

Women role in engineering education in innovation teams in terms of scientific and gender diversification

Antonia Moropoulou

Professor, Chemical Engineer PhD
9 Iroon Polytechniou str., Zographou Campus, 15780
Athens, Greece
E-mail: amoropul@central.ntua.gr

Agoritsa Konstanti

Laboratory Teaching Staff, Chemical Engineer PhD
9 Iroon Polytechniou str., Zographou Campus, 15780
Athens, Greece
E-mail: akonsta@mail.ntua.gr

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INTRODUCTION

A knowledge-based society, a society fostered by its diversity and capacities [1], requires a population with a reasonable level of scientific and technical literacy, capable of taking initiatives and becoming active citizens in the decision-making processes. Access to education for all is undoubtedly a right for citizens. In terms of diversity and capacities, the role of women is critical to meet the challenges of the diffusion of engineering sciences in order to engage society in technology and the innovation to strengthen competitiveness for facing the economic crisis and to sustain development. Equal women participation in all the scientific sectors and at all levels reinforces diversification, enhances European development, supports European economy, broadens the impact engineering has on society [2], [3]. However, the “leaky pipeline” is unfortunately a reality, even for Europe, excluding and isolating female scientists and engineers, not recognising their pivotal role in engineering education [4].

1 GENDER ISSUES

Gender refers to the socially constructed roles and relations between women and men [5] and gender equality refers to women and men sharing equal rights, responsibilities and opportunities [6]. Gender equality leads to economic growth, favors competitiveness and leads to progress in economic growth and innovation.

Equal women participation in all the scientific sectors and at all levels reinforces diversification, enhances European development, supports European economy, broadens the impact engineering has on society [7].

Diversity, representing the spectrum of human differences, refers to the distribution of the workforce composition, the participation of women and underrepresented minority group members within the workforce [5]. Diversity and gender balance are vital factors for successful implementation of science and innovation, as it relies on talent, collaboration and interdisciplinary research [8].

On the other hand, interdisciplinarity is considered the basis, which can lead to innovation and to the creation of new scientific fields and problems' solution. Interdisciplinarity in engineering education and especially in innovation teams is attractive and is considered to better satisfy the social and industrial needs of a changing society [9].

Gender innovations refer to the processes integrating gender issues into all phases of basic and applied research to assure excellence and quality in outcomes and promote excellence in science and engineering. The basic aim of gender innovations is the enhancement of scientific and technological excellence. Gender innovations focus on creating gender equality, enhancing creativity, stimulating economic and technological development, making research more responsive to society [10].

Within Horizon 2020 [11], promotion of gendered equality is favored. The pillars:

- promotion of gender equality in research and innovation
- exploitation of the whole potential of researchers, male and female
- incorporation of gender issues in the contents of the projects

lead to the enhancement of research quality as well as innovation strengthening.

2 WOMEN ROLE IN INNOVATION, INTERDISCIPLINARITY AND TEAM COLLABORATIONS

Women play a key role in innovation. They are regarded as “champions” in new interdisciplinary research and education fields and they have the potential to become champions in trans-disciplinary and sustainable innovation (economy, society, and environment).

Despite the encouraging numbers prevailing recently as far as women participation in research in Europe is concerned, equality has not yet been achieved. The “leaky pipeline” is still a reality, excluding women from science and technology [4]. Women represent 33% of researchers in Europe, 20% of University Professors and 15,5% of Universities' administration [12].

It is remarkable that during the period 2002 - 2009 women researchers are gaining ground in all fields of science in Higher Education, even in engineering and technology, sectors which tend recently to attract more women comparing to past years, although traditionally considered as “male” orientations [12]:

Table 1. Women researchers gaining ground in all fields of science in EU

	<i>Natural sciences</i>	<i>Engineering - technology</i>	<i>Medical sciences</i>	<i>Agricultural sciences</i>	<i>Social sciences</i>	<i>Humanistic sciences</i>
2002	35	26	64	45	54	65
2009	37	29	66	46	58	64

EU mean average

Additionally, women holding a PhD degree gain ground recently compared to men within EU-27 [12]:



Fig. 1. Women holding a PhD degree gain ground compared to men within EU-27

STEM employers seem to believe today that personnel homogeneity is not favouring innovation. Companies with diverse workforces and the presence of a greater number of women in the administration prove to be more profitable [13]. Engineering innovation, the key to global competitiveness, can derive due to a diverse workplace [14]. Scientific innovations are produced by team collaborations and team collaboration is remarkably improved by women presence, who can contribute through a different perspective [15]. In this respect, policies and programmes which target women or mainstream gender issues are important. A life-cycle approach is essential towards the direction of women gaining access to education and training, thus leading to their fruitful employment [16].

Women dispose the same qualifications with men and additionally natural communication skills, which account for their innovative role in development,

engineering, innovation and diffusion of science in society issues. Women role is remarkable in terms of Interdisciplinarity. Their presence is significant in various research science and engineering thematic fields, such as environment, sustainable development, quality of life, management of natural resources, art - architecture - urban planning, management of built environment, conservation and protection of cultural heritage, building materials, energy saving [7]. Therefore, they have to realise their important role, adopt a positive and self - confident and self - belief attitude and benefit exactly by this differentiation they present [13].

3 WOMEN IN SCIENCE AND ENGINEERING

Science and engineering constitute significant pillars for the achievement of innovation, economic growth and competitiveness, designing and developing new products and processes, providing up-to-date technological solutions to problems encountered in everyday life [5].

Referring though to technology and engineering studies, students' declining interest is observed at almost all industrial countries, especially among young women. According to research conducted in Austria, Finland, France, Germany, Greece, Slovakia, United Kingdom, most women chose engineering studies because of their interest in maths and sciences at school, good job projects, salary and social standing. Women are driven away from engineering studies usually due to the patriarchal structures of teaching, working climate, content and context in technology fields [9]. Crisis in women's interest for science and engineering subjects in the developed economies is observed, as a small percentage of girls in most European countries would consider becoming scientists or being engaged with technology. On the contrary, raised interest is observed in developing and emerging economies [17].

Women are under-presented in studies in STEM subjects in Europe [18]:

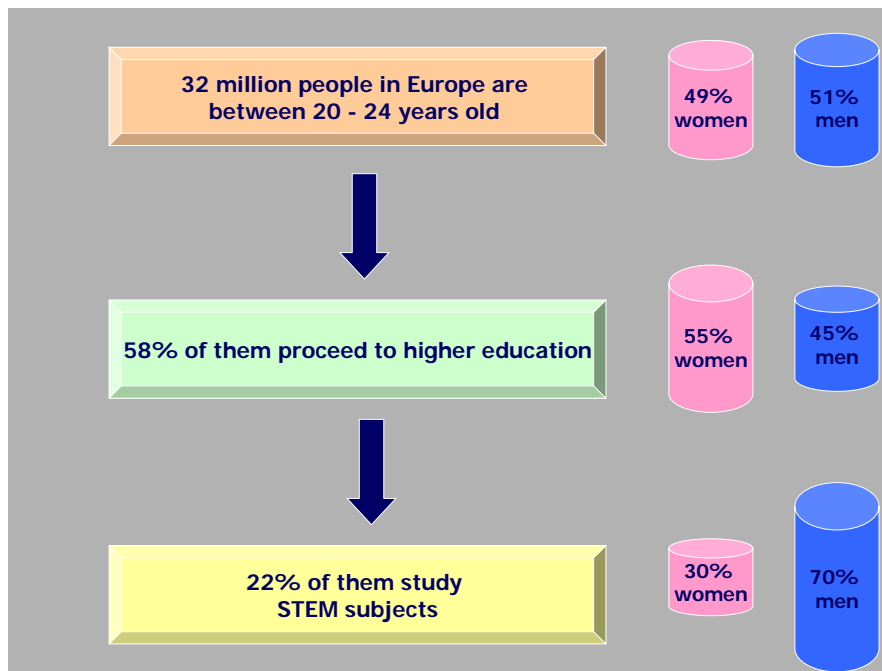


Fig. 2. Women under-presented in studies in STEM subjects in Europe

However, an increase of women graduates in engineering studies is observed. More specifically, increase at a percentage of 16,4% of the number of graduates is

observed in science and engineering courses between years 2000 - 2005. Remarkable increase is apparent in Estonia, Greece, Austria, Slovakia, Poland in Computing (83%), Architecture (4%), Manufacturing - processing (2%), Engineering (18%).

Women role is considered vital in engineering education, as “they specifically contribute to the culture and climate of the University and the development of students’ capacities and potential in science and engineering, with potential consequences for future generations of scientists and engineers” [19]. According to recent research [20], professor gender has a remarkable effect on female students’ performance in math and science classes and their likelihood of graduating with a STEM degree.

A synergy is apparent between scientific diversification, in terms of innovation and Interdisciplinarity, and gender diversification. This synergy can promote innovation in teams engineering education.

4 INITIATIVES TOWARDS STRENGTHENING WOMEN ROLE IN EDUCATION, SCIENCE AND TECHNOLOGY

European Commission and various international organisations recognise the fact that it is critical for women to have equal access to education and acquire the indispensable skills for STEM subjects, thus moving towards the achievement of sustainable development. In this respect, several actions have been taken.

Since 2011, United Nations Entity for Gender Equality and the Empowerment of Women has established recommendations for action in the following areas: strengthening national legislation, policies and programmes; expanding access and participation in education; strengthening gender - sensitive quality education and training, including in the field of science and technology; supporting the transition from education to full employment and decent work; increasing retention and progression of women in science and technology employment; making science and technology responsive to women’s needs.

Since the adoption of the above recommendations, several Member States, United Nations agencies, civil society organisations, educational carriers, stakeholders, and industrial partners have launched initiatives, such as academic and after-school programmes and camps for women for STEM skills’ development, networking programmes connecting women professionals with female students, campaigns for raising girls’ awareness, awards and academic scholarships for women recognition. However, there is still a lot to be done towards facing stereotypes regarding women participation in STEM subjects - careers and reversing their under-represented percentage in the relevant fields [21].

5 CONCLUSIONS

A great percentage of women worldwide are excluded from active participation in science, technology and research activities, often due to poverty, lack of proper integrated education or due to other legal, institutional, political, cultural issues prevailing in the environment they live. Gender equality describes the situation where all human beings are equal, favored to develop their personal abilities, realise their human rights, contribute and benefit from economic, social, cultural and political development. Due to its great importance, gender equality has become the third out

of the eight United Nations Millennium Development Goals “Promote gender equality and empower women” [22].

In order for science, technology, and innovation capabilities to be adequately shaped, more efforts have to be made towards the direction of helping young people, and especially women, to receive higher education. Despite the recognition of women role in economic development, science and engineering courses still seem not to be really appealing for women and many stereotypes prevail. Equipping women with the necessary scientific knowledge and technical skills needed for full employment is a critical aspect of the ability of countries to participate in the global economy. Women are central to economic and social development. It should be realised that development would benefit from greater involvement of women in the decision-making process for development policies [23].

Women represent a significant proportion of human resources base and they constitute a pool of talent for science, technology and innovation. In spite of women’s contributions to technological development and the existing and potential benefits that technologies can bring to women, women’s concerns and contributions are frequently disregarded in the relevant policies and strategies [22]. It should be realised that only through the exploitation of the whole talent pool it is ensured that men and women can equally contribute both at home within their families and simultaneously in their workplace, enhancing this way the well-being of both genders, and to society in general [24].

Unfortunately, in academic STEM, lack of gender equity, diversity and inclusion is observed, lack of critical mass of women faculty at all ranks and in leadership, unequal employment opportunities and job segregation, inequitable treatment and valuing of women employees (stereotyping, excessive scrutiny, biased evaluations, unequal access to resources and compensation), differential effects of conflicts between work and life / family demands for women and men faculty [5].

The need for gender mainstreaming is made apparent. Science & Technology can bring new opportunities for all women in all fields if they have equal access to resources and adequate education and training [22]. Mainstreaming comprises the systematic integration of equal opportunities for women and men into the organisation and its culture and into all programs, policies and practices, into ways of seeing and doing. Equal treatment, positive actions and mainstreaming equality form the basic pillars of the European mainstreaming policies [25].

EU can only reach the overall Europe 2020 target rate of 75% employment with a strong commitment to gender equality. In order to improve Europe’s competitiveness, better balance between women and men in economic decision - making positions shall be obtained [26].

The reinforcement of critical sectors presenting great interest and high participation of women could act as a vehicle for the reinforcement of the role of women in science, research, technology and engineering in Europe in an alternative way, promoting sustainable development for the benefit of society. Through the above, it is made apparent that gender equality is not imperative only for economic development reasons. It consists a moral imperative, responding to fairness and equity, including political, social and cultural dimensions [24].

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