gender-related elements of teaching styles should be agreed between the two teachers.

The box shows a page from a peer coaching guide[31] that has been used in Botswana. This is included on the CD – as is the whole guide – and could be given to the participants and discussed as an introduction to peer coaching.

It will also be necessary to discuss what a simple classroom observation instrument should look like. The important point here is that it must be something that can be used quickly and easily (ie by just ticking in table cells). A simple idea is a table with columns representing the different parts of the lesson plan and rows showing a small number of teaching activities (see a possible list below in activity 3.3) to be checked for gender bias. Each activity would have a 'girl' row and a 'boy' row.

Peer coaching

What is peer coaching?

Peer coaching is a confidential process through which two professional colleagues work together to reflect on their teaching and share ideas, in order to improve their professional skills.

Peer coaching involves two teachers, taking turns in coaching and being coached. As a coach, you observe your colleague and provide feedback. As a coached teacher, you teach a lesson while being observed by your colleague, and discuss the lesson with your colleague afterwards.

Benefits of peer coaching

Peer coaching offers you an opportunity to learn from your peers by sharing knowledge and ideas. This can be beneficial in a number of ways:

- A coaching partner can help you to implement new teaching skills in your daily teaching. When you get back to school after a training workshop and try to implement your newly

[31] Guidebook for peer coaching activities, UB-INSET. Included on the resource CD.

learnt teaching skills and methods it is often more difficult than expected. Students may behave differently from what you expected or intended, resources may be lacking, or timing may become a problem. Peer coaching may help to overcome short term discomfort in the interest of longer term learning and development. Together with a coaching partner you can share and solve initial problems and celebrate successes.

- Observing a colleague teach may bring you a lot of new ideas, tempting you to refresh your teaching repertoire. It may help you to come up with new, and perhaps easier methods of teaching.
- Together with a colleague you may be better able to look for solutions for certain problems than on your own: two know more than one.
- Feedback from your colleague helps you to reflect on your teaching and to look for ways of refinement and improvement of your teaching repertoire.

Activity 3.3 Creating a peer coaching instrument on gender bias in teaching style

1 Start the session by explaining what peer coaching is and how it can be used to improve teaching quality without any outside assistance (copies of the guide on the resource CD could be handed out). Explain that teachers using this tool to investigate gender bias in their lessons will probably be surprised to find that their teaching exhibits gender bias when they thought it did not. Much bias is subliminal and the teachers are unaware that they are showing it and likewise the girls themselves may be unaware of it; its effect on them may also be subliminal.

2 Ask the group to develop a simple instrument that can be used by an observer of a lesson that will give an indication of any gender bias in the teaching style being observed. Ask the group to try and think of as many examples as they can of possible gender bias and then choose perhaps four (or any number they wish) that they would consider the most significant.

Start the session off by suggesting one or two examples of bias (from the list below) to the group to start them off. Ask for all the ideas to be written on a flipchart.

- directing questions more to the boys than to the girls
- looking at the boys rather than the girls when addressing the class
- favouring groups of boys rather than girls when assisting with group (practical) work
- praising boys more often than girls
- evidence of a different attitude towards girls than towards boys in the class
- using examples from the traditionally male world to illustrate concepts
- are there any detectable expectations in any aspect of the teaching about girls' ability in the subject relative to the boys'
- etc; the list is not exhaustive.

2 Ask them to split into small groups and develop a peer coaching instrument for a typical lesson using a small number (say 4-6) of the teaching activities on the flip chart. Give assistance if needed.

3 Display and discuss some of the results.

4 After the workshop encourage teachers to pair up in their schools and use the instrument. If they are to meet again in a subsequent workshop, allocate a session for reporting back.

5 Try and ensure that all participants have a copy of all the points on the flipchart (in the workshop report perhaps) so that all of them are available for use in subsequent peer coaching exercises.

Contextualising science and mathematics topics

Solomon [32] claims that when physics is contextualised the difference in performance between boys and girls diminished. So a possible solution to this problem may be to contextualise science teaching in a way that links it more firmly with the world of the learner. The box below gives one example of what this might mean

What is meant by 'Contextualising Science Teaching?'

Contextualisation means 'Teaching science through its applications'. This approach is based firmly on the constructivist theory of learning which suggests that learners construct meaning from instruction based on what they already know and experience. This theory says that new information is linked in some ways to existing knowledge such that a broader or even different understanding of the existing knowledge results. To facilitate this process instruction makes deliberate effort to bring up existing knowledge so that it is confronted, challenged, discussed and developed. Therefore, contextualised teaching presents a familiar or potentially familiar scenario, activity or picture from real life experiences and then challenges students to speculate from the point of view of their existing knowledge. This exercise tends to allow learners to clarify their own conceptions of the situation and may even reveal misconceptions. Both boys and girls benefit from questioning their mental models and understanding their own way of thinking. Girls may become particularly interested when speculations invoke emotions or touch on value and morals.

The main difficulty around contextualisation of science is the potential loss of a systematic approach to learning that could lead to omissions and to confusion. Syllabuses tend to be laid out in a systematic manner whereas a context-based approach to teaching may include a number of disparate elements in the syllabus linked to a context.

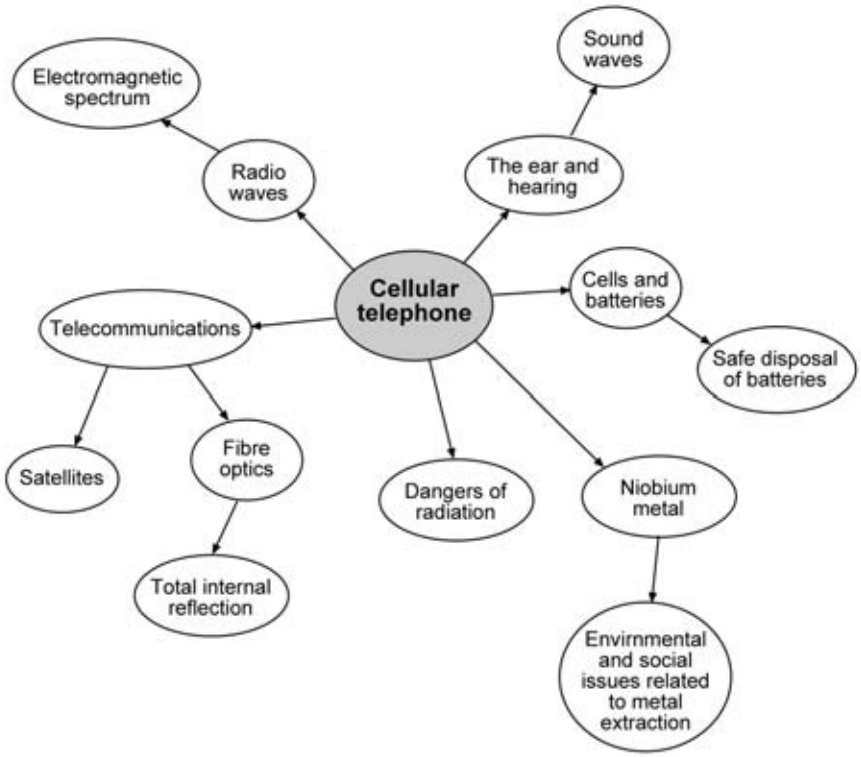

Figure 5.1 Using the cellular telephone as a context for teaching science topics

The concept map above shows how a number of elements of a physical science syllabus can be taught starting with a central context.

The concept map shown illustrates how a large number of topics can be developed from a single context, the cellphone. A simpler approach would be to use this context to teach just one such topic; perhaps the electromagnetic spectrum.

[32] Solomon J. and Aikenhead G. Ed. (1994). STS Education. International perspectives on reform. Teacher College Press. London.

The key element in contextualisation of teaching is to start with the context as this is what the learners are familiar with. The science is then taught by developing ideas from the context; by asking questions like 'how does a cellphone work?' An important point to note is that this is the reverse of the traditional way of teaching which would start with the science - say the electromagnetic spectrum - and the cellphone application would be added as an unimportant afterthought (or not be not added at all).

Activity 3.4 Develop a short scheme of work for teaching a topic starting with a context

1 Working in small groups with the same subject interest, select a topic from the syllabus (any grade) and develop a concept map showing how the topic can be taught around a central interesting context that is part of the daily experience of the learner.
2 Develop the concept map into an outline scheme of work that shows in more detail how you would use the context to teach the basic scientific principles
3 Display selected ideas to the whole group and allow discussion

Participants may need assistance with this or some contextual ideas could be provided. Possible ideas are

- Use the context of what makes clothes comfortable in cold weather and lead via the insulating properties of different fabrics to the concept of conduction of heat
- Use the context of water to lead to a variety of different concepts according to phase. These could include solubility, energy, changes of state, pollution, density, pressure, etc
- Use the context of the refrigerator to study phase changes, particle theory and latent heat.
- Use the context of growing crops as a starting point for a variety of biological concepts such as photosynthesis, plant growth, soil structure and types, energy flow in living systems, food chains, environmental conservation, etc.

Developing a scheme of work from the concept map may be a task that some teachers will find difficult. For this reason not all ides should be displayed. Select some of the best for the final display and discussion.

Classroom activities

There is a considerable amount of research evidence on gender related likes and dislikes related to classroom activities but very conducted in the African context. Some of the work suggests, for example, that group practical exercises in physics and chemistry can deter girls from the subjects whereas they have the opposite effect on boys. This probably arises because the girls feel that the activity is inappropriate for a female; i.e it did not fit well with the conventional female stereotype. It is important when teaching the subjects therefore to include a mix of different kinds of activities including ones that girls enjoy and feel happy about doing. The next activity encourages the participants to think about the kinds of activities in science and mathematics that girls might enjoy.

The activity will require a list of science and mathematics activities that the participants will be asked to rank according to how attractive they may be to girls. The list below (also on the resource CD) can be used as a start.

Science activities

- Making paper or polystyrene models of simple molecules
- Caring for a laboratory fish tank
- Making a long poster display showing the main periods of the geological timescale
- Demonstrating Ohm's Law for a fixed resistor
- Making a periscope
- Talking in groups about how to mitigate the impact of HIV and AIDS
- Setting up and using a pulley system to lift a heavy load
- Drawing the image of a cell seen under a microscope
- Discussing how the global warming might influence the climate of southern Africa
- Separating salt from a mixture of sand and salt
- Growing a large copper sulphate crystal
- Writing in their books the answers to questions written on the board

Mathematics activities

- Making hollow shapes out of cardboard from nets
- Showing experimental probability using dice
- Solving problems using linear equations to model real situations
- Constructing and interpreting straight line graphs
- Drawing and using bar charts to illustrate grouped data
- Solving numerical problems related to the cost of vegetables
- Solving data problems related to football results
- Solving data problems related to mobile phone ownership
- Multiplying decimals mentally
- Comparing datasets using mean, median and range

Activity 3.5 Bias in classroom activities

1 In subject groups, consider the list of science and/or mathematics activities. Ask them to rank them according to how much they think they might appeal to girls. Discuss the reasons for the decisions. (For the ranking they could use, if they wish, a scale of 5 where 1 means that girls might thoroughly dislike the activity, three is neutral and 5 means they would like the activity very much). Participants should then add some more activities of your own to the list.

2 Discuss the exercise in a plenary session. Teachers will probably realise that the bias often depends on how the activity is carried out. Try and draw some generalised conclusions or rules for the two subjects for carrying out activities in a manner that ensures that girls enjoy them as much as boys.

   Teachers may wish to consider how extra-curricular science activities may be used to inculcate an interest in science among girls (see below 'extra-curricular science and science fairs')

3 Ensure that the conclusions from this session are circulated to all participants.

One conclusion that participants will probably mention is that very often the appeal of an activity will depend on the context (particularly in mathematics). A mathematics problem that is directly related to the lives of the girls will be more appealing than the same mathematical technique applied to a problem that is remote from their lives. This has been addressed in Activity 3.4.

A second point that should be mentioned is that if teachers always try and devise activities for girls that the girls feel happy with, then they are actually reinforcing the stereotyping that they are trying to undermine. Finding the right balance is a complex issue.

Extra-curricula science and Science Fairs

Experience shows that girls often out-perform boys in extra-curricular science work and science fair exhibits. There are many possible reasons for this that may be related partly to the fact that the girls may be free to choose science projects that are of particular interest to them, and also because some of the skills that are important in such work, such as communication and presentation skills, are those that girls often excel in.

No activity is suggested for this section as the topic has been mentioned in Activity 3.7. The resource CD includes self-training material to assist teachers develop extra-curricular science and mathematics clubs and enter students in science and mathematics fairs.

The learning environment

This activity encourages teachers to think about the learning environment for teaching mathematics and science. While primary teachers often have realised the importance of an attractive learning environment, many secondary classrooms in Africa are bleak unattractive places with broken windows, broken or scratched furniture, dusty surfaces and dirty floors. This activity addresses two issues, firstly why is this the case in so many schools and secondly, if it can be rectified, how can the science or maths learning environment be made particularly attractive to girls.

The activity is in two parts, the objective of the first part is to pinpoint school management issues that must be addressed in order that conducive learning environments can be created and maintained. The second part considers how such learning environments in maths and science might be made girl-friendly.

One outcome of this section must be the realisation that in order to create a positive learning environment, it is necessary for the teacher to ‘own’ the room so that he or she can oversee what happens in it. This is normal in primary schools but very often in secondary schools the learners stay in the room, often unsupervised over breaks, and the teachers move between the rooms. This means that the teachers have no control over their learning environment. Solving this problem requires timetabling skills that senior management may not have.

Activity 3.6 Making the learning environment welcoming to girls

Part 1 This activity should be a fairly large discussion group which will allow ideas from different schools to be heard.

1 Describe a typical classroom in a poorly run school - no teacher supervision, dusty surfaces, dirty floors, no storage space, no pinboard or nothing on the pinboard, damaged furniture, broken windows. Ask teachers to indicate if the description is typical of their school. Some (or many) may raise their hands. Ask the group to list reasons why this is the case; write the points on a flip chart.

2 Ask the group if there are examples where this is not the case and where attempts to create a conducive learning environment have been made. Ask the group to discuss the necessary pre-requisites for this to happen. List these pre-requisites on a flip chart.

3 Ask the group to debate the issues raised and develop a list of actions that should be taken by a school that will permit conducive learning environments to be maintained. It is likely that this will focus on the requirement for teachers to be in charge of the classroom environment that they are trying to create.

Part 2 This part should be done in subject groups

1 Discuss within each subject group mechanisms for creating a working environment for the study of the subject that might particularly appeal to girls. Include in the discussions how girls might become voluntarily involved in the development and maintenance of the environment. List ideas on a flip chart

The conclusions from both these discussions should be made available to all after the workshop.

Assessment practices

Assessment practices in mathematics and science can be analysed for gender bias. Teachers should be asked to consider the assessment practices used in the schools and examine them through a gender lens. Participants should have brought to the workshop some examples of topic tests and examinations. They should recognise the various different forms of assessment that they use and be able to analyse them for significant gender elements:

- formative assessment; questioning, class written work, homework, etc
- summative assessment; topic tests
- summative assessment; examinations.

Activity 3.7 Gender bias in assessment

1 Work in school and/or subject groups

Part 1

2 Return to the peer coaching exercise (activity 3.3) and discuss what, if anything, should be added to the instruments used in the peer coaching exercise to ensure that formative assessment techniques used in class teaching are analysed for gender bias. The obvious issue of questioning may already have been debated but the informal assessment techniques associated with helping with problem solving exercises and group work may not have been.

Part 2

2 Modify the gender lens developed for materials (activity 3.2) so that it can be used for topic tests and examinations.

Topic 4 THE ROLE OF THE SCHOOL IN PROMOTING GENDER EQUITY IN SCIENCE AND MATHEMATICS

This topic addresses the many issues that have an impact of the issue of girls and science that are beyond the control of the science and mathematics teachers alone. There are many whole school issues that affect subject choice ranging from admissions policy, through staff appointments, timetabling to the very important matter of school ethos.

In the first part of this topic, participants will conduct an analytical exercise to reveal any elements of gender bias that have an impact on girls taking science or mathematics subjects. Then, in the second part, they will look at how to develop a school action plan to address these issues over time.

Inadequate school management is a major cause of underperformance in schools. Many of the elements of this topic address management issues that are generally as well as also having a gender dimension. Improving school management generally is likely to also improve gender related problems. The importance of school senior administrators attending this kind of training will be obvious.

Whole school gender inequities

In this activity participants should return to the activity in Unit 2 in which a gender lens was developed to look at institutions. This lens will be refined to look at the school. Additionally, it is useful to develop some 'operational notes' to help use the instrument. The ultimate purpose of this is that teachers should be able to expose the gender inequities of their institution in a convincing manner and to suggest ways of combating them. If time permits, they could use the instrument to carry out an initial analysis before they leave the workshop.

Below is a list of whole-school issues that could have an impact on the progress of girls in science and mathematics subjects. This list is also on the resource CD. It should be prepared for the group either on a flip chart or ohp or given out as a handout. It is not a complete list.

- school admissions policy; are equal numbers of boys and girls admitted
- school subject choice policy generally; are there gender implications (e.g. home economics vs technology, netball vs football)
- school subject choices in sciences (mathematics vs biology, technology vs biology etc)
- gender balance in staff, senior staff, science staff
- advocacy processes encouraging girls to take non-traditional subject choices
- timetabling processes that force subject choices along traditional gender lines
- advice to parents on subject choices
- school ethos and beliefs; in particular, what achievements does the school hold to be its most important and significant goals
- what actions are routinely taken to ensure and monitor gender equity?
- etc

Activity 4.1 Developing a gender lens for looking at whole school practices

1 Ask participants to work in groups of 6-10 to ensure a lively debate. Ask them to produce the results of Activities 2.1 and 2.2 in Unit 2 applied to a school. Alternatively they could be given an example of such a lens..

2 Before they start the group debate ask for suggestions of school management issues that may have an impact on girls' progress in science subjects. Write their suggestions on a flip chart. Then show them the list above and ask for comments on it. there should be some overlap between the issues they raise and the ones on your list.

3 Ask groups to develop quite a complex whole-school gender analysis instrument that also has, where appropriate, some notes on its application. These notes should clarify what each question is looking for and how it might be applied.

4 Draw the ideas together in a plenary such that participants can leave the workshop with as good a product as possible (some participants may be persuaded to take this process further on behalf of the others either during or after the workshop to produced a polished product).

5 If time allows, participants may break into school groups and apply the instrument to their own institution and then share their main findings with the group.

Whole school development plans

This section looks briefly at whole school development plans and self-help monitoring instruments. This can be omitted if schools already have experience of such plans. This is a major topic and the short introduction here does not do it justice. Nevertheless, teachers that have never been involved in school planning and school performance analysis may find it useful before they move on to the next section.

This section builds on two useful resources that are included on the resource CD. These are:

- *Schools Count: World Bank Project Designs and the Quality of Primary Education in Sub-Saharan Africa,* by Ward Heneveld and Helen Craig. World Bank Technical Paper No. 303, 1995, ISBN: 0821334603
- *Building Capacity from Within; School Improvement Program,* Basic Education Support Programme, Namibia, 2005

The first document, 'Schools Count', is an analysis of research into school improvement programmes worldwide that also suggests a framework for African school improvement programmes where self-help is a key element. The second resource is a package of resources based on the *Schools Count* framework that have been used with some success by the Basic Education Support Programme[33] (USAID supported) in northern Namibia.

The framework described in *Schools Count* is summarised in figure 5.2 below. The Namibian team has taken the framework and developed a series of self-assessment instruments based on groups of measurable indicators that between them, cover all the factors related to effectiveness covered in the framework. The Namibian instrument is organised in the following four categories:

[33] The Basic Education Support (BES) programme has been successfully operating in primary schools in northern Namibia for some years and has self-help at its centre. It is supported by the United States Agency for International Development (USAID) and managed with the assistance of the Academy for Educational Development (AED). Their materials are used here with permission.

1 School management and leadership;
2 Teaching and learning practices;
3 Parent and community support;
4 External support (in terms of materials and other assistance from the government and other agencies).

Each indicator used in the Namibian instrument is assessed on a 4-point rating scale with 4 being excellent and 1 being very poor or absent. This allows an overall rating to be calculated for the school. Also part of the instrument are places where the school staff write in any can collective decisions on areas of improvement that they can concentrate on before the next self-evaluation.

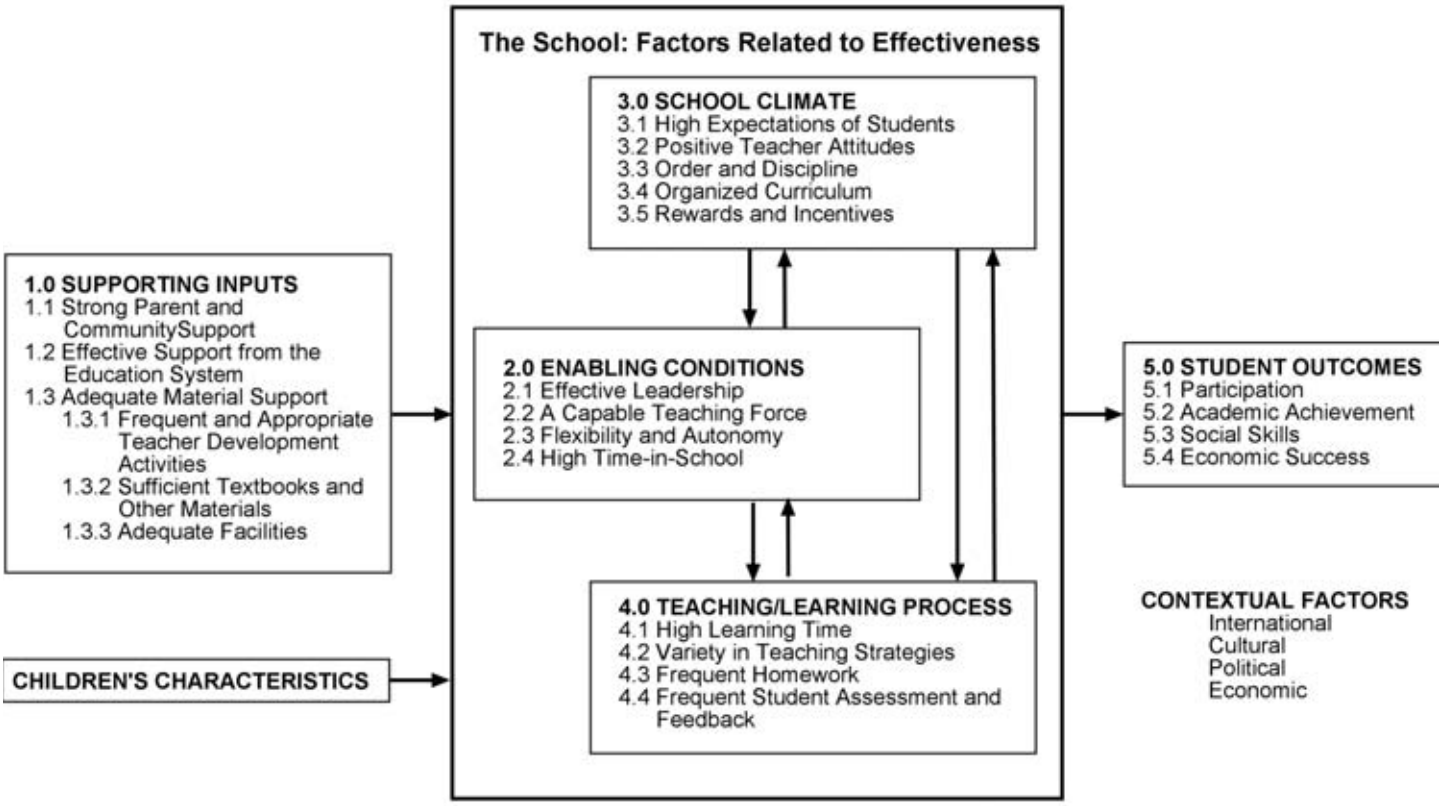

Figure 5.2 Conceptual framework for whole school development
(from Schools Count, Heneford and Craig, World bank 1995)

The next two activities make use of the Namibian document. The first exercise is designed to familiarise the teachers with the document and the second is designed to get the teachers thinking about how the document might be modified (if at all) to include supporting girls' education so that they are encouraged to take science subjects. Note that all that can realistically be achieved at this stage is a familiarisation exercise; quite extensive training is required to use the instruments effectively.

Ensure that there are enough copies of *Building Capacity from Within; School Improvement Program* (BES, 2005) for all participants

Activity 4.2 Familiarisation with a whole-school self assessment instrument

1 Hand out copies of the self-assessment framework (figure 5.2) or display it. Make a short plenary presentation that summarises the framework for school self assessment. Allow questions and discussion. Background information for this can be obtained from Chapter 3 of Schools Count, available on the resource CD.

2 Hand out copies of the Namibian self-assessment instrument Building Capacity from Within; School Improvement Program. Take the group through the instrument, particularly pages 2-4 so that they understand what it is.

3 Divide into groups not less than eight. Within each group ask the teachers to work in pairs (or more), one pair to each of the four categories. They should complete the them for an imaginary school that bears some similarity to the school(s) that each pair are familiar with. The important element of this task is not that they should agree on what the mark they give for each indicator means in practice.

   Example – *Under the indicator 'parents monitor attendance, volunteers visit homes of absent learners'(3.2.1g) they may decide that in the school there is a small groups of parents that are active in two of the communities that send children to the school and between them only four visits have been made in the past term to check on children whose attendance is poor and who are showing signs of distress. They might, after discussion, award a mark of 2 against this indicator. This is a poor score and it is an area that could be improved.*

4 It does not matter if this exercise is not completed; the purpose is to give them a flavour of what is involved. If it is, all the results could be put together on the final sheet. They need not discuss the 'Actions we can take' sections.

The next activity can follow directly on from Activity 4.2. Participants will note that there are a few very general gender matters in some of the indicators. They should now think up some indicators that explicitly refer to girls science and mathematics education. Ask participants to think back through all the activities in this unit and in unit 2.

A good indicator is something that can readily be measured. Thus, in the section on teacher attitudes, a phrase like "male science teachers show sympathy for female learners" is not as good as "female learners perform at least as well as male learners in science lessons taught by male teachers." This second one is a possible expected outcome if the first one is happening.

Activity 4.3 Adding gender elements to a self-assessment instrument

1 Work in subject groups of about 6. Look through the instruments (including the school performance data) and add some indicators that can be used to measure the success of the school in attracting girls into science lessons and providing them with an effective programme which they enjoy and succeed in. These can be written on cards and posted. As they are posted similar suggestions can be grouped together. In this activity they should make use of the gender the lens developed in Activity 4.1.

2 Share all the ideas in a plenary session and develop a set of six (say) key indicators that show how well the school is performing in this area.

3 Ensure that participants have a copy of the indicators to take away with them.

Whole school gender action plan

The next section looks at the action that a school could take for redressing any gender related imbalances that the previous analytical tools might uncover. This corresponds to the third section in each of the Namibia categories; 'actions we can take'.

Participants should look through the main issues emerging from activities 4.1 to 4.3 think of ways that possible imbalances might be addressed. Some might be redressed immediately by some quick actions while others might require some training (such as in timetabling skills) and still others might be ideas that take several years to phase in (such as a change in subject choice options)

Gender issue	Possible action plan development activities	Responsibility	Timing	Resources needed
Gender discrimination in subject choices	• timetable training • establish a process for developing a phased 5 year plan for revising subject choice mechanisms so that thy are free of bias • plan for changes in teaching skills required			
School gender policy	• appointment of a policy making committee with senior female representation. • develop and agree broad terms of reference for the committee and give a reporting date			
Gender balance among science staff (assumed in this example to be mainly male)	• consider balance • advertise for and offer preferential appointments to females			
Gender advocacy among parents and community groups	• establish a committee to produce costed recommendations on procedures, taking into consideration examples elsewhere • implement procedures and modify in the light of experience			
Gender sensitive science and mathematics teaching	• identify and prioritise the elements of teaching that should be addressed • identify existing gender biases • develop training programmes aimed at eradicating biases	Heads of departments and subject heads	Forthcoming year	Cost of training programmes

Table 5.3 Some example elements of a gender action plan

The main outcome of the debate will be a framework for a school plan for addressing gender issues. It should be noted that some of the proposals may have a significant impact on major elements of school administration, such as the teaching skills required of the staff

Some illustrative examples are shown in table 5.3.

The school already has a development plan then the gender issues can simply become elements of the plan as appropriate. Where the school does not have a plan then the task is a much more complex one and the first activity of teachers is to advocate for (and present examples of) such a plan as it is likely then gender lens will throw into focus many other deficiencies that are not necessarily gender related.

It is important here to emphasis that what the participants will be doing in the next activity is to develop a process for developing a gender plan and not the plan itself. **They must be very clear that they are not making decisions on what should be in the final plan but rather they are identifying the activities that can lead to those decisions**. Participants will probably find this distinction difficult to grasp and much time can be wasted in debating the decisions themselves rather than simply identifying a process for making them. Warn them of this and tell them that you will interfere in group debates that stray in this respect.

Activity 4.4 Laying the foundations for a whole school gender action plan

1 Present the idea of a whole school gender action plan to the whole group. Use examples from table 5.3 to illustrate some of the possible elements of such a plan. Allow time for discussions and for examples of good practice – of school plans and gender plans and policies – to emerge.

2 Then divide into groups as in activity 4.3. to develop the elements of possible generic gender action plan that can be applied to a wide spectrum of schools. it is anticipated that the indicators that they have developed earlier can be used to assess how well the plan is working. Groups could outline the elements of their plan on flipchart paper and use a format as in Table 5.3. Note that they need not necessarily at this stage consider the details that will eventually go into columns 3 to 5.

3 Share ideas in a final plenary. As in activity 3.1, a group or individual could be encouraged to produce a polished version of the deliberations as a workshop product

Topic 5 THE SCIENCE TEACHER AS A CAREER ADVISER

> 'Though it may sound heretical in a book on science education, my suspicion is that if girls and women saw that employers whether academic or industrial, were actively willing to hire and promote women scientist and engineers, and to put in the necessary social supports to make their participation practicable, the message that science was welcoming to women would reach down into the process of science education, making the task of transforming the pedagogy easier. The difficulty for science educators is that girls and boys can read the sharply gendered message still being sent from the scientific labour market, including that of science education itself '[34]

Unfortunately in most parts of Africa, employers are not yet noted, generally, for their willingness to hire women to work in science related careers and this makes the task of schools and teachers that much more difficult

The science and mathematics teacher can, however, help open the world of science to girls in a number of ways:

- by developing the kind of gender sensitive teaching styles addressed in topic 3
- by instilling confidence in the female learners; they come to see themselves as successful mathematicians and scientists. This has been covered in Unit 2 topic 4
- by 'selling' science; by integrating into their teaching, information about the kinds of careers available to their students, both boys and girls in a manner that encourages both sexes into science

This topic looks at the third bullet point in the list above

'Selling' science

The best time for students to hear about careers in science fields is when they are studying the fields and the interest, hopefully, is there. This session asks the participants to generate ideas on how to find out about available careers, what kinds of skills and competencies are required by them, and how information about them might be integrated into science and mathematics teaching. The Facilitator should look back at Units 3 and 4 and be aware of the materials available to the careers advisory service; in particular you should be aware of information this is publicly available on the internet. This information could be local or international.

There are many ways that career information may be integrated into teaching. The following list includes some and the participants will be able to develop others:

- commercially produced display posters showing career opportunities
- the use of booklets produced by industries that give career information as well as information on their processes
- end-of-lesson short career discussions
- industrial visits
- talks by visiting professionals (such as nurses, farmers, industialists, etc) that include not only scientific elements of the work done by their organisations but also career details.

The following activity requires access to the internet. If it is not available, information from the internet should be made available to participants (where indicated) either in the form of paper copy or in the form of downloaded pages viewed on computers at the workshop.

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[34] Rose in Solomon and Aikenhead, 1994, (vid sup.) page 156.

Participants may need some help in accessing and searching the internet. A useful and quick way to do this is to divide them into small groups around each computer and nominate an experienced one to teach the less experienced ones.

Activity 5.1 'Selling' science

1 In a plenary session outline the task which is to get science teachers thinking about where they can get information about careers related to a teaching topic and how they can integrate it into their teaching. Information should include, where possible, the required skills and qualifications at different entry levels. At the end, this session should have built up a list of local information sources that can be a workshop product. The participants will also have shared ideas on the methodology of incorporating them into their teaching.

2 Ask them to divide into groups of 4–6 sharing a common discipline (ie biologists together, physicists together etc). Their task is as follows:
   - Select a broad area of the syllabus - say 'mammals' or 'diseases' or 'extraction of metals' in which there are manifestly many local job opportunities.
   - List the career areas that you are aware of that are associated with that part of the syllabus. The internet can assist in this, particularly if there is a local career site and local company sites [35] that can be accessed (some examples are shown on the resource CD) [36]. List the career areas on a flip chart showing also the level of education needed to access them.
   - Suggest how to integrate this information into teaching

3 Report back using the display charts they have created.

REFERENCES

BES (2005), *Building Capacity from Within; School Improvement Program,* Basic Education Support Programme, Namibia, 2005.

FEMSA Swaziland (1999). *Female Education in Mathematics and Science in Africa: report on the school study project.*

NSTA, *Gender Equity in Science Education,* http://www.nsta.org/main/pdfs/PositionStatement_GenderEquity.pdf

Solomon J. and Aikenhead G. Ed. (1994). *STS Education, International perspectives on reform.* Teacher College Press. London.

World Bank (1995), *Schools Count: World Bank Project Designs and the Quality of Primary Education in Sub-Saharan Africa,* by Ward Heneveld and Helen Craig. World Bank Technical Paper No. 303, 1995.

[35] Most large companies have websites that contain both scientific information (though not usually in a language that can be understood by the general public or schoolchildren) and career information. See for example the Namibian Uranium mining company http://www.rossing.com

[36] See, for example http://www.connexions-direct.com/jobs4u and follow the links to 'job families'. For a Namibian site see http://www.ics.org.na/careers/INDEX/link-1.htm

Unit Six

INITIAL TEACHER EDUCATION

Rationale

It is still quite unusual for initial teacher education programmes in science and mathematics education to address specifically the issue of gender in science education. Though it is now common knowledge that gender imbalances in science, mathematic and technology areas exist, those affected are often found to be unaware or un accepting of the situation thus would not naturally feel the need to address them. While the role of the teacher in this process is crucial, teachers are normally not concerned by it mainly because of lack of awareness of its consequences both to the learner and to society. Secondly, much of what goes on in education has been cited in the propagation of gender imbalances. It is the aim of this unit to address teacher during their formative years thus this unit targets the teacher trainers with the hope that they will in turn use these ideas in produce a teacher who is ready to address gender problems in the classroom. The activities of this unit take teacher educators through the process firstly of analysing their existing programmes for gender related issues and then devising strategies to meet the demands of the issues. In the process they will also spend some time on how to design useful student activities that can be part of the courses they design.

Target groups

This unit is designed for those responsible for initial teacher education of mathematics, science and technology teachers.

Prerequisites

All participants should be familiar with the issues raised in units 1,2 and 5 of this module.

Learning outcomes

By the end of this unit participants should:

- be able to recognise and rectify elements of their own teacher education programmes that discriminate against girls
- be aware of the gaps in their own training programmes in the area of the science and mathematics education of girls
- have developed methodology course descriptions and activity outlines to address the gaps
- have developed some examples of student activities that could be part of the revised methodology programmes
- be aware of mechanisms for assisting trainee teachers to become science career advisers

Contents

Items to bring to the workshop

- Gender disaggregated statistics showing enrolment, progression and achievement in secondary science and mathematics programmes in the schools served by the training institution.
- Gender disaggregated statistics showing enrolment, progression and achievement in science and mathematics programmes in the their institution

Topic 1 ANALYSIS OF EXISTING TRAINING PROGRAMMES AND THEIR CONTEXT

Teaching materials and resources are often found to present biases to the learner. Though whole education programmes are important in determining what is taught and how it is taught, not much research seems to focus on whole programmes for gender imbalances. In this section participants will do just that. They will look at their existing science education programme(s) to determine the extent to which the topic of gender issues in science and mathematics education is covered. This is a multidimensional issue affecting both the institution and the national or regional context within which it operates and the first task is to identify the different dimensions. Some significant dimensions are shown in the list below.

- How big is the problem of girl's under-enrolment and underachievement in the country or region served by the institution
- Is there a national or regional recognition of the problem and if so, what steps are being taken to address it? Are there any policy documents that relate to it?
- What kind of career advice service exists and who trains the teachers for it
- Are gender issues reflected in any of the teacher education courses in the institution?
- Has the institution ever examined its own programmes for aspects of gender bias and inequality?
- Has any research been done into any aspect of the gender inequality?

The next task is to develop an overall strategy to ensure that all the significant dimensions of the problem are reflected in the training programmes of the institution. Subsequent topics in this sequence will look in more detail at how this strategy might be implemented.

Participants should have available the necessary statistics to be able to study the issue at a national and regional level and at their own institutions.

Participants should have undertaken the activities in Unit 2 Topic 1 to determine the extent of the problem in the schools served by their institution. Likewise they should have had opportunities in Unit 1 Topic 4 and Unit 2 Topic 2 to develop a gender lens to analyse the gender performance of their own institution, faculty or department.

In the next activity participants are asked to analyse by sex the science and mathematics admission numbers, progression and output quality of their own institution. The output should be the start of a plan to address any shortcomings.

There is a significant gender disparity in admissions to tertiary science, mathematics and technology programmes throughout the continent. This is partly a consequence of the disparities in school performance. A number of tertiary institutions have taken action to reduce this inequality through various affirmative action programmes. If the participants are familiar with any of these, their impact should be discussed. One such example is a pre-entry programme to the Faculty of Science at the University of Dar es Salaam that was designed exclusively for female students who failed to enter the faculty through the normal procedures. It was established in 1997 and extracts from a preliminary analysis are included on the resource CD.

Activity 1.1 Analysing science and mathematic admissions and performance statistics

1 Participants should have undertaken Unit 2 Topic 1 which looked at gender differences in school enrolment and performance in science and mathematics subjects. Spend a short time, if necessary, looking at this again so that everyone is aware of the extent of the problem nationally.
2 Working in institution groups examine intake and progression gender disaggregated statistics of the science and science education programmes. For this exercise you may need to analyse institutional data as the appropriate statistics may be hidden. Answer the following questions:
   a. What proportion of girls enter science options and what proportion complete in the science options at school
   b. What proportion of girls achieve in the range C and above at school leaving examinations
   c. What proportion of girls enters and complete in the science or science education streams.
   d. How do you explain this situation?
3 Share results in a plenary session. Details of any programmes designed to redress inequities should be presented during this session. If possible propose implementable strategies to address the problems.

In the next activity teacher educators should break down the complex issue of the underrepresentation and underachievement of girls into a number of clearly defined components for the purposes of teaching about it. The participants are then asked to identify the programme element where these might best be covered and so develop a framework that can form the basis of subsequent activities. Table 6.1 shows an example of such a framework. Across the top are possible components of a conventional teacher education programme. Down the left column are some of the facets of the gender and science issue that have been covered in this module. The table can be completed with ticks, or better with a few explanatory words, in the appropriate table cells. A similar framework could be built around mathematics or technology.

This table should be shown as an example only; each institution will have a different list of programme elements across the top and the participants should decide on the contents of the left column. Table 6.1 is available on the resource CD.

	Foundations of education	Sociology and psychology of education	Methodology	Assessment in science	Teaching practice	Guidance and counselling	Science content courses	Etc
Sex and gender								
Cultural and societal pressures								
Bias in the curriculum								
Bias in teaching strategies								
Bias in learner and assessment materials								
Data on girls underachievement in science								
Whole school and community gender matters								
Gender policy								
Etc								

Table 6.1 A framework for gender issues in a science teacher education curriculum

Activity 1.2 How gender – sensitive are my local programmes?

Working in institution groups do a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of your existing programmes, both science and science education, and identify reasons for the strengths. The following questions can be used as the basis for the SWOT analysis but participants may suggest others.

a What areas of the existing programmes are strong in relation to gender sensitivity and why?
b What areas of the programmes are most likely propagating gender disparities? Explain.
c What features of your programmes or system would best be used to address gender issues in science education?
d What aspect of your education system would make it difficult to address gender problems in science education?

Use the results of the SWOT analysis in Activity 1.3.

Activity 1.3 Where can gender problems be dealt with?

1 Show table 6.1. Ask the groups to develop their own framework based on table 1 to show where, in their existing programmes, the different facets of the gender and science issue should be placed.
2 Allow time for groups to share and discuss their frameworks in a plenary session.

Topic 2 ACTIVITIES FOR TRAINEE SCIENCE AND MATHEMATICS TEACHERS

This topic offers an opportunity for participants to develop ideas for course materials to be used by their students. The activities of this module offer a rich source of ideas that can be adapted. If the participants have not taken part in the activities of Unit 5, these should be presented to them in some form before they attempt the next activity which will build on them.

A number of unit 5 activities can be adapted to produce ideas for student-centred assignments. Possible examples are:

Activities 1.1 and 1.2	Gender and sex. Gender and sex roles
Activities 3.1 and 3.2	Developing a gender lens to analyse curricula and learning materials
Activity 3.3	Creating and using a peer coaching instrument to analyse gender bias in teaching styles. This could be developed as a teaching practice exercise
Activity 3.4	Contextualising science topics in a way that may appeal more to girls

Another source of gender bias studies is the student's own experience. An assignment could be built around the construction and use of an instrument to analyse their current or past science or mathematics programmes for bias

Activity 2.1 Generating student assignments

1 Explain the purpose of the activity and refer them to Unit 5 as a useful source of ideas. Insist that the assignments that they design should ideally be student-centred, that is they must involve the students, working individually or in groups, in doing something, not simply regurgitating what someone else has written

2 Divide into small groups. Ask each group to develop at least one assignment on any aspect of gender and science and mathematics education.

3 Ask each group to also develop a small research assignment around a gender issue that students could undertake, either individually or as a group assignment, when they are undertaking school-based teaching practice.

4 Share ideas in a plenary session.

5 An additional exercise that could be undertaking in the same way is to repeat steps 2 and 3 but this time the objective would be to develop ideas for small masters level research topics.

Topic 3 THE SCIENCE TEACHER AS A CAREER ADVISER

Most teacher education institutions offer courses in guidance and counselling. Sometimes these are compulsory courses for all trainee teachers but more often they are specialised optional courses that address the need for guidance teachers. There has recently been a move to mainstream elements of the guidance programmes in response to the need for more teachers to share the burden of counselling related to HIV and AIDS and also in response to an increasingly held view that all teachers should be able to take on their share of the pastoral responsibilities of the schools.

The view that teachers of science should also be able to make some input into the career guidance of their students is not yet commonly held. However, teachers of science are required to have a general understanding of the science behind the major science-based industries of the country as well as an understanding of what are the main fields of science research in the country. It follows that their training programme should incorporate some elements that familiarise the students with the key science-based industries in the country. This could involve visiting lecturers from the industry or class visits to the industry. It should also involve familiarity with any publicity material produced by the industries, including familiarity with their websites.

The kind of knowledge of the science-based industries in the country that student teachers should access through their training programme will put them in a position to be able to 'sell' science as a career, to girls as well as boys. This notion is elaborated in Unit 5 Topic 5 which the participants should be familiar with before they undertake the next activity

In the next activity participants are asked to consider firstly whether their own programmes provide their trainees with an adequate knowledge of the main scientific activities that are taking place in the country and secondly, if not, what strategies could be developed to ensure that they do. Their work done in activity 1.3 with table 6.1 will be useful.

Activity 3.1 Reflecting local science in the science teacher education programmes

1 Working is institution groups, identify the kind of scientific activities that are taking place in the main science-based companies or sectors. Also identify any other science-based sectors that have a demand for qualified scientists but may not be characterised by large companies. Examples may be agriculture and tourism, (which will include wildlife conservation). Also identify any national research facilities that may employ scientists.

2 Answer the following questions about the teacher education programme
   - Is the science knowledge which underpins the work of the institutions identified in task 1 adequately covered in the teacher education programme?
   - Do the students have any knowledge or understanding of the scientific processes and activities of the companies or sectors identified in task 1? Do they know what the scientists employed there actually do?

3 If the answer to either of these questions is no, discuss how this can be remedied.

4 Share ideas in a plenary session.

Topic 4. DRAFT COURSE DESCRIPTIONS AND ACTIVITIES

This topic will assist the participants to develop or modify course outlines and to develop and outline scheme of activities for the new courses. It is assumed that they will have brought existing examples of both. It will first be necessary to come to a common understanding of what is meant by course outlines and activity schemes. The former is what is in the legally binding document (often referred to as the Calendar) that is produced by the institution that defines what will be taught in each course. The second might be the elaboration of this that the lecturer might give to the students at the beginning of the course. Neither will explore the content in great depth but will establish the framework in which such an exploration will happen.

The gender issues discussed in topics 1 and 2 of this unit will probably cover a number of different courses taken by a number of different lecturers and participants should be reminded that some mechanism will be needed to ensure that all relevant courses are redeveloped and that the lecturers responsible for them fully understand their purpose. Participants should spend some time debating how this can be made to happen effectively in their institutions. They may feel that a gender programme coordinating group might be required in order to see that all elements of the programme are developed and integrated coherently. Or they may feel that suitable institutional structures already exist that could take on this task

In the next activity participants, working in institution groups, are asked firstly to look at their existing offerings noting where gender issues can be dealt with (referring back to activity 1.3) and also to look at the overall gender sensitivity of their programme both in terms of content and in terms of organisation (given, for example, that research shows that a programme arranged around themes is more accessible to females than one arranged around subject areas).

As participants will know well, drafting good course outlines and teaching programmes, is a complex and extensive task that cannot be undertaken in the short time available in a workshop such as this. The intention of this activity if to develop the process rather than to produce a polished product.

Activity 4.1 Developing course outlines and activities

1 a. working in small groups, participants study their teacher education programme and identify (i) areas where gender issues can be dealt with, (ii) arrangement of content that would be gender sensitive, (iii) content that needs to be substituted with more gender sensitive content.

b. write objectives of a gender sensitive programme

c. write a programme for one semester that is gender sensitive.

2 Working in the same groups participants should identify where in the existing programmes the gender issues discussed should feature. It is likely that should be part of a number of courses and not simply methodology.

3 The groups should then draft the concise form of words that should be included in the course outline to cover any new gender-related elements.

4 The group should then draft the new outline teaching schemes which outline in a little more detail when and how the gender issues will feature in the courses.

5 In a plenary session, different institutions can compare their solutions.

Research topics

Many teacher education programmes include research topics. These range from small topics undertaken by students when they are on school-based teaching practice to doctoral theses. A number of ideas for gender-based topics have been suggested in this manual, particularly in Unit 5. The resource CD that accompanies this manual provides a comprehensive collection of reference materials in this area. including examples of two useful dissertations, one a small MA question [38], the second a full PhD thesis [39]. Participants should, if possible, be given a copy of the CD.

[38] Crompton, Z., How can we effectively engage underachieving girls in science?, MA Essay question, University of Leeds, 2004

[39] Sinnes, A., Approaches to Gender Equity in Science Education. Two Initiatives in Sub-Saharan Africa Seen Through a Lens Derived from Feminist Critique of Science, University of Oslo, 2004

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