

Educational Strategies for Empowering Women in Science and Technology

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Abstract

The present paper investigates the educational strategies for encouraging women in science and technology at the university level, having as references strategies and policies proposed by two European Projects. In the theoretical section, various models in investigating the study and career path of women in science, technology and engineering are presented. The differences between Eastern and Western European societies are illustrated using some quantitative data and discussing social transformations in the Romanian case. Based on qualitative methods, interviews and focus groups, a model for enforcing and empowering women, students and teaching staff, is proposed contextualised for a university in the Romanian cultural and socio-economic context.

Introduction: European policies towards gender in science and technology

The present paper has been presented at the conference “Critical Issues in Science and Technology Studies” and it is based on a research project conducted as a fellow at IAS-STIS in 2005-2006. The project aims at investigating women’s interest and activism in science and engineering versus teaching science and technology. The current report is a work-in-progress and should be cited only as a draft. The main issues discussed in present research report are: (1) European policies towards gender sensitive measures in science and technology (2) Gender differences / gender equality in Europe (3) What statistics show? (4) Women in science and technology - Romanian experience; and (5) Case study for a development strategy at the University level - educational measures.

A continuing issue in Europe and in the United States is women’s under-representation in science and engineering (Lane 1997; Kohlstedt & Longino 1997; Adelman 1998). Moreover, at a time when technology seems to be playing an ever increasing role in society, there has been noticed a low interest in science, engineering, and technology. In Europe, starting from 90’s and more acute in last

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years there has been an urgent need to largely increase the number of students in science and technology and more specifically women entering science, engineering, and technology studies and to support their future careers. As Lisbon Agenda 2000 seems to indicate, Europe desperately needs more researchers to achieve scientific and technological excellence and to reach the goal of becoming the world's most competitive knowledge and dynamic knowledge economy by 2010. As women are currently under-represented in the field of scientific research or in technology, the European Commission is promoting measures specifically aimed at encouraging women to take part in European research. However, the efficiency of these measures located only at the university level is disputable, research or industry's hostile environments being mentioned as key factors affecting the retention rate of women in these fields.

With the growing awareness of the under-representation of women in the scientific community, technology and engineering, there is a real need for new policies and strategies, yet there is a debate about what and how should be proposed or imposed. The discussion topics varies between quantitative objectives like quotas or positive action as changing culture of universities, industry, research and development sectors or even positive discrimination measures. Moreover, it is argued that higher education, government and industry, should have an imperative for equal opportunities and female-friendly climate.

For the general research domain, European Commission settled in 1999 an Expert Group (ETAN 1999) on Women and Science, Science Policies in the European Union with the main aim promoting excellence through mainstreaming gender equality. Its priorities have been formulated in terms as:

- women's participation must be encouraged - supporting research by women;
- research must address women's needs - more research for women should be designed;
- research must be carried out on the gender question itself – research about women should be promoted.

Recently there has been launched the European Platform for women scientists (EPWS 2006) in order to build a structural link between women scientists and research policy makers. The aim is to introduce a new key strategic actor into the research policy debate by making the voice of women scientists heard but also linked to education,

industry and research and development. At the same time the platform aims to make women scientists better understand the role they can play in the research policy debate and how to fully benefit from these opportunities by bundling their powers and forces. The aim is also to promote the understanding of the gender issue in science as well as promoting women scientists from all disciplines. The main characteristics are:

- focus on understanding of the gender issue in science;
- open to any women doing research in any discipline taught at university level;
- especially dedicated to women scientists working in engineering and technology.

Gender differences versus gender equality in Europe

Gender might be defined as a constructed concept referring to the social differences between women and men that are learned, changeable over time and have wide variations both within and between cultures. How is perceived gender issue in relation with science and engineering in various cultures in Europe? Is it possible to generalise and to identify patterns which might be applicable for very different contexts? This is obviously a difficult issue and to differentiate between east and west seems to be as inadequate as making reductions and ignoring the specific culture of various nations within Europe. Nevertheless, in one of the next section, the Romanian experience in constructing gender and sex roles within the communist period and nowadays will be presented. Some categories in exploring gender differences in life patterns, needs, interests and opportunities are presented below to get an overview about how relevant these differences are for investigating educational policies of supporting women in science and technology. The following dimensions give an overview of the gender differences in relation with gender sensitive measures, and not necessarily with gender equality:

- rights – general human rights and access to justice; legal, political or socio-economic environment, education;
- resources - time, space, information, money, political and economic power, education and training, jobs and career, new technologies, health care etc;
- participation - target/population groups, decision-making;
- norms and values - influencing gender roles, division of labour by gender, attitudes and behaviours of women and men, inequalities in considering masculine and feminine characteristics/ patterns.

Engineering, technology and science can be considered gendered at least in three ways. First, gendered structures are visible in gender difference in the division of labour and in the work styles of women and men in all these domains. Second, the symbols and images of engineering and science knowledge and practice are gendered through cultural associations between masculinity and technology. And third, individual scientists and engineers have gendered personal and professional identities and experiences (Harding 1986; Faulkner 2000).

Central to stereotyping engineering or science is the explanation of cause-effect, a perception that has been called in the literature “binary thinking” or the “hard-soft” dualism (Faulkner 2000). Stereotypical images of science and technology seems to have obvious connotations with the masculine sides of dualisms such as hard - soft, abstract - concrete, people-centred - technology-centred, mind - body, rationality - emotionality.

Engineering study is considered a more gender-segmented field than any of the natural sciences. As Adelman (1998:61) argues: „One of the problems in the traditional literature is that the analysis of sex differentials and inequality in scientific careers is grounded in the sociology of academic science, not the practice of engineering”. It is argued that the culture of engineering is more a culture of industry and then it is reasonable to assume that when the experience of women in industries where they are a distinct minority seeps down to undergraduates, then women's low representation or even migration from engineering programs is not surprising anymore. Women engineering students seem to be more successful in classrooms than in the laboratory (McIlwe and Robinson 1992, cf. Adelman1998) and moreover, it is argued (Felder et al. 1995 cf. Adelman 1998) within the small cooperative working groups their work and contributions seem to be undervalued.

Choosing engineering path might be problematic nowadays in Romania, as statistical data and our interviews showed. Neither women nor men will choose engineering – except maybe those having the right models of what is a real engineer - for the right reasons unless universities can reach out to potential students and society as a whole, with an elaborated and drastically changed portrait of a new culture and practices associated with it. In these conditions this might be the only real reason for attracting more prospective students. Technical studies and careers should be presented and perceived as describing an ”object world” or a “social world” of engineering (Bucciarelli & Kuhn 1997) and then it should be clear that women belong

to this reality. An important point to consider before looking at the barriers women face in science and engineering disciplines is the argument that women know they are not welcome in these disciplines and therefore do not pursue a career in where they are not welcomed. This is what mentioned as identification between masculinity and technology as the main reason for this lack of interest for engineering professions (Faulkner 2000).

Jonsson (1999) is exploring sex segregation with regard to choice of type of education, or educational programme. In order to explain this phenomenon, the author is proposing a rational choice model in which sex-specific comparative advantages in different fields of study are in focus. Such relative advantages in sex-typical areas of study are hypothesized to influence educational choices through their effects on the expected probabilities of success in different study programmes. As a conclusion, confirming Jonsson's hypothesis it can be stated that sex segregation depends on the projection of future success for both sexes. Boys seem to be relatively advantaged in male-typical field of study (like engineering and natural sciences) and vice versa girls' expectations to be successful will determine their choices for fields of education and occupations socially constructed as female-friendly.

Of course encouraging as many students male and female, as possible to engineering or science fields is a desire for many institutions or national education policies but it should be accepted that ultimately individuals have to choose their field of interest, and in many regards forcing this issue by positive discrimination might be a problem. It is true that one can encourage but ultimately individuals have to choose.

As stated already various measures have been promoted in Europe both at the level of policies and practices. Different scientific projects across Europe are focussing on strategies to overcome low representation of women in some areas like science, technology and engineering.

Analysing only two of these projects WomEng - Creating Culture of Success for Women Engineers and ENWISE – Gender Equality in a Wider Europe - Women Scientists in the Central and Eastern European countries and the Baltic States, the present paper is investigating in the empirical section, how the envisaged recommendations or policies designed for academic sphere or universities are received in a specific institution in Eastern Europe, more precise in Romania.

The first project *WomEng* has been designed to compare training degrees in engineering in Europe; analyze professional positions of women engineers; evaluate the process of recruitment of women engineers; and investigate existing innovations which make engineering training desirable for females. Indeed, it was searching for strategies related to question “What should be done for enhancing the number of women in engineering studies and professions?”.

The *Envisé* project addressing mainly the issue of women scientists in the Central and Eastern European countries and the Baltic States was oriented towards identifying existing and relevant statistical data for Eastern Europe and designing recommendations for increasing women’s participation in European Community programmes.

Getting insight the reports of these projects it is obviously there is still a gap between the western countries and the ex-communist ones. Even it is not yet acknowledged there are significant differences, not only in numbers but in mentalities, opportunities or generally speaking in socio-economic contexts.

Western countries are constantly proposing measures to increase and support women participation whereas, sometimes in central and eastern Europe there might be differentiated two extreme stances: from no concern to this issue of female in science, technology and engineering (due to the high representation and support of women during the communist period) to an exaggerated attitude sometimes blaming the values of democracy who brought major problems in relation with unemployment, wages or socio-economic conditions for women.

The recently launched European platform for women scientists already mentioned seems to have only one female representative from Eastern Europe. It might be only a fact but meanwhile it seems to be a trend in associating the unproblematic and so called high representation of women in eastern countries as a fact which automatically gives perspective for future and better employment.

Next section is bringing into discussion statistical data illustrating the quantitative differences between east and west.

What statistics show?

Two different analysis are presented: percentages of woman graduates, in tertiary education (2001-2003) and proportion of female PhD graduates (2003) using OECD (2006) and European Commission (2006) data.

Figure 1 Evolution of female graduates distributions - ISCED 5A – W Europe

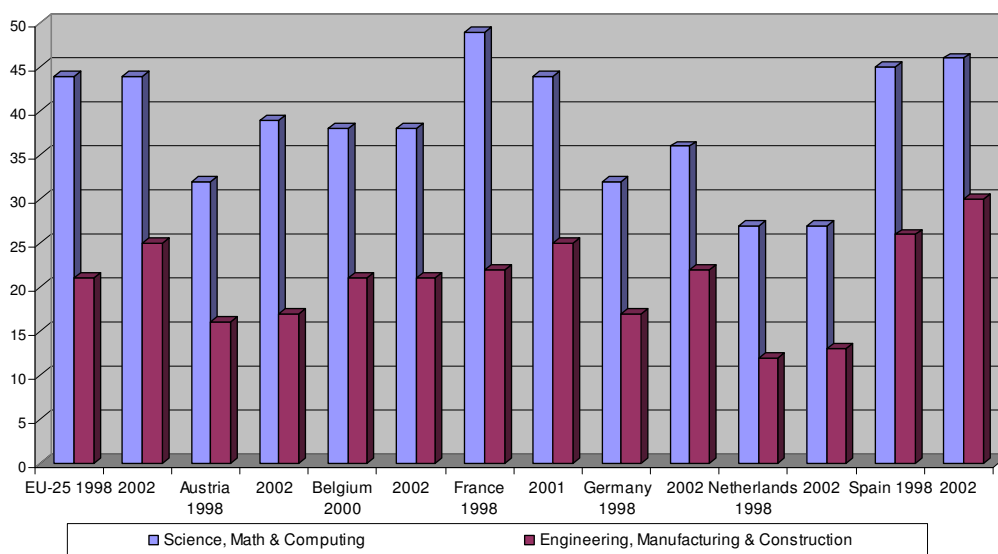
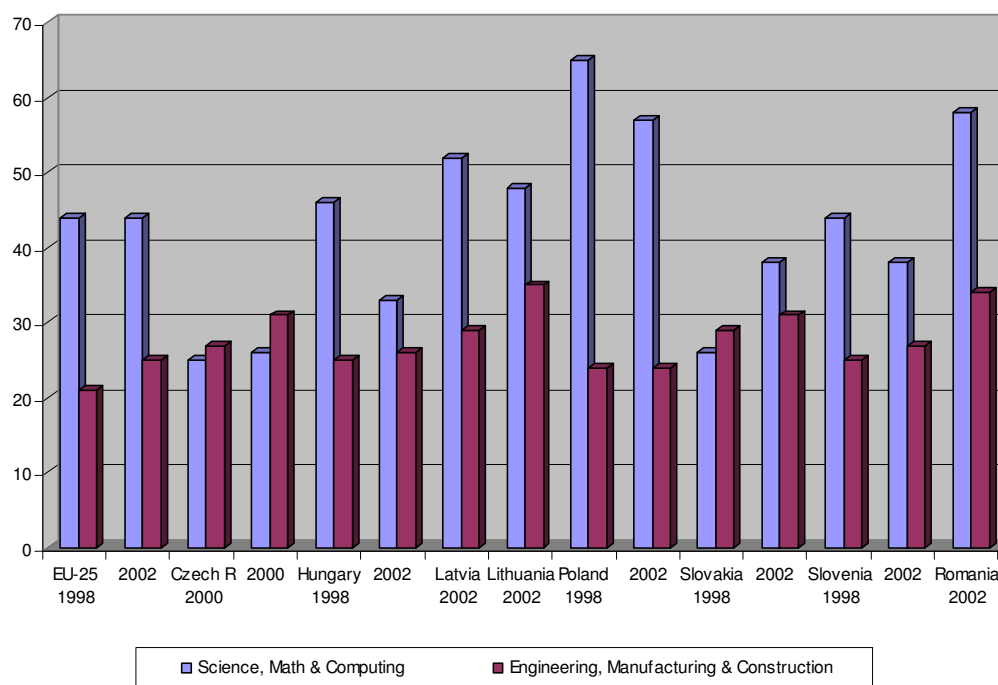


Figure 2 Evolution of female graduates distributions - ISCED 5A – CE Europe



In the table 1 the percentages of women graduating the tertiary-type A programmes in some countries in Europe are presented (ISCED 5A). These types of educations (not necessarily only universities but also post-secondary school institutions) are largely theory-based and are designed to provide sufficient qualifications for entry to advanced research programmes and professions with high skill requirements (OECD 2006).

Table 1 Percentages of woman graduates, ISCED 5A
Tertiary education - Eurostat Education Statistics (OECD 2006)

Area of study	Science, Math & Computing	Engineering, Manufacturing & Construction
Country	Women %	Women %
EU-25 1998	44	21
EU-25 2002	44	25
Austria 1998	32	16
Austria 2002	39	17
Belgium 2000	38	21
Belgium 2002	38	21
Czech Republic 2000	25	27
Czech Republic 2000	26	31
France 1998	49	22
France 2001	44	25
Germany 1998	32	17
Germany 2002	36	22
Hungary 1998	46	25
Hungary 2002	33	26
Latvia 2002	52	29
Lithuania 2002	48	35
Netherlands 1998	27	12
Netherlands 2002	27	13
Poland 1998	65	24
Poland 2002	57	24
Slovakia 1998	26	29
Slovakia 2002	38	31
Slovenia 1998	44	25
Slovenia 2002	38	27
Romania 2002	58	34

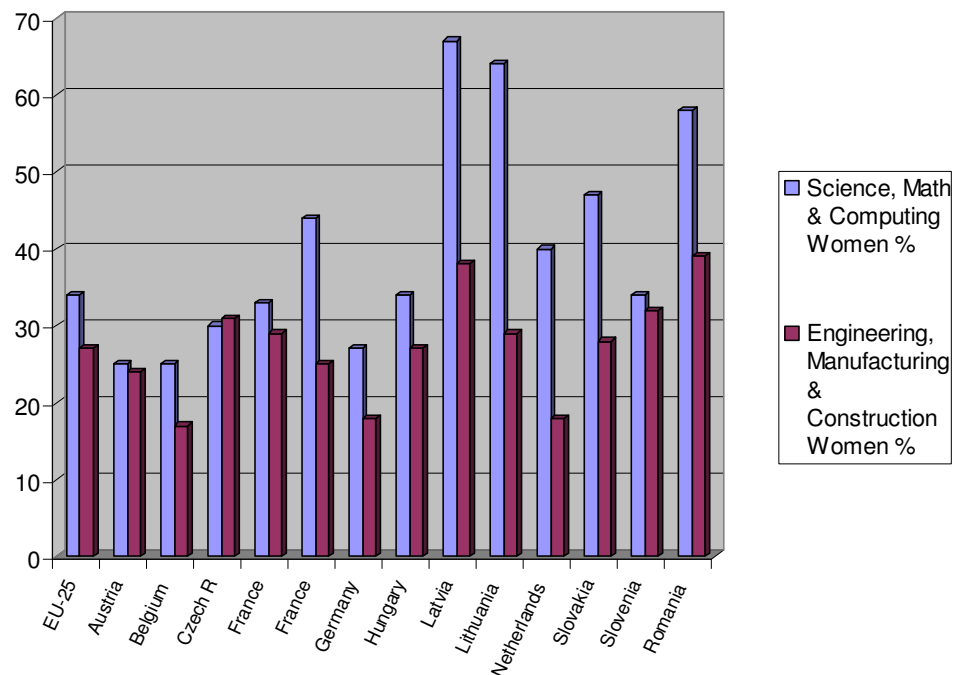
The statistical data shows that women remain still a minority among western graduates in engineering, manufacturing and constructions; nevertheless a slight increase of 3% at the EU (25) has been noticed. Comparing with the Western Europe (figure 1), the data representing the situation the east (figure 2) show better circumstances; the percentage of women are higher and there is also a trend to increase these percentages of female graduates at the ISCED 5A level.

While all of these indicate a continued positive trend overall, the situation that women remain underrepresented in science, technology and engineering jobs or especially in leading position (European Commission 2006).

Table 2 Proportion of female PhD graduates in 2003
Based on Eurostat Education Statistics (European Commission 2006)

Area of study	Science, Math & Computing	Engineering, Manufacturing & Construction
Country	Women %	Women %
EU-25	34	27
Austria	25	24
Belgium	25	17
Czech Republic	30	31
France	33	29
France	44	25
Germany	27	18
Hungary	34	27
Latvia	67	38
Lithuania	64	29
Netherlands	40	18
Slovakia	47	28
Slovenia	34	32
Romania 2002	58	39

Figure 3 Evolution of proportion of female PhD graduates in 2003



An interesting perspective is represented by female PhD students' rate. As we show in table 2, there are again differences but situation seems to be improved at least in the fields of Engineering, Manufacturing and Constructions.

Women in science and technology - Romanian experience

During the communist period and in almost all the states assuming such an ideology, including Romania, it has been stated as a priority to get women into technical higher education and later on to employ them in technical professions as engineers or researchers. In terms of quantity (as a quota) it has been successful, but what about the quality like advancement policies, payment, and prestige or with how much effort and what kind of support?

More or less, the so called “eastern communist mentality” regarding women’s involvement not only in science or technology but as fully employees, can be described, in a context where everything was an imperative, by inculcated values that women are able succeed, so there should be given the chance. There has been also a support offered to women (childcare facilities and sometimes flexible study or work schedules) but still, women were responsible for the household. Women in western societies have been, and maybe still are underrepresented in science and technology for the major reason that only few women were given the training or opportunity and also because there has not been an urge to pursue such a career, or just to be the second breadwinner in a family. Then it is invoked the society who has not empower women in west meanwhile in east to be a women employed has been perceived as an urge and in science and technology a real demand.

When speaking about differences there should be discussed some dilemmas, not necessarily comparing east vs. west; more important is the process of understanding the cultural differences and thus the mentality and socio-economic characteristics in east and more accurate, connecting the two different periods: communism and transition and evoking their impact on society. The two questions we pose in the present discussion which will be illustrated with the specific features of the Romanian reality are: (1) Are there any stereotypical images of the Eastern European women? and (2) Are the women in these contexts aware of their position, existing gender differences, or gender sensitive issues in their societies? An eloquent picture of contradictions and paradoxes is expressed using the antithesis between the apparently independence and professional activities of women and the relatively conservative gender patterns which are still dominating the Romanian mentality. These are relevant when considering the everyday struggles of women in science and technology, not only in Romania, but we should be aware of the specific meanings of concepts like representation, involvement, activism, shared responsibilities or even feminism in

post-communist contexts; they have not the same meanings and sometimes these differences are not very well known in western societies.

In understanding Romanian context we will locate the analysis in two periods: the communist era between 1945 and 1989 and the transition period of more than 15 years and the so-called “wild capitalism”. There are few steps and phases which should be pictured as indicating the legacy of the communist past, namely the low industrial development before 1945; the great emphasis of transforming society when all people, regardless sex and race, were considered equal politically, economically and socially. All those capable of working in the paid labour market should work, and women explicitly should work in order to pursue the aim of social transformation which was active participation of all on the labour market. The aim of industrialization was providing workers with better living standards, building industrial colossi as well as small industrial enterprises which not always were profitable, providing free, education and the possibility/ obligation to take a designed job/position associated with future rewards (getting on the lists for obtaining an apartment or buying a car). Of course, there have been significant privileges for people belonging to communist nomenclature, including those in research and industry having not only access to Eastern publications/ conferences/ stages but also to Western research arena.

The shift of the transition brought the emergence of new contradictory statuses and roles for all people and sometimes women had more difficulties to assume the adaptation for these transformations. Rebuilding of democratic system, and reshaping the values and norms have been also difficult tasks of Romanian society. Transition to market oriented economies created sometimes unexpected problems for people who were not prepared for assuming active roles, relying as before, only on state support. These problems are mainly connected to no stable jobs, concurrency, unemployment, as a consequences various phenomena occurred: poverty, aging, decreasing fertility rate, brain drain. There have been and still are problems in reshaping institutions; the “institutional vacuum” should be addressed and it requires radical attitudes, responsibilities and skills having to be learned. Of course, there have proposed policies like promoting equal opportunities, anti-discrimination measures and so one; nevertheless their effects are still expected. One can ask the question how has been changed the reality for women during the transition period. Two levels should be mentioned here: changes regarding the roles of women as paid workers / mothers

(reshaping the career-family balance) and new opportunities for women as social, civil and political actors.

There are no uniform paths regarding these two aspects and unfortunately still there is no coherent public mainstream discourse in terms of gender impact; but a dominance of former attitudes and mentalities at the societal level.

Method and Data

The present paper is reporting, as an exploratory study, the partial results of the qualitative data analysis in relation with changing organizational culture of one University in Romania towards a more sensitive environment for empowering women in science, technology and engineering. The main focus was on two type of directions:

- Engineering faculties: (1) Electrotechnic and Informatics; (2) Energetic Engineering; (3) Management and Technological Engineering;
- Natural sciences: (1) Mathematics and Computing; (2) Physics; (3) Chemistry.

Having in mind the theoretical considerations about science and technology at the EU level and in the literature, like “the research agenda” for “making gender stick to engineers” (Faulkner 2000:109-111) and extended to science and technology as well; and the results of the two already mentioned projects *WomEng* and *Enviser*, we proposed a research design to investigate how valid are the measures and directions of these studies for a specific educational higher education institution.

There have been proposed the following methods:

1. Interviews with 10 respondents employed at the university: 2 in high administrative positions (one male and one female professor); 4 female engineers (1 assistant professor, 1 junior lecturer, 1 senior lecturer and 1 professor) and 4 female students (2 from natural sciences and 2 from engineering).
2. Two focus groups interviews with women: the first one gathering 6 academics (2 assistant, 2 lectures, and 2 professors) and the second one consisting of 8 students.

The interviews have been oriented towards the following dimensions:

1. Women and science, technology and engineering at the national, European level;
2. University policy regarding gender issues;
3. Institutional development.

Specific issues discussed were also recruitment policies, career chances for graduates, adjusting education fields and labour market, teacher training strategies and the partnership between schools – university – industry - research.

The focus groups have been organised as follow: in advanced, the participants receiving a two-page document about the major findings of the two mentioned projects, in relation, of course with university.

The structure of discourse, both in interviews and focus groups, reveals not very different patterns with respect to equal opportunities for male/female students or academic staff. The major problems mentioned by almost all interviewees were located at the industry or research domains where the labour market seems to be weak and unable to absorb the trained labour forces, especially not being flexible towards women.

National and European policies related to gender issues: gender mainstreaming or gender watch system is unknown in proportion of 90% of respondents. As people stated, there are not enough opportunities for informing or getting in research projects (especially on gender policies) at the European level, and for the national competition still this issue is not very important.

“Students benefit from <no discrimination> policy” as an academic staff member declares; no examples of problems regarding any gender related issue were possible to be revealed in focus groups or interviews. In science, more and more students are female (60-70%), as they are preparing for possible teaching careers, and having chances for a future job in research and development or industry for these graduates are rather low. The real problem in natural sciences like physics or chemistry is that not enough students are interested anymore in such careers. In engineering faculties the situation is better, they have more prospective students but the female one represents around 35-40% in some faculties, while in some specialisation like Robotics or Technology of Machine Building or Engine Engineering is very low (0-10%) .

As students argued, the curriculum is not differentiated nor gender sensitive, but still optional social subjects like marketing, law, communication theory, sociology or teacher training module, are followed by more female students from engineering and technology faculties. The female students are keen to have the possibility to study gender related subjects, having yet no opportunity to enrol in such courses. As academic staff declared, there are no specialists dealing with this gender – technology - society issue at the university, but it might be an interesting direction for research.

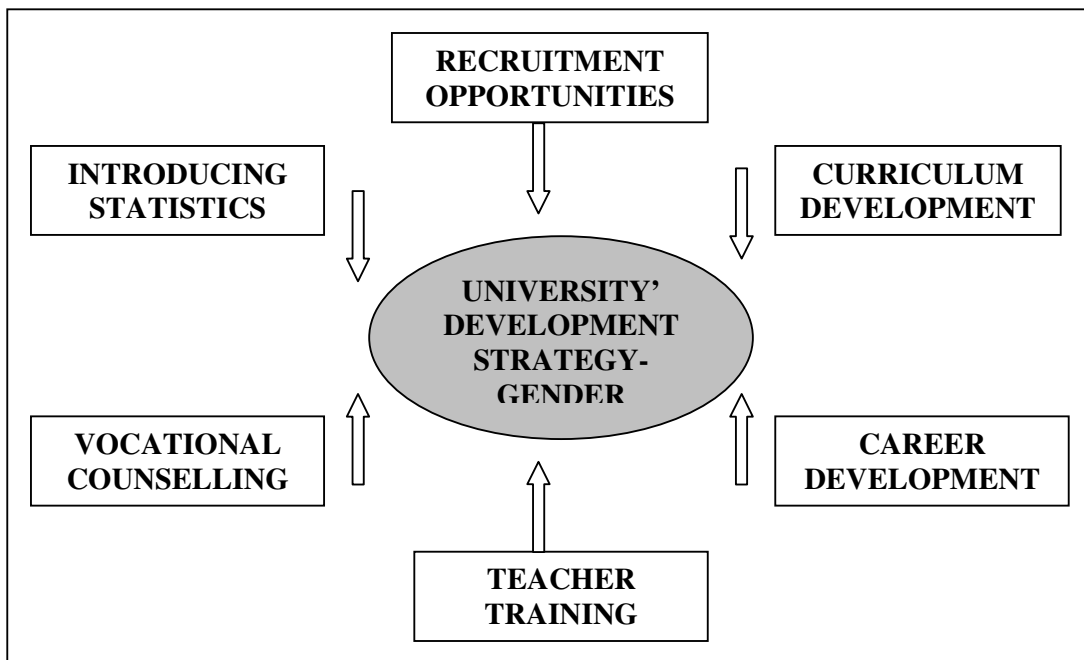
As, a conclusion, the main themes which can be summarized are related to:

- Research - more opportunities for research projects;

- Teaching - gender sensitive curriculum;
- Employment - more career counselling and more chances on the labour market;
- University culture - developing a strategy for a sensitive environment.

It has been agreed that an initiative group on gender issues should be settled based on the voluntary bases, and following the research study a strategy should be followed. In figure 4 are presented the main areas of intervention. These dimensions will be future elaborated, and will be part of the final scientific report.

Figure 4 Planned strategies for university development in relation with gender issue



Conclusions reflections

Recent developments in the European area - related with democratization, citizenship, employment and equal opportunities - made participation and activism both in education and at the workplace an important area of research. Western European countries, as well as Eastern post-socialist nations are complaining of a low representation of women in some areas like science, technology and politics. Across Europe, various measures are focusing on encouraging women in science and technology, and sometimes the differences between east and west are not considered. The prevalent research topics and expected impacts of these measures have been investigated as a departure point in the present paper. In the theoretical section, various models in investigating the study and career path of women in science and

technology are presented (Adelman 1998; Jonsson 1999, Faulkner 2000). To illustrate different patterns between east and west, quantitative analysis based on the ISCED (International Standard Classification of Education) database are presented showing differences on female students' representation in science and engineering at the university level. The relevance of some interesting results of the European project "WomEng" (Creating Culture of Success for Women Engineering) is investigated in relation with the Romanian situation in this field, in the context of dissemination and valorisation. Based on qualitative methods, interviews and focus groups, several educational strategies for enforcing and empowering women, students and teaching staff, are presented contextualised for a university in the Romanian socio-economic context. Study and work in engineering and natural sciences shows not so highly gender-segmented fields at the level of higher education, but later in professional career there are more barriers for women entering these fields. The issue of diversity and gender sensitive policy in education and employment is not about engineering and / or science only; not about women only and not to be solved by women only. That's why a strategy – at least in university should follow the dimensions: statistics data in reporting gender related issues; improving recruitment opportunities; curriculum development; vocational counselling; career development and teacher training.

Notes

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