United Nations Nations Unies

Commission on the Status of Women
Fifty-fourth session
New York, 1-12 March 2010

INTERACTIVE EXPERT PANEL

Access and participation of women and girls to education, training, science and technology, including for the promotion of women's equal access to full employment and decent work

Women's access to and participation in science and technology*

Submitted by

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* The views expressed in this paper are those of the author and do not necessarily represent those of the United Nations.

This paper assesses the current state of knowledge, data and practice on the participation and representation of women and girls in the science, engineering and technology (SET) education and employment. It starts with an overview of the latest data on the representation of women in SET, with the UK as the main example. It provides a summary of the reasons and consequences of the low-representation of women, including the important topic of gender stereotyping. It provides a brief description of good practice and some selected examples of the initiatives that have been successful in addressing the underrepresentation of women. The paper ends with a discussion of the important action that the governments should take to address this situation.

The lack of participation of women in science and engineering is now regarded as an issue affecting scientific development, productivity and excellence. UNESCO (2007) predicts that if the current growth rate in research and development in science and technology continues it will be necessary to increase the numbers of men and women researchers worldwide. Despite the share of women's participation in education and work increasing in OECD countries overall, many women worldwide are excluded from the full benefits of scientific careers by poverty, lack of education, legal, institutional and cultural factors. **It is important that systematic and comparable data is collected from the public and business sectors to inform policy decisions**. The EU's *SHE Figures* produced every 3 years to benchmark and monitor progress against a number of indicators is an example of good practice in this respect.

Attrition

The underrepresentation starts early and the attrition of women continues with each stage of the vocational and professional career ladder, a phenomenon known as the 'leaky pipeline'. Additionally women's participation is uneven across the scientific and technical fields with women predominating in scientific fields associated with health and caring, such as medicine and bioscience in many countries. In the UK, for example, girls are 42 per cent of students taking STEM (science, technology, engineering, and mathematics) A level exams (qualifying exams for university entry), but only 10 per cent of exam entrants in computing and 22 per cent in physics, despite outperforming boys in these subjects. In higher education women make up about 33 per cent of undergraduates and postgraduates studying STEM but this masks their low representation on degree courses in engineering (15 per cent) and computer science (19 per cent). This situation is even more acute in the vocations, where women are only 2.8 per cent working in engineering and manufacturing technologies, and there is a mere one per cent in construction.

Attrition of women from SET is particularly severe in the transition from university to employment where qualified women are lost from the SET workforce in higher proportions than male graduates. According to the Eurostat data women make up only 18.8 per cent of the SET workforce in the UK. International data indicates the universality of the low representation of women in SET occupations. Across the 22 European countries women's representation in the SET workforce varies between 8.6 per cent in Luxemburg to 28.2 per cent in Lithuania. Women account for 25-35 per cent of

researchers of most OECD countries, apart from Japan and Korea who each have 12 per cent.

The underrepresentation of women is most severe at the senior levels where decisions on how organizations are run, how funding is allocated and what science is pursued are made. Vertical segregation is common across many regions and countries and also impacts on the career aspirations and motivations of young women, offering few role models with which they can identify. The attrition of women in academia is well documented. Women account for roughly 30 per cent of researchers and 26 per cent of lecturers in SET at the UK universities, but less than one-tenth of professors. It is important to note here that the decline in the proportion of female academics at each career stage holds irrespective of whether women are in a faculty with a 'critical mass' of female students and researchers, such as biosciences, with women accounting for almost half of all researchers but only 15 per cent of professors, or disciplines where women remain severely underrepresented at all stages of academia, such as mathematics, with one-fifth of all researchers and a tiny 4.4 per cent of professors. The ENWISE report about women scientists in eastern Europe shows how even in countries which have a greater number of women scientists overall, women as a group are disadvantaged by being concentrated in low expenditure spheres of work, suggesting a waste of potential which is repeated globally.

Women make up only 9 per cent of board directors in the UK SET FTSE 100 companies, an increase of just 1 percentage point since 2003. Although not SET specific, a notable exception is Norway where from January 1, 2004 boards of all state owned companies are obliged to have a minimum of 40 per cent representation of each gender, and a law from January 2006 specified similar requirements for the boards of all companies registered on the stock exchange.

Attitude bias

An important cultural and social aspect of gender specific barriers to SET is the bias in attitudes towards women studying and working in science and technology areas. In developing countries this includes access to education per se (Huyer, 2004). The early formation of career aspirations and choices are influenced by a complex web of interacting factors which include socio-cultural attitudes and gender stereotyping about which occupations are considered appropriate for girls and women and the perception of SET as a masculine territory, and thus not a suitable career option for girls; a view often held by parents, teachers and career advisors. The problem can be exacerbated by teaching materials, textbooks and lectures which tend to depict science and technology as a male domain, fails to connect to the values and concerns of young women and deprives girls of positive role models (Huyer, 2004, Schreiner and Sjoberg, 2007) Another important contributing factor is the 'chilly' classroom climate, with boys given more attention and praise by the teachers who also hold higher expectations for boys than girls, and see girls as less likely to go on to higher education in STEM disciplines (Huyer, 2004; Murphy and Whitelegg, 2006). Gender inclusive teaching, gender targets, monitoring and reporting on STEM enrichment programmes can help solve

underrepresentation. **Afterschool engineering clubs in Sweden and the UK with mandatory participation of 50 per cent girls have been successful**.

Evidence suggests that simply increasing the numbers of women in scientific research is an inadequate strategy on its own and is persistently hard to achieve. Attention also has to be paid to retaining and progressing women. Recent research in the UK into the career intentions of PhD organic chemists found that whereas 72 per cent of first year female PhD chemists intended to pursue a research career after completion compared to 61 per cent of men, by the third year, this figure had declined to just 37 per cent for women compared to 59 per cent for men. The main reasons given for the decline in interest in research careers were supervisors' attitudes, male-dominated competitive research groups and the research experience itself (Lober Newsome, 2008).

Institutional barriers

Barriers to successful careers in SET continue into vocational and higher education and employment. Many barriers affect women and men, but the combination of negative factors is often more decisive for women resulting in a "discriminatory snowball effect" (SHE Figures, 2009). Examples of institutional barriers in academic and research careers include, lack of transparency on pay and promotion procedures, short term contracts and employment insecurity, low organizational status and low pay, mobility and relocation demands and the need to defer to their partners' career priorities, lack of provision for part-time work or flexible delivery of research contracts, poor support for maternity leave during research contracts, lack of female role models and few networking opportunities for important contacts for progression and visibility (Garforth and Kerr, 2009; Lober Newsome, 2008; Martinez, et al., 2007; Universities UK, 2008).

Women have the major responsibility of childcare and still experience maternity discrimination. Many countries do not have state-assisted flexible childcare, which limits the ability of primary carers to work full time. The return to work, if accompanied by a request for part-time work, often results in a downshift in position, resulting in women working below their qualification level (Webster, 2005; Bagilhole, 2008). This has significant long-term effects on women's career progression because of limited access to quality senior part time roles (Moore et al., 2005). Additionally a frequent measure of scientific excellence in academic or research careers is the volume of publication output which can also disadvantage women who take career breaks or work part time. In Iran for instance, men accounted for 94 per cent of scientific academic articles in 2003 (Mozaffrin and Jamal, 2008). Consideration could be given to the **obligatory reporting of 'lost time' due to career breaks** by university managers and **the option of fewer submissions, with no penalty.**

The dominant culture in SET is based on long-working hours, and the expectation of total availability, with anything less interpreted as a lack of commitment to career, profession and company (Lingard, 2004; DTI report, 2005). This is perceived by many women as incompatible with family obligations (Bagilhole, 2008). Furthermore, workplace cultures often undermine work-life balance polices and practices which have the potential to

enhance opportunities for women in the workplace (Lewis, 2001). Women scientists and engineers perceive that to take up the policies would put them at a distinct disadvantage in comparison to their male colleagues, who rarely use such policies (Cross and Linehan, 2006).

Gender stereotypes and unconscious bias

Gender stereotypes and unconscious bias that exist in wider society are also reflected in SET professions. Clear stereotypes exist relating to women's job performance and future potential. In particular, because of the dominant association between traditional notions of masculinities and technology (Cockburn, 1985; Faulkner, 2000; Adam et al., 2005) women are perceived to be unsuitable for purely 'technical' careers (Webster, 2005). This perception is also apparent in Africa where it is considered (not least among, usually male, maths and science teachers) that girls can't think or work scientifically and that science is too mechanical and technical for girls, thus discouraging female students (Quaisie, 1996; Hafkin, 2001).

Historically the image of engineering has been tough, heavy and dirty and associated with machinery. Therefore, in terms of cultural image, engineering is perceived as a man's profession. This is not only because the workforce is predominantly masculine, but because the prevailing cultures and ethos of SET industries appear to be extremely masculine (Gale, 1994; Bagilhole, 2008). Furthermore, it is argued by Wallsgrove (1980: 147) that *'science is power so science is defined as masculine'*, thus making clear the crucial link between gender and power relations that pervades issue of women's presence in SET. A key cultural aspect of the ideology of the masculine sciences is expressed through language. Faulkner (2006) suggests that use of the 'generic he' to refer to engineers means that women engineers are both invisible and a non-entity. Humour can be used as a means of embedding risky or unacceptable behaviour in superficially harmless statements or as a means of emphasising power relationships (Holmes, 2000).

As a consequence of widely spread stereotypes, women scientists and engineers are seen as women first and professionals second, and successful SET professionals are not perceived as feminine or to possess supposedly feminine qualities (Faulkner, 2005, 2000; Womeng, 2006). The sexualisation and objectification of women in SET can also mean that they are simultaneously invisible (as successful professionals) and visible (as they are in a minority) (Bagilhole, 2008). An assumed association between masculinities and technology can mean that women are pushed into 'softer' areas within SET occupations, which afford lesser career opportunities (Bagilhole, 2008). The literature also suggests that women can face conflict in establishing their identity, given the perceived incompatibility between femininities and technology. Linguistic reproduction of gender stereotypes/use of humour leads to undermining women's professional status and reinforcing men's views of women as merely sexual beings (Holmes, 2000, Bagilhole, 2008).

Economic consequences

Poor practice, lack of support and cultural barriers results in gender inequality with skilled, qualified and talented people lost to SET, resulting in skill shortages in many occupational areas (Adam et al., 2005) and causing a limiting effect on economic growth. It has been reported that removing barriers to women working in occupations traditionally done by men, and increasing women's participation in the labour market, could be worth between £15 billion and £23 billion or 1.3 per cent to 2.0 per cent of GDP in the UK economy alone (Women & Work Commission, 2006). Internationally, closing the gap between male and female employment would have huge economic implications for the global economy, boosting US GDP by as much as 9 per cent, Eurozone GDP by 13 per cent, and Japanese GDP by 16 per cent (Goldman Sachs report, 2007). Importantly, increased participation of women in the labour force and earnings are associated with reduced poverty and faster growth (World Bank, 2006). Well-documented business benefits of a diverse workforce include improved organizational and financial performance and better corporate governance. There is increasing evidence that increasing women's representation on boards and in teams to 30per cent improves profitability and performance and that flexible working arrangements result in benefit to the employer as well as to the individual (McKinsey, 2008, Catalyst, 2007). Board diversity has been linked to good governance credentials, including more attention to audit and risk oversight and control, and greater consideration for the needs of a variety of stakeholders (Conference Board of Canada, 2002).

Focus on the structures of inequality and the 'politics of difference'

Recommendations from a number of EU reports state the need to focus on the structures of inequality rather than changing individual women: overcoming outdated attitudes and modes of practice that impede women's scientific careers and improving the conditions and culture of the workplaces are necessary for women to establish and progress in scientific, ICT and engineering careers (Widmar, 2008). The European Commission has tried to embed 'the gender dimension' within and through EU science funding programmes at a macro level. The US NSF ADVANCE Programme **targets its grant schemes at changing the structures and cultures of institutions** as well supporting individual women. The academic institutions funded through the 5-year ADVANCE Institutional Transformation (IT) Awards, define and implement comprehensive customised action plans. Significant results have been achieved by many of the higher education institutions supported to date, with the development of best practices, effective networking and dissemination strategies, and innovative assessment approaches.

Change also has to occur at the micro level of individual behaviours, motivations and mindsets to overcome bias. Widmer (2008) recommends **gender training** for decision makers and the UKRC has trained over 1000 decision makers, influencers and managers in how to create inclusive learning and working environments in SET that recognise gender difference.

The InterAcademy Council (2006) talks of **'good management practice'**, which includes top-level commitment within the organization to equality, establishing the necessary infrastructure, reviewing policies and procedures for their gender impact, transparency in communication, recruitment, promotion, salary reviews, and conferring of awards, widening the 'inner circle', where decisions are made, leadership training and mentoring, and supporting a healthy work-family balance.

Legislation can also have a role in supporting institutional change as well as protecting the individual from discrimination. In 2006 the UK introduced **the Gender Duty** to complement the existing duties for race and disability. This means public sector employers have a duty to positively and proactively consider the impact of policies on women and are legally required to produce an action plan addressing how they will do this. This has driven up awareness of equality issues and demand for how to put equality into practice. More forward-thinking employers are **driving equality through their supply chains when procuring their services**. The forthcoming Equality Act in the UK will extend and merge the separate equality duties into a single duty.

Examples of good practice

Some countries have responded by setting up Resource Centres to deliver national strategies to increase the participation of women scientists and engineers, provide leadership and to establish knowledge repositories to share best practice. NIS-WIST in the Republic of Korea is one such example, the UK Resource Centre for Women in SET (UKRC) another.

The Korean Government initiated a 'recruitment target' to achieve 25 per cent of women by 2015 from their 12 per cent base in 2005. UKRC want to see 30 per cent participation in the professions by 2020. A national programme of initiatives in each country supports this drive. The UKRC focuses on two strategic outcomes: to influence cultural change in SET business and organizations and to support the career development and progression of women. Women are offered an integrated flexible model of support available throughout the UK. This ranges from career development workshops, travel and training bursaries, an online career reorientation 12 week course delivered through the Open University (T161), mentoring, advice and guidance on getting ready for the workplace, work experience opportunities and help in finding permanent jobs. Women are encouraged to register on GetSET women, which provides an online networking community and offers a gateway to UKRC services. In the 18 months from April 2008 to September 2009 UKRC estimates to have reached and influenced 60,000 women and 60 per cent of those engaged in UKRC services are now in employment.

UKRC reaches 18 per cent of the 7.4m SET workforce in the UK through its work with business and organizations. 100 companies have signed the UKRC's **CEO Charter**[1] including corporates such as Sony, Atkins Global, and Arup. A **cultural analysis tool**

[1] a visible commitment from the CEO or senior management of organizations within SET to implement positive culture change to increase the participation and progression of women

helps to analyze the culture of organizations and the UKRC has recently introduced a national accreditation and award schemes for employers, the **SET Fair Standard**[2] complementing the **Athena SWAN charter**[3] for higher education institutions which has awarded 43 UK universities so far. These recognition schemes have aroused international interest.

There is a role for leading science institutions to lead by example. Three national academies—the Indian National Science Academy, the National Academy of Sciences, and the Indian Academy of Science—have helped initiate a profound change in attitude regarding women's participation. Working jointly, they convinced the Indian Government that it was urgent to take actions, and fund initiatives, to improve opportunities and working conditions for women scientists. The country's National Academy of Sciences has achieved gender parity on its Council (InterAcademy Council, 2006).

Further examples of good practice from North America, Australia, and Europe can be found in the PRAGES "Guidelines for Gender Equality Programmes in Science" released in December 2009. This benchmarks a series of programmes and good practices, among which stand out a number of institution-aimed programmes, including several initiatives developed by NSF-ADVANCE-funded universities, as well as the Athena-SWAN scheme. The online Good Practices database developed by PRAGES provides detailed information on the selected programmes, their contents, focus of activity, dissemination strategies, and level of assessment regarding quality, impact and transferability, as well as a possibility to directly contact the programme promoters via e-mail.

In conclusion governments' involvement is crucial in tackling gender stereotyping. The UKRC suggests that a national strategy on increasing the participation and position of women in SET is an important first step with a lead minister established to champion and coordinate a cross-government framework on occupational desegregation and gender stereotyping to drive the implementation of gender inclusive policies and practices across education, skills and employment policy areas. As the world increasingly recognizes the value of women's labour to the economy, it is necessary to create the conditions in which women can have fulfilling careers and enjoy the benefits of participating in science, engineering and technology careers equally to men. This will bring benefits to science as well as improve women's pay and prosperity.

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[2] rewarding good practice in gender equality through a straightforward on-site assessment process undertaken by trained assessors, http://www.ukrc4setwomen.org/html/employers/set-fair-standard
[3] http://www.athenaswan.org.uk/html/athena-swan/

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