

How to influence gender stereotypes - Increase attractiveness of engineering

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INTRODUCTION

In different European Commission projects horizontal gender segregation has been found, resulting in a low number of female students in engineering in most of the European countries. Enduring gender and engineering stereotypes with sets of dualism influence our thinking fundamentally like: People versus technology, soft versus hard technology, concrete versus abstract approaches, body versus mind. Those gendered dichotomies with soft characteristics defined as female can be seen as central to Western culture and economy. In engineering the stereotypes of male competence and female distance to technology are created through socialisation and construction and persistence of gender roles in puberty. As outcome the absence of technical confidence or competence does indeed become part of feminine gender identity, as well as being a sexual stereotype [1].

She-Figures show the numbers of women in science and engineering declines from one level to the next. Women account for only 31 % of the student population at the first level. In contrast with what was observed for all fields of study taken together, the proportion of women increases throughout the first hierarchical echelons to reach 38 % at the level of PhD students and 35 % at the level of PhD graduates. In terms of career progression, in science and engineering, the attrition of women increases at post-PhD level and improvement over time is small and slow. It is, therefore, not surprising that in the fields of engineering only 7.9% of women hold full professorships [2].

The thesis of this paper is that gender stereotypes in society which are reflected in engineering degree courses can explain this gender segregation, and, that foremost interdisciplinary and single sex elements in degree courses can change the image and culture of engineering in higher education. Furthermore the image can be influenced by youth media, teachers, school books, innovative division of labor in families and divers initiatives for young people. The paper will summarize and discuss the results from different European projects about measures to increase gender equality in engineering degree courses.

1 STATE OF THE ART

A big amount of relevant research literature has shown that what drives women away from technology are not women's deficits in abstract thinking, etc. but the content and climate prevalent in technical institutions, which construct an atmosphere of "dominant masculinity"[3]. Nevertheless most initiatives to make engineering degree courses more attractive for girls focus on individual girls and not on curricula, climate and masculine organisational culture [4]. In a former paper a WEPAN Policy Climate

Survey was referred which found out that engineering students' perceptions of the educational climate at colleges and universities can explain the higher dropout rates of women engineering students. This study has shown that throughout their academic career women never catch up with their male colleagues as far as academic self-confidence is concerned. While this study came to the result that men are less affected by poor teaching, poor organisation of course material and by dull course content than women Wolframs study about engineering students in Germany found that male and female students see it the same [5]. This study pointed to non-technical subjects as contextualising ones and ones that prepare for professional practise like communicating and team competencies.

Interdisciplinary curricula [6] introduces more complexity and contextualisation in engineering degree courses and this focus of interdisciplinary in transforming engineering degree courses will attract more women students. If the non-technical contents meet the interests of female students they have the possibility to study engineering in greater contexts and so broaden their horizon of technology, and by this way the gender gap in engineering can be decreased. With subjects like technological sociology, psychology of group dynamics and conflicts, technology politics and ethics, cultural and gender studies for example students develop the potential to analyse and solve complex problems with a wider horizon and by this way hopefully encouraging students to cross their 'disciplines' borders and work co-operatively. On the other hand those non-technical elements further perhaps so called soft skills e.g. in communication and languages, fields which are necessary for engineering practise. Gender studies may contribute to a better awareness of discriminating situations and structures and this perspective can help against individualisation of study problems. So, interdisciplinary in this way could help to get a critical standpoint to technology learning about social and gender biases.

Single sex education could deconstruct gender differences. Furthermore instead of reproducing different stereotyped characteristics of female and male students those differences between female students are allowed to become visible. Another argument for single sex education in male dominated degree courses is that female students get more self-confidence by being taught in single sex contexts. Several studies have shown that women engineers have been succeeded over representatively from girls' schools [7]. Because of the crucial self-confidence for a successful career in a male dominated world, one can expect that single sex can help to overcome the inner and outer barriers. In Germany the discussion about the effects and acceptance of women only universities is controversial. Kahlert and Mischau [8] found about German institutions of higher education that a broad acceptance of mono-educative women's university exists under certain conditions. At the same time others think that single sex education will foster gender stereotypes and effect 'doing gender' and co-education will have more probably the effect of 'undoing gender'. The main contra argument of self-stigmatising by separated educational rooms for women does not fit in every culture and nation because in countries like the US or South Korea women colleges are accepted and flourishing.

2 INTERDISCIPLINARY AND SINGLE SEX DEGREE COURSES

Statistics about choices of degree courses in the project INDECS have shown that – without Slovakia with a special post-communist situation – in every partner country gender segregation exists, with women prevalent in language and cultural studies, and men prevalent in natural and even more so in engineering studies. We found that engineering could become more attractive for young women - measured by the number of female students - if curricula would include more interdisciplinary non-technical subjects and if the pedagogy would include some single sex education,

especially in the beginning of degree courses. Industrial engineering is an interdisciplinary degree course which has to integrate a large percentage of human and social sciences because it deals with technical problems, economic problems, management problems and human problems as well.

Experiments with single sex degree course in engineering existed at the time of the common European projects only in Germany. Therefore in INDECS and Womeng project two different universities of applied sciences – one from Western (University of Applied Sciences, Wilhelmshaven¹), one from Eastern part of Germany (University of Applied Sciences in Stralsund) was included to study the organisational culture there.

Non-scientific subjects represent at least 35% of the curriculum in these single sex degree courses. Moreover project work, small groups and special preparations for industrial placements are normal parts of the model degree course, too. Self-organised learning and teaching and interdisciplinary team competence are practised. Besides programs are running to recruit and attract more women for engineering and technique (mentoring, summer university, special information offers for girls and women). Compared to the single sex degree course at the University of Applied Sciences, Wilhelmshaven, the co-educational degree course industrial engineering focus civil engineering at the Technical University of Braunschweig without changing teaching methods and the masculinity culture of engineering showed a great drop out of female students of nearly 40% after the first two semesters [4].

Resistance to change of the culture by interdisciplinary comes from representatives from universities with traditional degree courses. Barriers were seen in full schedules for students with technical subjects, which all seemed to be necessary. So there was seen hardly any space for non-technical subjects. Even so employers seem to be open minded and wish new concepts of engineering in practise of their companies, higher education staff seem to hesitate to change the status quo.

Self-assurance as a prominent factor for female success in engineering studies is seen by most of the faculty. Staff members of one investigated single sex degree course stated the opinion that single sex teaching increases self-esteem and self-confidence of female students. On the other hand most students and faculty of co-educational engineering institutions are claiming that single sex classes represent an artificial world and women who want to study engineering must have self-confidence right from the start. Against institutionalisation of single sex elements and more against women's universities principle prejudices of universities representatives at management level seem to be the most prominent barrier. Moreover, from the European perspective, in France and UK exists no actual positive discussion of single sex education. Elite single sex institutions have been closed, arguing from outside these women's colleges that these institutions have been seen as less qualitative, with less money and equipment.

3 CHANGING THE MASCULINE CULTURE OF ENGINEERING

Because, in higher education of engineering, two central elements in fighting against gender and engineering stereotypes weakening gender segregation and masculine culture in engineering are interdisciplinary and single sex education, this was again one focus in Womeng project.

¹ From the beginning 1997 this model degree course was supported by the ministry and strongly promoted by industry, especially Volkswagen and Telekom. So there was an acceptance with good career possibilities for the graduates. The co-educative degree course was founded much earlier, but it was evaluated and changed in 1997, too.

Interviews with female students in Germany, France, Austria, and Slovakia demonstrated that they perceive the contents of their engineering studies as male-dominated. From quantitative questionnaire results, we found that non-engineering subjects would be preferred by more than one third of the engineering students and more than one quarter of the non-engineering students say that they would have chosen an engineering degree course if more subjects from human and social sciences were included. Especially female students in Austria and Greece, who feel more discriminated than females from other partner countries, would prefer more non-technical subjects in comparison to students from other partner countries. Out of the non-technical subjects, languages are preferred with over 50.0% agreement in all countries, followed by “soft skills” as team work and communication abilities.

The results show that in academia, female staff and students see the image of engineering mostly as masculine and websites reflect this overall impression. Engineering in universities is a male domain with both open and more subtle kinds of discrimination, combined with traditional or changing masculinities of organisational cultures which determine coping strategies by female students demonstrating more or less self-assurance. Looking for possible changes, the resistances of most engineering faculty interviewed are the same than in the project earlier. They believe that interdisciplinary subjects cannot be included and institutionalised because of the full schedules and the loss of indispensable technical subjects. Pedagogical-didactical methods are one other factor for the study culture for students. Female students prefer well-coordinated curricula, more non-technical subjects, and projects as well as group-oriented teaching methods. In interviews with female students, lectures are mostly criticised as boring without enough practical links. In summary Sagebiel/Dahmen found that three factors which make for the lower number of female students: the masculine definition of engineering together with the male image and less information about the profession [9].

4 GENDER STEREOTYPES IN SOCIETY AS FACTOR FOR GENDER BIAS IN ENGINEERING IN ENGINEERING RESEARCH

The project PROMETEA offered the opportunity to further investigate questions of masculinities and organisational cultures in women’s engineering careers, focusing on areas of research in academic, governmental, and industrial organisations. Gender stereotypes were found nearly everywhere, but the most extreme positions and traditional attitudes about women’s and men’s stereotyped characteristics and differences engineers had shown in the same countries where a very traditional role and labour division existed. All stereotypes define men as predominant and more apt for leadership roles.

Strong traditional stereotypes exist in Lithuania, where men’s thinking is determined by traditional gender dichotomies. Men engineers believe they are more self-confident and therefore naturally occupy highest positions. Lithuanian women in a focus group agreed that men are more qualified as leader: “*Men are rough, have more features characteristic to leaders*” or another statement: “*Women’s qualification not always is suitable for occupying the highest positions*”. Similar attitudes were stated by Russian women in engineering. As result men are sure that it is more difficult for a woman to carry out the practical part of a research like working with techniques for instance metal or machinery.

These gender stereotypes are stated more frankly by Eastern European countries, but this does not mean that the situation for female engineers is much better in the Western European countries. The difference is that there it is not any more political correct to speak about those prejudices. The results show that still existing gender

stereotypes together with a low gender awareness biased research in engineering and this went along with gendered division of labour in SET organizations which reflect gendered division of labour in the European societies at large [10].

5 YOUTH MEDIA, SCHOOL CONDITIONS AND INITIATIVES AS FACTORS FOR CHANGE OF MASCULINE IMAGE OF ENGINEERING

“Recent studies show that structural and life-course factors play a major role, both in terms of educational achievement and study field choices. Differences are less pronounced in integrated educational systems and in more gender equal societies” [11]. From different hypotheses about development of gender stereotypes in MOTIVATION project the influence of gendered socialisation (e.g. by teachers, peer groups, family), youth media, and initiatives to attract girls for SET were studied. The focus has been on measures to change gender stereotypes with factors outside the higher education system.

Pupils' images of SET persons are still very stereotypical, despite the increased numbers of women SET persons there are in society. In all countries the image of SET is sometimes positive, e.g. pupils find it interesting as subject or hobby, but they don't want to go for a career, because it is 'not fun', 'not about people' and 'monotonous'. What they do consider SET jobs to be about is about 'earning money', 'getting opportunities' and it is 'for/with men' [12]. A lack of visible female SET role models also explains why pupils hardly ever draw a woman SET person. If they draw a woman engineer or scientist they indicate that this is a drawing of a specific person they know, 'their teacher' for example. An attractive curriculum can contribute in stimulating the interest in SET. For pupils, the influence of teachers is huge. They serve as role models for SET jobs. Teachers' training is necessary especially for arising gender awareness and further their pedagogy. It seems that pupils with a traditional labour division in family will make more traditional choices of degree courses. The father is by far most often considered the most competent SET person in the household with Slovakia as the biggest exception. Family relations seem to be mostly traditional in all partner countries of MOTIVATION project.

From the analysis of results it is clear: Female SET related role models should be created to reduce gender stereotypes. Second, knowledge about SET seems a prior condition for taking in account to study an engineering degree course. Results show for media that more diverse and realistic job images should be integrated in youth media like magazines and soap operas. To change the situation editors and producers should look for industries' and universities' support. Essential is that they meet the teenagers' interests in SET presentation as relevant topics for the audience. In almost all European countries, regulations or laws do pay attention to gender issues in school books, in fact, it is not taken into account everywhere. The challenge would be to have an attractive presentation of sciences (including maths) in context, with an attention to gender and without abandoning the substance of the scientific contents. For vocational education, the issues would be a more gender-balanced representation of sciences which would imply a gender-neutral representation of professions. German national wide established Girls' Day is a one-day activity for girls that offers insight into job fields where women are still underrepresented with the aim of weakening gender stereotypes in job decisions. For appealing young people to SET they initiatives to promote SET choices by girls should start at an early age and organizers should ensure safe funding for years ahead including funding for evaluation. Late teenagers may demand other kinds of activities like creating inventions, for example visiting and working in academic SET environment, and/or having mentors. Cooperation and networking between initiatives/ projects and academic/ non-academic institutions and companies would improve success in the

long run.

6 CONCLUSIONS

Interdisciplinary and single sex education, even though most promising measures to get more women to start and retain in engineering, meet several problems with institutionalisation because staff in engineering degree courses are against those innovation even though industry would appreciate those changes. Unless the changes are institutionalised and incorporated in the normal academic organisation, they will depend on the presence of the promoting individuals and the culture would not change to a less masculine one.

INDECS and Womeng project results which were based on qualitative and quantitative data found similar hindrances against changing the masculine culture in SET, hostile attitudes against interdisciplinary and single sex education. PROMETEA showed that engineering research cultures are gendered too. Polarisation between engineering/non engineering have to be broken. The influence of peer groups on female attitudes towards natural sciences, maths and technology which are to pretend that they dislike these fields as they seem to be male terrains has been demonstrated by MOTIVATION project. So girls learn to adopt to what they think is the prevalent female image and to avoid deviant behaviours from these images.

The masculine atmosphere is blamed to hinder women from retaining and finishing their engineering study or to feel not “at home”, leaving after the exams making no efforts for a planned career in the field. So it is not the “hard” science subject which explains withdrawal of female students – they normally succeed in these subjects likewise as male students, but the felt women excluding atmosphere. If traditional engineering degree courses out of many reasons are constructed as a male and masculine world, efforts for change must start at deconstructing masculine organisational culture. Women’s ‘invisibility’ within engineering, not only because of their absence as staff and students but also in terms of any recognition of their contribution to the history of technology must be changed for providing a suitable study environment at higher education institutions.

To overcome gender stereotypes from a theoretical point of view, one has to combine a perspective of gender differences, differences between women, and at the same time the construction of gender differences in a two-gender-constructed society. The construction of masculinity can be seen in parallel way. Even though reality has changed both in gender and engineering the stereotypes are still alive and they are still influential as most women do not choose engineering as degree courses so long as it seems to be unchanged a men’s field. Research work on gender of and in engineering has to address the interactions between gender identity, symbols and structures and thus try to destabilise the equitation of masculinity and engineering [13].

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